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Article

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O. Saliaj, A. Mesiti & A. Mullaj

Acalypha australis (*Euphorbiaceae*), a new alien species in the urban areas of Tirana (Albania)

Abstract

Saliaj, O., Mesiti, A. & Mullaj, a.: *Acalypha australis* (*Euphorbiaceae*), a new alien species in the urban areas of Tirana (Albania). — Fl. Medit. 34: 5-11. 2024. — ISSN: 1120-4052 printed, 2240-4538 online.

The flora of Albania, in relation to its surface, is one of the richest in Europe. Currently, it includes more than 3629 species; 230 species belonging to 58 different families have been documented as alien species in Albania. *Acalypha* is the fourth largest genus of the *Euphorbiaceae* with approximately 450-570 species. *Acalypha australis* found recently in Albania, represents not only a new alien species for the Albania flora, but also a new genus (*Acalypha*). *A. australis* is native to the Russian Far East, China, Japan, and the Philippines and naturalized in Australia and other regions in Eurasia, including the Caucasus, Ukraine, Italy, Armenia, and Turkey. In Albania, *A. australis* was found in the city of Tirana with a small number of individuals (one or two), on third November 2022. In 2023 the species has reproduced successfully and is forming large populations in the new urban ecosystem, becoming potentially invasive in the next years.

Key words: xenophytes, alien flora, urban flora, biogeography.

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Introduction

Alien species have been introduced intentionally or unintentionally for centuries. The alien flora of Albania is rather poorly documented. Until the middle of the 19th century, no floristic records containing alien species have been published for Albania, new alien species were reported during the communist era, but most of them had probably arrived earlier and were just detected in that period (Barina & al. 2013). The spread of invasive alien species (IAS) is now recognized as one of the greatest threats to the ecological and economic well-being of the planet. These species are causing enormous damage to biodiversity and the valuable natural agricultural systems upon which we depend (IUCN 2000). As in other parts of the world, a large number of alien species have been introduced in Albania (Mullaj & al. 2007).

According to Barina & al. (2013), 230 species belonging to 58 different families have been documented as alien species in Albania, mostly part of *Onagraceae*, *Plantaginaceae* and *Polygonaceae*.

Acalypha australis L., found recently in Albania, represents a new alien species for this country. The flora of Albania, in relation to its surface, is one of the richest in Europe. In the published editions of "Flora of Albania" (1988-2000) 3250 specie are included (Paparisto & al. 1988; Qosja & al. 1992; Qosja & al. 1996; Vangjeli & al. 2000), but from that time till nowadays, a large number of new taxa have been reported (Meço & Mullaj 2015; Nobis & al. 2018).

Euphorbiaceae in the flora of Albania includes only four genera (*Chrozophora* Neck. ex A. Juss., *Euphorbia* L., *Mercurialis* L., and *Ricinus* L.) (Qosja & al. 1992), consequently the new species *Acalypha australis* L. represents not only a new alien species for Albania, but also a new genus.

Acalypha L. is the fourth largest genus of the *Euphorbiaceae* with approximately 450-570 species in the world. Several *Acalypha* species are used as medicinal plants in Africa and in the Mascarene Islands (Seebaluck & al. 2015). The genus is distributed mainly in the tropics and subtropics, with about 60% of species native to the Americas and about 30% in Africa (Duman & Terzioglu 2009).

Acalypha australis, is a weed of gardens, roadways, and waste places (Ohwi 1984; Delendick 1990; AgroAtlas 2010), but seems to be even more harmful in row crops (AgroAtlas 2010). It causes economic losses in cotton, melons, pulses, root and tuberous crops, and vegetables (Zhirong 1990), and may be a dominant weed in maize (Zuo & al. 2008).

The aim of the present paper is to report the species as a new record for the Albanian flora and to provide some data regarding its ecology and distribution.

Material and Methods

In the last three years (as part of the PhD study of the first author), we have carried out data for the urban flora of Tirana city, capital of Albania, based on literature sources and field observations. Apart the urban flora, we have been focused on alien species outside cultivation.

In the first year (2022), we have been focused more in literature review and we have visited different urban areas of Tirana (most of them close to the center) preparing new herbarium specimens.

During the second year (2023), we followed a systematic methodology for the investigation of the urban flora in Tirana city. The Skanderbeg statue in Skanderbeg square was taken as the central point. A circular area with a radius of 2 km has been selected from this statue (Fig. 1). Grids of 250 × 250 m were drawn on this layer and within these grids, 20 were selected and sampled through the random selection function in the QGIS 3.4 Madeira program. These sampling stations were visited during this year, collecting all the species of the urban flora found.

Voucher specimens are deposited in the National Herbarium of the Research Centre of Flora and Fauna, Faculty of Natural Sciences, Tirana University.

Plant nomenclature follows Flora Europaea (Tutin & al. 1972), as well as the Euro+Med PlantBase (Euro+Med 2006).

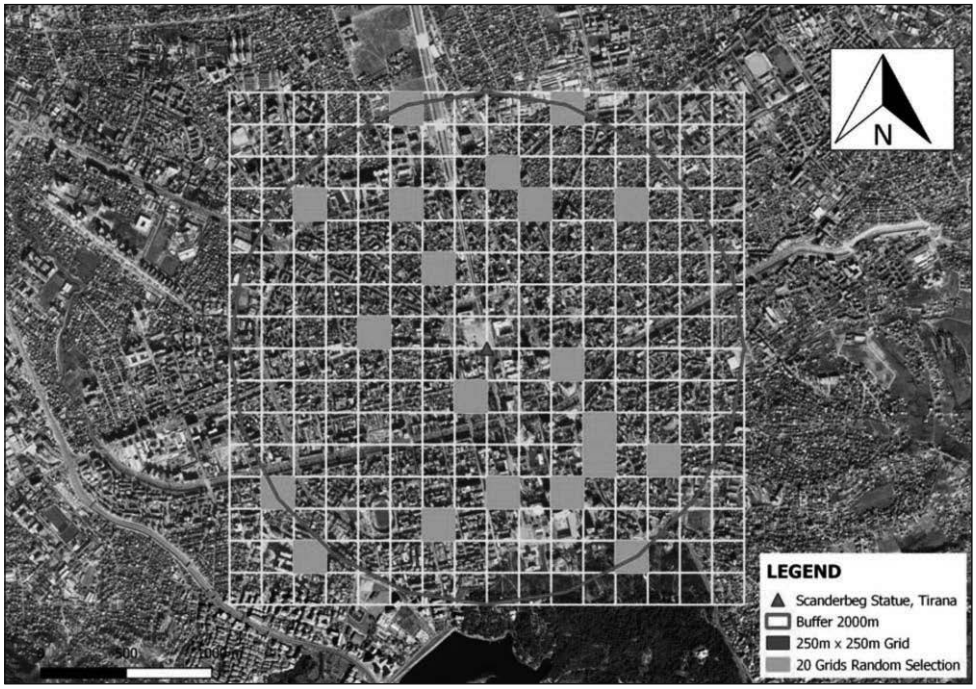


Fig. 1. The map of observation area and sampling stations.

Results and discussion

Acalypha australis, commonly known as Asian copperleaf, is native to eastern Asia (Lee 2015). It is a herbaceous annual plant, growing 20–50 centimetres tall. Its leaves are oblong to lanceolate, 3–9 cm long, 1–5 cm wide with petioles 2–6 cm long. The flowers are in axillary (sometimes terminal) panicles, forming inflorescences 15–50 mm long. There are 1–3 female flowers and 5–7 male flowers per bract; the female flowers have three sepals, whereas the male ones have four (Huaxing & Gilbert 2008).

Acalypha australis, is native to the Russian Far East, China, Japan, and the Philippines. It has naturalized in Australia (NGRP, 2010) and other regions in Eurasia, including the Caucasus, Ukraine, Italy, Armenia, and Turkey (Mulkidzhanyan 1962; Efimova & al. 1997; Berezutsky & al. 2002; Moisiienko & Vasyl'ieva 2003; Alexeev & al. 2009; Duman & Terzioğlu 2009; AgroAtlas 2010; DAISIE, 2010). The species has also been introduced to New York (Delendick 1990), northern Australia (Queensland to Victoria) and eastern India (Singh 1967; Huaxing & Gilbert 2008).

In Albania, *Acalypha australis*, was found in Tirana with a small number of individuals (one or two), on third November 2022, during the first year of field survey of the urban flora. It had a very limited distribution along an alley that connects "Avni Rustemi" Square with the "Ring" Road of Tirana (Fig. 2).



Fig. 2. Surveyed area of *Acalypha australis* in Tirana.

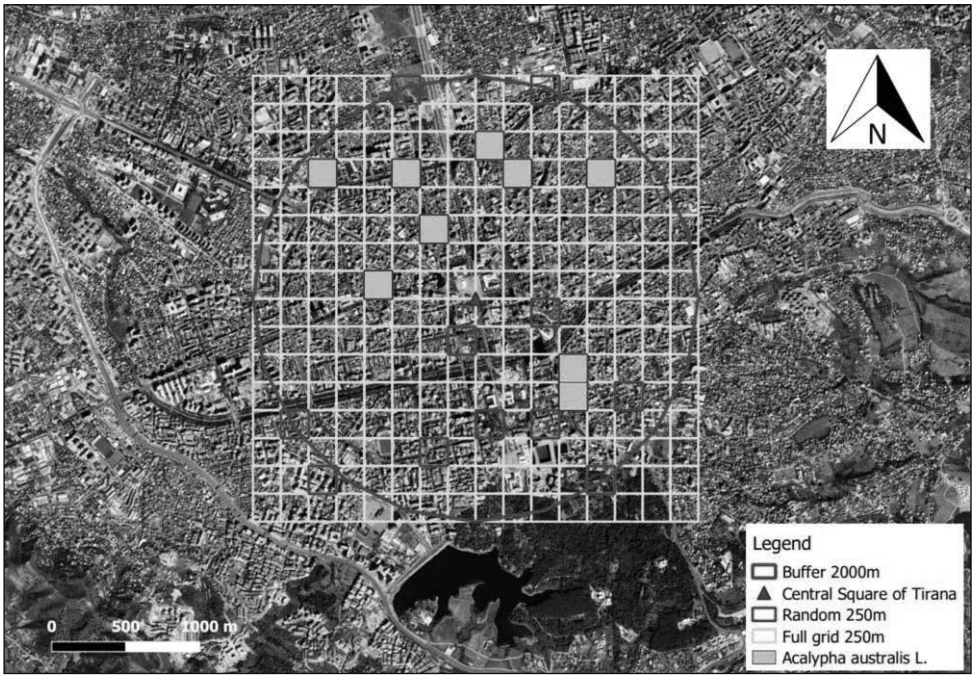


Fig. 3. Presence stations of *Acalypha australis* in Tirana city.

The study area, as part of the city of Tirana, has a typical lowland Mediterranean climate. The average temperature in the city is 15.1°C. The absolute maximum temperatures have reached 41.5°C, while the absolute minimum temperatures have reached - 10.5°C. In Tirana, an average of 1,273 mm of rain falls per year (Noti & Totoni 2012).

During this year, visiting all the 20 chosen sampling stations, we found again *Acalypha australis*, in more than 9 stations (Fig 3). In all these areas *A. australis*, was found in large populations with a number of up to 100 individuals and even in flower pots (Fig 4).

Knowing the features of the species (not being an ornamental plant) and the place where it was first found (in the corner of the wall), we can assume that this species is accidentally introduce by humans.

The results above confirm that this species has reproduced successfully and is forming big populations in this new urban ecosystem, becoming potentially invasive in the next years.

In the next years we will continue with the investigation of the urban flora of Tirana and we will complete the distribution map of *A. australis* L. with new data.



Fig. 4. Picture of *Acalypha australis* in large populations and in flower pot.

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Article

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A. Ruggero, E. Trainito, G. Bacchetta, L. Podda, A. Lallai, F. Mascia, M. Manca, G. Bertotto & G. Calvia

Contribution to a new vascular flora of Sardinia (Italy): I (1-30)

Abstract

Ruggero, A., Trainito, E., Bacchetta, G., Podda, L., Lallai, A., Mascia, F., Manca, M., Bertotto, G. & Calvia, G.: Contribution to a new vascular flora of Sardinia (Italy): I (1-30). — Fl. Medit. 34: 13-46. 2024. — ISSN: 1120-4052 printed, 2240-4538 online.

In the context of creating a new, updated, and revised vascular flora of Sardinia, this work contributes new data on the distribution of various taxa in the island. These include both native and alien taxa, which are characterized by their rarity, limited recognition, phytogeographical significance, potential issues, or novelty to Sardinia. These updates mostly result from floristic research primarily conducted in north Sardinia, with several discoveries in other sectors of the island. The first report of *Convolvulus sabatius* subsp. *mauritanicus*, *Cyperus brevifolioides* (naturalized) and *Brachychiton populneus* (casual alien) in Sardinia is documented here. Moreover, this study includes new distributional data for 27 taxa, some of which required confirmation. Notably, *Trifolium clusii*, previously considered doubtful in recent years, along with *Fuirena pubescens* and *Silene inaperta*, which were indicated for the southern part of Sardinia over thirty years ago and have not been reported elsewhere since. For others, an expansion or a better definition of their distribution range within the island is documented, as in the case of *Chloris gayana*, *Digitaria ciliaris*, *Eragrostis curvula*, *Paraserianthes lophantha*, *Sporobolus indicus* (naturalized alien species), *Asparagus asparagoides*, *Cenchrus setaceus*, *Eclipta prostrata*, *Halophila stipulacea* (invasive alien species), *Allium sardoum*, *A. savii*, *Anthyllis barba-jovis*, *Asplenium marinum*, *Bellevalia romana*, *Butomus umbellatus*, *Cladium mariscus*, *Dianthus sardous*, *Dysphania botrys*, *Jacobaea maritima* subsp. *maritima*, *Leersia oryzoides*, *Nepeta foliosa*, *Nuphar lutea*, *Spirodela polyrrhiza*, *Utricularia australis* (rare native).

Key words: Alien Species, Mediterranean vascular flora, Rare Plants, Sardinia, Tyrrhenian islands.

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Introduction

Sardinia (Italy), with an area of 24,090 km, is the second-largest island in the Mediterranean Basin. It is located in the center of the western Mediterranean area and is part of the Cyrno-Sardinian biogeographic province, with Corsica and the Tuscan Archipelago (Bacchetta & al. 2012, 2013). The island falls within the Italo-Tyrrhenian

Superprovince (Ladero-Álvarez 1987; Bacchetta & al. 2013) and has been divided into six biogeographic sectors and 22 subsectors (Fenu & al. 2014).

Geologically, Sardinia is rather diverse (Carmignani & al. 2016), and its climate is typically Mediterranean (Bacchetta & al. 2009), though two macro-bioclimates, seven thermometric belts, and 43 isobioclimates were recognised by Canu & al. (2015). Despite not having towering mountains, with Punta La Marmora (Gennargentu Massif) rising to 1,834 m, the island is characterized by a coastline more than 1,900 km long (Ginesu & al. 2016) and has a high variety of environments that allow the presence of many vegetational typologies (Bacchetta & al. 2009).

According to the most recent checklists, the Sardinian vascular flora is represented by 2,330 native taxa (including cryptogenic ones), with an additional 108 archaeophytes and 412 neophytes, resulting in a total of 2,963 taxa, including casual alien ones (Bartolucci & al. 2021).

As part of research efforts aimed at expanding the floristic knowledge of Sardinia, several taxa new to the Sardinian flora and/or rare, little known and of particular phytogeographic interest have been discovered, along with various alien taxa deserving to be monitored. These investigations comprehensively covered the entire island territory, although this contribution specifically focuses on the Turritano, Logudorese, Gallurese and Baronico biogeographic subsectors, encompassing the northernmost portion of the region. (Fenu & al. 2014).

Floristic research in Sardinia began in the early 19th century when botanists, notably Moris, undertook botanical expeditions in the then Kingdom of Sardinia, compiling the first lists of plant species on the island (Moris 1827, 1837-1859). Subsequently, new botanical explorations, descriptions, and findings were conducted by numerous other botanists during their travels to various locations in the regional territory. These contributions were later consolidated into floras or floristic lists by authors such as Parlatore (1848-1875), Barbey (1884), and Fiori (1923-1929).

Further floristic updates occurred between the late 19th century and the early 20th century, thanks to the contributions of various authors, including Nicotra (1896), Terracciano (e.g., 1909), Negodi (1931), and Schmid (1933). From the mid-20th century, numerous more comprehensive floras were compiled for specific areas, especially coastal or mountainous zones (e.g., Desole 1960; De Marco & Mossa 1974; Veri & Bruno 1974; Camarda 1984; Bocchieri 1996; Mossa & al. 1996).

In the early 21st century, a project for a complete flora of the island was complemented by Arrigoni (2006-2015). Concurrently and more recently, other floristic contributions have been made, encompassing specific categories of taxa and introducing new reports to the flora of Sardinia (e.g. Bacchetta & al. 2007; Desfayes 2008; Podda & al. 2012; Puddu & al. 2016; Bartolucci & al. 2019, 2020; Galasso & al. 2018b, 2019, 2022, 2023a, 2023b; Fois & al. 2022).

However, floristic knowledge concerning the island of Sardinia is far from complete, and new findings and updates continue to be made from north to south, necessitating ongoing revisions of their occurrences, distributions, and the communities they form. In this first contribution, we present the findings of newly discovered taxa for the island, offering a more precise definition of the distributional data for various native taxa of particular phytogeographic interest. Additionally, we highlight alien taxa that merit future monitoring. Furthermore, our report includes information on the rarity and threats faced by the native

taxa documented here, along with a revision of the invasiveness status for the mentioned alien taxa on the island.

Materials and method

This work is based on extensive plant collections made by the authors in Sardinia between 2001 and 2023, together with a bibliographic and herbarium revision. The field research, which has engaged the authors for several years and still does, was followed by the study of numerous herbarium samples and extensive bibliographic material. 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) and monographs, as for the genus *Utricularia* (Taylor 1989).

The status of each alien species was determined and ordered on the basis of 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 the systematic classification of Pignatti & al. (2017-2019), while the nomenclature is derived from Bartolucci & al. (2018) and Galasso & al. (2018a). Herbarium specimens are preserved in personal herbaria of some authors (Herbarium Ruggero, Herb. Calvia, Herb. Mascia, Herb. Manca) and in the CAG and SS herbaria. Acronyms follow Thiers (2024).

Native taxa

Allium sardoum Moris (*Amaryllidaceae*)

Distribution update

Findings: Oschiri (Sassari) lago Coghinas, in loc. Mandras (40.760403°N - 9.068523°E). Luoghi aridi, rocce. 165-180 m. 23-06-2008, *G. Calvia* (Herb. Calvia); Berchidda (Sassari) SP138 a Canale Longu (40.833548°N - 9.242113°E). Luoghi aridi sabbiosi. 400-450 m. 17-07-2010, *G. Calvia* (Herb. Calvia); Oschiri (Sassari) Sigalesa, lago Coghinas (40.738829°N - 9.060062°E), pascolo. 28-07-2019, *A. Ruggero* (Herb. Ruggero).

Observations: *Allium sardoum* is a narrow Mediterranean species found in the Iberian Peninsula, Provence, Italy, the Balkan countries, Greece, Turkey, Morocco, Algeria, Tunisia, and Libya (POWO 2024). In Italy, it is known in Latium, Apulia, Basilicata, Sicily, and Sardinia, while it is not confirmed in Campania, erroneously reported in Veneto and Molise, and uncertain in Calabria (Bartolucci & al. 2018; Conti & al. 2023). Moris (1827) described the species based on material from Mandas (province of Sud Sardegna), along the route from San Nicolò d'Arcidano (Oristano) to Aritzo (Nuoro). Later, the species was reported in the territory of Oliena (Nuoro) (Martinoli 1955; Garbari 1976). Additional data came from Santadi (Sud Sardegna) (Bacchetta 2006), Sassari and Oschiri (Sassari) (Arrigoni 2015), Anela (Sassari) (Farris & al. 2018), and

Monte Limbara (Calvia & Ruggero 2020). This last report, was referred to findings in Calangianus (Sassari) and Berchidda (SS) sides, and near the northern shores of Lake Coghinas (Oschiri). To this information, we add findings from the plain of Riu Mannu of Berchidda, along with other sites close to Lake Coghinas (Oschiri, Tula - Sassari). Additionally, we confirm its presence near Oschiri (updated distribution in Fig. 1).

Rarity and threats: the species is likely more frequent than currently recognized. Some populations appear to be conspicuous, but threats like wildfires and human activities (e.g. roadworks, building sites and agricultural works) pose concern about the local durability of the species. To address these concerns, *ex situ* actions are needed.

Allium savii Parl. (*Amaryllidaceae*)

Distribution update

Findings: Berchidda (Sassari) Riu Mannu in loc. Sas Rujas (40.757918°N - 9.142945°E). Pozze a ristagno temporaneo nei cespugli di *Polygonum scoparium*. 03-08-2008, *G. Calvia* (Herb. Calvia); Berchidda (Sassari) Riu Mannu in loc. San Marco (40.762457°N - 9.137794°E). Prati umidi. 29-08-2021, *G. Calvia* (Herb. Calvia); Chiaramonti/Ploaghe (Sassari) loc. S'Ena 'e Gorzi-Santa Giusta (40.706678°N - 8.796708°E). Pendii umidi su substrati ad alta rocciosità. 26-08-2023, *F. Mascia* (Herb. Mascia); Nulvi (Sassari) loc. Piana Ederas (40.815097°N - 8.767339°E). depressioni stagionalmente allagate ai margini della sughereta, con *Eryngium barrelieri*. 26-08-2023, *F. Mascia* (Herb. Mascia).

Observations: this species is an endemic of the western Mediterranean biogeographic region, confined to Minorca (Fraga 2002), Provence (Tison & al. 2014), Corsica (Delage & Hugot 2020), peninsular Italy (Emilia-Romagna, Tuscany, Latium), and Sardinia (Bartolucci & al. 2018). Based on bibliographic data, the species appears to be highly rare across much of its range, with a larger number of populations known only in Corsica (Delage & Hugot 2020). Knowledge about its distribution in Sardinia was limited to a few high hilly or sub-mountainous areas of the central and central-southern sectors (Aritzo and Campeda, Nuoro; Laconi, Oristano; Mandas, Sud Sardegna - Brullo & al. 1994; Arrigoni 2015a).

The populations here reported are situated in north Sardinia, in the municipalities of Berchidda, Chiaramonti, Nulvi and Ploaghe (Sassari), where the species grows in wet meadows, humid slopes, temporary stagnant wetlands and puddles, from 165 to 450 m a.s.l. (Fig. 1).

Rarity and threats: in Sardinia, this species is currently known from less than 15 sites, with an occupancy area often limited to a few square meters. Heatwaves and extreme droughts can represent a serious threat for the species. *In situ* and *ex situ* conservation actions are needed and the species should be evaluated for a regional assessment according to IUCN criteria.

Anthyllis barba-jovis L. (*Fabaceae*)

Distribution update

Findings: Arzachena (Sassari) Pevero (41.112025°N - 9.547843°E). Bordo superiore della spiaggia. 05-04-1999, *A. Ruggero* (Herb. Ruggero); Trinità d'Agultu (Sassari) presso Li Cossi (41.049646°N - 8.937925°E). Tra le rocce. 09-04-2017, leg. *A. Ruggero*, *A. Di Giacomo*, *G. Calvia*, det. *A Ruggero* (Herb. Ruggero).

Observations: this species is native in the central-western Mediterranean, encompassing southern France, Corsica, Italy, Sardinia, Sicily, Balkan Countries, Algeria and Tunisia (Barina & al. 2013; Terzi & al. 2020; Delage & Hugot 2020; POWO 2024). It is acknowledged as naturalized in Spain, Libya, and Australia (Castroviejo 2000; POWO 2024). The populations in Greece are presently classified under *A. splendens* Willd. (Dimopoulos & al. 2013). The species distribution in Italy is confined to the Tyrrhenian regions (Tuscany, Latium, Campania, Calabria, Sardinia and Sicily), and to a few spots in Apulia (Bartolucci & al. 2018; Pignatti & al. 2017-2019).

In Sardinia, the species is documented in scattered sites in the northern part of the island, such as the calcareous promontories of Capo Figari (Golfo Aranci, Sassari), where it was first collected by Lisa in 1840, and Capo Caccia (Alghero, Sassari) (Camarda & Valsecchi 2008). On granitic substrates at La Maddalena Archipelago (Sassari) on the Islands of Budelli, Italiani central islet and Santa Maria (Bocchieri 1992; Biondi & Brugiapaglia 1995; Bocchieri 1996; Arrigoni 2010b). Finally, other populations were recorded on the dune system of Pevero Beach (Arzachena, Sassari - Trainito 2009) and on the islet Le Rocche (Arzachena - Bocchieri 1996; Trainito 2009). This study confirms the species' presence in all previously known sites, with special emphasis on Capo Figari, which received confirmation after 184 years without official verification. We also identified the species on the neighboring islet of Figarolo. Furthermore, we document a new growing station on the northern coast of Sardinia, in granitic rocky areas along the path leading from Costa Paradiso to Li Cossi Beach (Trinità d'Agultu, Sassari) (Fig. 2).

Rarity and threats: the species is often scattered and represented by only a few individuals. The population at Capo Figari was nearly entirely destroyed by a wildfire in June 2013. Other populations face threats from tourism activities (e.g. enlargement or creation of new paths, trampling) and local issues related to browsing. *In situ* and *ex situ* actions are needed and the species should be evaluated for a regional assessment according to IUCN criteria.

Asplenium marinum L. (*Aspleniaceae*)

Distribution update

Findings: Santa Teresa G. (Sassari) Capo Testa (41.242935°N - 9.143344°E). Sotto sporgenza in arenaria, tra i graniti, presso il mare, 16-02-2002, leg. *A. Ruggero*, *A. Di Giacomo*, det. *A. Ruggero* (Herb. Ruggero); Santa Teresa G. (Sassari) Capo Testa (41.243625°N - 9.142512°E), *G. Bacchetta* (CAG); Isola di Razzoli (Sassari) (41.300633°N - 9.340859°E). Anfratti rocciosi direttamente esposti all'aerosol marino, esposizione S-SE, 3 m s.l.m. 09-05-2023, *F. Mascia* (Herb. Mascia).

Observations: this species exhibits a scattered distribution in several European countries, Morocco and Algeria (Pichi Sermolli 1979). In Italy, it is known from a few localities in Tuscany (Capraia and Elba), Latium (Circeo promontory), Apulia (Gagliano del Capo near Grotta Grande del Ciolo, Gallipoli and Taranto), Sicily (Pantelleria Island) and Sardinia (Beccarisi & al. 2001; Marchetti 2004; Bartolucci & al. 2018; Bartoli & al. 2021; Rizzo 2021).

In Sardinia, the species is known from a few sites: Capo Testa (Santa Teresa Gallura, Sassari), La Maddalena Archipelago (La Maddalena, Caprera, Spargi and Spargiotto) in

the northern part, Cagliari(?) and Isola dei Cavoli (Villasimius, Sud Sardegna) in the southern part (Barbey 1884; Mossa & Tamponi 1978; Marchetti 1999; Arrigoni 2006). The first report of the species in Sardinia is due to Moris (1827), who discovered it on the eastern coast. Subsequent researchers did not confirm the species in that part of the island.

In this study, we confirm the survival of the Capo Testa population, also noting its presence in a second small site near Santa Teresa, beneath the Aragon tower, on crevices of granitic coastal cliffs. Additionally, we discovered a small growing station on trachyte coastal cliffs east of Cala Ostina beach, near Castelsardo (Sassari). Moreover, we add a new island of La Maddalena Archipelago, namely Razzoli, to those where the species grows (Fig. 1).

Rarity and threats: the species is very rare in Sardinia, mostly consisting of only a few individuals per site. Some of these sites face threats from tourism activities, particularly climbing on the crevices of Capo Testa. Hence, *in situ* actions are needed and the species should be evaluated for a regional assessment according to IUCN criteria.

Bellevalia romana (L.) Sweet (*Asparagaceae*)

Distribution update

Findings: Berchidda (Sassari) Sa Tanca ‘e Su Re (40.778751°N - 9.174679°E). Incolti, cigli stradali. 200-230 m. 15-03-2010, *G. Calvia* (Herb. Calvia); San Giovanni Suergiu (Sud Sardegna) Matzaccara (39.110418°N - 8.483537°E). Luoghi umidi lungo la strada. 16-03-2014, *G. Calvia* (Herb. Calvia); Oschiri (Sassari) lago Coghinas in loc. Su Campu (40.700126°N - 9.042805°E). Prati umidi. 165 m s.l.m. 14-04-2014, *G. Calvia* (Herb. Calvia); Villanovaforru (Sud Sardegna) loc. Acqua Frida (39.626083°N - 873707°E). Margini di seminativi a cereali, 12-03-2021, *F. Mascia* (Herb. Mascia); Elmas (Cagliari) loc. Santa Caterina (39.260540°N - 9.051359°E). Pascoli sub-nitrofili. 28-02-2023, *F. Mascia* (Herb. Mascia)

Observations: the species has a central-eastern Mediterranean distribution, limited to Provence, Corsica, Italy, the Balkan countries, Greece, and Egypt (Boulos 2000; Delage & Hugot 2020; POWO 2024). In Italy, it is present in almost all regions, excepted Val d’Aosta and Piedmont (where it was mistakenly reported, Bartolucci & al. 2018).

Its presence in Sardinia has been relatively recently reported, mostly in relation to coastal areas: San Teodoro (Sassari) (Chiesura Lorenzoni & Lorenzoni 1984), La Maddalena (Cesaraccio 1990), Santa Gilla and Molentargius (Cagliari) (Ballero 1995), around Olbia, and in Oristanese (Arrigoni 2015a). New findings came from Berchidda (Calvia & Ruggero 2020). We added here our new findings from Lake Coghinas (Oschiri), Villanovaforru (Sud Sardegna), Elmas (Cagliari) and Matzaccara (San Giovanni Suergiu, Sud Sardegna) (Fig. 1).

Rarity and threats: the species is often poor in individuals. The plants commonly grow on meadows and grasslands that are occasionally subject to trampling, mowing, grazing and human activities like roadworks and hydraulic works. *Ex situ* actions are needed, and the species should be evaluated for a regional assessment according to IUCN criteria.

Butomus umbellatus L. (*Butomaceae*)

Distribution update

Findings: Oschiri (SS) lago Coghinas, Frassu (40.725127°N - 9.022648°E). Prati umidi presso le sponde lacustri. 164 m s.l.m. 22-05-2011, leg. *G. Calvia*, *A. Manca*, det. *G. Calvia* (Herb. Calvia); Mores (SS) Riu Mannu a monte della stazione (40.546325°N – 8.880101°E): Flora ripariale. 200 m s.l.m. 10-08-2011, *G. Calvia* (Herb. Calvia); Norbello (OR) Rio a valle delle cascate di Liune (40.156851°N - 8.820299°E). *G. Bacchetta* (CAG).

Observations: this Euro-Siberian species, found in various regions of Europe and invasive in North America (Gaskin & al. 2021), in its native area is often considered rather rare and locally CR (critically endangered) due to habitat reduction, as seen in Trentino (Prosser & al. 2020).

Its presence in Sardinia was first reported by Moris (1827) near Decimomannu and Bosa, in slowly flowing waters (presumably Riu Mannu and Temo River). Later, the species was recorded at Santa Gilla Pond and near Assemini (Cagliari), at the mouth of Rio Gutturu Mannu, along Rio Cixerri, near Uta (Cagliari), and on the canals of Oristanese (De Martis & al. 1984; Bacchetta 2006; Arrigoni 2006). The occurrence of the species along Riu Mannu and Rio Cixerri is here confirmed.

In north Sardinia, specifically in the Coghinas catchment basin, the species is sporadically spread along Riu Mannu of Ittireddu, Mores and Ozieri (Sassari), as part of the riparian helophytic and bankside flora. On the shores of Lake Coghinas, a station was found along a small stream. Another population was recently found in a small stream of central Sardinia, in the municipality of Norbello (Oristano) (Fig. 1).

Rarity and threats: the species is quite rare and faces competition from other taxa, such as *Phragmites australis* (Cav.) Trin. ex Steud. In addition, alien species, such as the red swamp crayfish (*Procambarus clarckii*) and the coypu (*Myocastor coypus*), represent a threat for some populations. The collection of its flowers has also been observed, along with grazing and habitat reduction due to roadworks and bonification. *In situ* and *ex situ* actions are needed and the species should be evaluated for a regional assessment according to IUCN criteria.

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

Distribution update

Findings: Berchidda (Sassari) Rio Badu Pedrosu (40.750995°N - 210942°E). Flora ripariale, 200-205 m s.l.m. 31-08-2020, *G. Calvia* (Herb. Calvia); Oschiri (Sassari) versanti occidentali dell'altopiano di Balascia, in loc. Sarra Niedda (40:803761°N - 9.042337°E). Zone umide (tre nuclei lungo il sentiero), 450 m s.l.m. 02-07-2022, *G. Calvia* (Herb. Calvia).

Observations: this sub-cosmopolitan species grows spontaneously across all continents and is considered native throughout Europe (POWO 2024). In Italy, despite being known in all regions, it is considered rather rare (Pignatti & al. 2017-2019) and is occasionally included in regional IUCN red lists, even classified as EN (endangered), as in Trentino (Prosser & al. 2020).

Knowledge about its presence in Sardinia was limited to a few coastal river mouths or ponds, such as Platamona (Porto Torres, Sassari, Sorso - Chiappini 1963), Rio Li Cossi (Trinità d'Agultu, Sassari), Santa Maria Navarrese beach (Baunei, Nuoro - Desfayes 2008); upstream from Arbatax beach (Nuoro) and near Tancau beach, in Lotzorai

(Nuoro - Scudu 2022). The latter author also mentioned the traditional use of this species for building hut roofs in San Giovanni di Sinis (Oristano). More recently, a small population has been described for the inner part of Porto Conte Cove (Alghero, Sassari) by Morabito & al. (2023).

We confirm the previous reports, and we add a population close to Fiume Santo (Porto Torres, Sassari). Furthermore, we found several populations inland, in north Sardinia, between 50 and 450 m a.s.l. These populations are all concentrated in the Coghinas catchment basin: Coghinas River (Oschiri, Tula, Erula, Tempio Pausania, Bortigiadas, Perfugas); Rio Badu Pedrosu (Berchidda, Oschiri); Rio Mannu-Rio Rizzolu (Buddusò, Oschiri); Rio Cantares de Uda-Rio Sa Conca and its left tributary (Alà dei Sardi, Berchidda). Finally, we identified a small population near a rivulet tributary of the Coghinas River, at the western boundaries of the Limbara massif (Calvia & Ruggero 2023). We also found other inland populations on calcareous outcrops in Ogliastra (central eastern Sardinia), along some streams of the municipalities of Osini, Ulassai and Ussassai (Nuoro), at an elevation between 760 and 805 m a.s.l. (Fig. 1)

Rarity and threats: despite being quite rare, the species locally covers relatively wide areas, (e.g. Platamona Pond). However, since it inhabits wet places and riverbeds, it is susceptible to periodic extreme events, including floods and/or droughts, along with human interventions designed to reclaim wet sites. *In situ* and *ex situ* actions are needed.

Dianthus sardous Bacch., Brullo, Casti & Giusso (*Caryophyllaceae*)

Distribution update

Finding: Arzachena (Sassari) Capo Ferro (41.155353°N - 9.516846°E). Rocce metamorfiche sul mare. 22-05-2016, *A. Ruggero* (Herb. Ruggero)

Observations: this is an endemic species of Sardinia, with a rather extensive distribution on the island, being reported in most of the island's sectors (Bacchetta & al. 2010).

With this report, we highlight the first and only known population of this species in the Gallurese subsector, where it was found in a coastal area, on schistose rocks and scree, in the territory of Arzachena (Fig. 2). This is the northernmost known station of a *Dianthus* species in Sardinia and the only one in Gallura, based on the bibliographic data available.

Rarity and threats: this taxon is widespread on the island, occurring in various environments and geologic substrates, and ranging from sea level to 1,300 m a.s.l., being not particularly susceptible to threats. Nonetheless, the sole population known in Gallura should be monitored and protected, being small and close to tourist sites constantly under threat of new construction projects.

Dysphania botrys (L.) Mosyakin & Clemants (*Amaranthaceae*)

Distribution update

Findings: Pattada (Sassari) lago Lerno (40.584385°N - 9.163384°E). Sponde sabbiose. 07-07-2012, *G. Calvia* (Herb. Calvia); Berchidda (Sassari) lago Coghinas loc. Funtana 'e Cannas (40.759968°N - 9.096712°E). Sabbie. 160-165 m. 18-08-2022, *G. Calvia* (Herb. Calvia)

Observations: this Eurasian taxon, now alien in many countries, particularly in the United States of America (POWO 2024), was considered native in all Italian regions except Abruzzi (mistakenly reported), Friuli-Venezia Giulia and Sardinia, where it was reported as alien (Bartolucci & al. 2018).

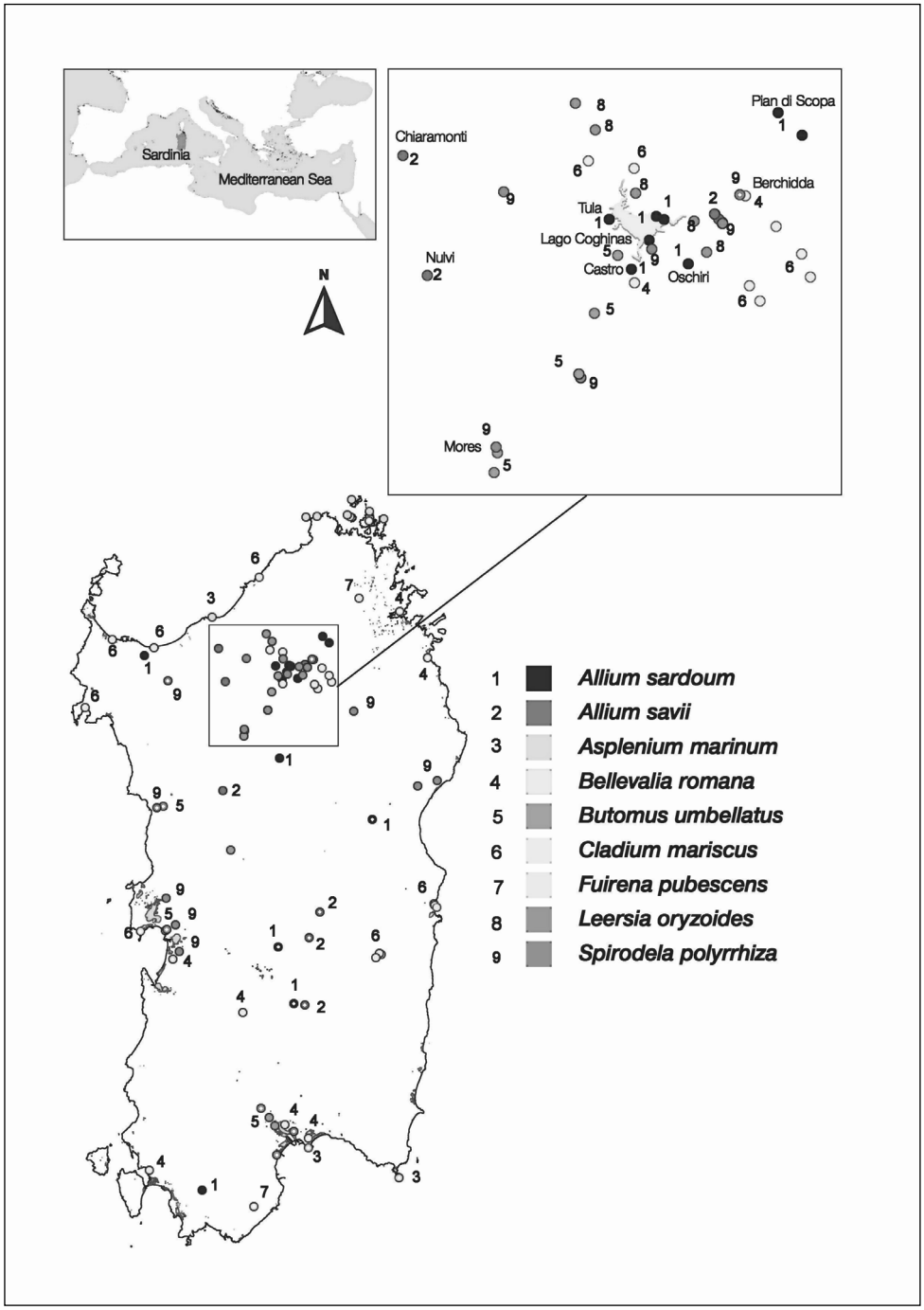


Fig. 1. Distribution map of some native species cited in this article. Pointed circles refer to not confirmed data.

In Sardinia, the species was considered rare and limited to a few locations in the southern half of the island. The first report came from the surroundings of Cagliari (Gennari & Pirotta 1885). Subsequently, Tutin & al. (1964, 1993) confirmed its presence. Camarda (1982) collected the species near Nuraghe Arrubiu (Orroli, Nuoro). Finally, Arrigoni (2006) cited only previous reports.

In recent years, we have discovered the species in northern and central Sardinia, often near waterbodies and artificial lakes. Specifically, it is relatively common along the shores of lake Lerno (Pattada, Sassari) and rarer on Coghinas (Berchidda, Oschiri). We also found it along Riu Mannu di Ittireddu, near a small lake in the locality Genna Orruali (Gairo, Nuoro), along Rio Govosoleo (Fonni-Lodine, Nuoro) and middle Flumendosa river (Seulo, Sud Sardegna) (Fig. 2).

Rarity and threats: the species can be still considered rare in Sardinia, but its actual distribution is far from certain. The species grows in sandy soils that are temporarily submerged during the winter, suggesting its seeds might be transported by waterbirds (Viana & al. 2016). As for other species that are naturally expanding their range in the island due to waterbirds, also this species cannot be considered alien with certainty, thus we consider it as cryptogenic.

Fuirena pubescens Kunth (*Cyperaceae*)

Distribution update

Finding: Sant'Antonio di Gallura (Sassari) Sarra di Littu Petrosu, luoghi umidi tra le pinete naturali e la cava abbandonata (40.978319°N - 9.370332°E). 400-420 m. 21-05-2018, *G. Calvia* (Herb. Calvia).

Observations: this paleo-temperate species is known in many African and south-western Asian countries (POWO 2024). The Mediterranean Basin represents its northern limit, especially with Ligurian populations (Pignatti 1982). The population at the mouth of the Lao River in Calabria is now considered extinct (Bartolucci & al. 2018). *Fuirena pubescens* is also documented in various locations in Corsica (Briquet 1910; Jeanmonod & Gamisans 2013; Delage & Hugot 2020).

In Sardinia, the species was reported only along the Rio Pixinamanna (Pula, Cagliari), where it appears to be rather rare (Arrigoni 1964; Pignatti 1982; Bacchetta 2006). Desfayes (2008) included *F. pubescens* among the taxa deserving confirmation, due to the lack of recent records.

We located this species in a site in north Sardinia (Sant'Antonio di Gallura, Sassari), under the canopy of natural pine woodlands and in stagnant water and small rivulets of a nearby granite quarry now abandoned. This finding expands the species' distribution towards the northern part of the island and confirms its presence after 60 years of absence in new records (Fig. 2).

Rarity and threats: the population is substantial in numbers but remains isolated and its occupancy area is less than 0.5 ha, thus deserving attention. *Ex situ* actions are needed and the species should be evaluated for a regional assessment according to IUCN criteria.

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

Distribution update

Findings: Santa Teresa (Sassari) Santa Reparata (41.228266°N - 9.167063°E). Gariga

marina (sub *Senecio cineraria* DC.). 20-05-2001, *A. Ruggero* (Herb. Ruggero); Olbia (Sassari) di fronte al faro di Lido del Sole (40.919515°N - 9.560802°E). Sabbie, garighe costiere, 1-2 m, 17-06-2015, *G. Calvia* (Herb. Calvia); Sant'Antonio di Gallura (Sassari) Sarra di M. Santu (40.982953°N - 9.385931°E). Pinete naturali, 550-600 m. 21-05-2018, *G. Calvia* (Herb. Calvia).

Observations: this taxon has a natural distribution limited to Spain, southern France, Corsica, Morocco, Algeria, Tunisia, and Italy (POWO 2024). In Italy, it is native in Liguria, Tuscany, and Sardinia, and is alien in Umbria, Abruzzi, Molise and Apulia (Bartolucci & al. 2018).

Previous studies only recorded this taxon along the northern coasts of Sardinia (e.g., Camarda & Valsecchi 1990). More specifically, it has been reported in Capo Caccia (Alghero) and Capo Figari (Golfo Aranci) on carbonate substrata, and in smaller islands and islets in the northern sectors: Asinara, La Maddalena Archipelago, Figarolo, Tavolara, and Molara (Barbey 1884; Desole & Pignatti 1961; Bocchieri 1988, 1996; Biondi & Bagella 2005; Bocchieri & Iiriti 2005; Arrigoni 2015a). The taxon is confirmed in those places and is also present in the Stintino promontory (Sassari), near Costa Paradiso (Trinità d'Agultu), Santa Teresa Gallura, Baja Sardinia (Arzachena), Soffi and Mortorio Islands and Le Camere islets, and near Olbia. Recent surveys at the island of Razzoli have also confirmed its presence at the northernmost micro-insular territories of Sardinia. Moreover, we found this species inland, in scrublands, rocky places, and pine woodlands on the Monte Pino and Monti Santu high hills (Olbia, Sant'Antonio di Gallura, Telti), at altitudes up to 670 m a.s.l.

The species also occurs along the north-western coastline from Alghero to Bosa (Oristano) as far as Porto Alabe (Tresnuraghes, Oristano). Moreover, the southernmost growing site of the island, located in the Isola Rossa (Teulada, Sud Sardegna) is here reported (Fig. 2).

Rarity and threats: since the species is currently known in Sardinia on coastal environments, it is potentially susceptible to threats related to tourist sites' expansion and locally to coastal erosion (Gulf of Olbia). Nonetheless, in most of the sites, the species is currently not subject to threats.

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

Distribution update

Findings: Bortigiadas (Sassari) fiume Coghinas, presso Scala Ruja (40.862743°N - 8.972515°E). Riva fluviale, 19-09-2011, *A. Ruggero* (Herb. Ruggero); Perfugas/Bortigiadas (Sassari) fiume Coghinas presso la traversa di Donigazza (40.838635°N - 8.996166°E). Flora ripariale di sponda. 60 m s.l.m. 16-09-2023, *G. Calvia* (Herb. Calvia).

Observations: this sub-cosmopolitan species has a distribution encompassing much of North America, Europe, and Asia (POWO 2024). In Italy, it is present in most of the regions, excepted Val d'Aosta, Abruzzi, Molise, Apulia, Basilicata, and Sicily, and was mistakenly reported in Calabria (Bartolucci & al. 2018).

The first report of *Leersia oryzoides* in Sardinia is due to Calvia & Urbani (2007), on a stream in the southern Limbara and in the Riu Mannu of Berchidda. Lately, Arrigoni (2015b) cited it as a probable occasional adventive, a status subsequently adopted by

Bartolucci & al. (2018). Later, Calvia & Ruggero (in Bartolucci & al. 2019b), based on new findings along the Riu Mannu of Oschiri and confirmation of previous records, confirmed it as a native species in Sardinia.

More recently, new findings and the rediscovery of a neglected herbarium specimen allowed us to enlarge our knowledge to the lake Coghinas shores and the Coghinas River, in the riparian vegetation downstream of the homonymous dam (Perfugas, Bortigiadas, Sassari) (Fig. 1).

Rarity and threats: the new findings better define the species distribution to a broader area within the Coghinas River basin. However, the species is rare in the island, with a low occupancy area. The species faces threat of an increased frequency of extreme floods, alien species expansion (both plants and animals) and human activities such as road-works and bridges' building.

Nepeta foliosa Moris (*Lamiaceae*)

Distribution update

Finding: Olbia (Sassari) Isola di Tavolara, versante SE, quota 440-445 m a.s.l., incl. 35-40° (40.894618°N - 9.697592°E). Calcari mesozoici, 09-06-2021, *G. Bacchetta* (CAG).

Observations: this species is a rare Sardinian endemic with a restricted distribution area. After the description on the calcareous outcrops of Monti d'Oliena (Nuoro) (Moris 1827-1839), it was later found on the eastern side of Tavolara Island (Olbia) (Béguinot & Vaccari 1929; Béguinot & Landi 1931). This finding was not confirmed by Desole (1960) in the vascular flora of Tavolara, thus not considered by further authors (Valsecchi & Diana-Corrias 1973; Diana-Corrias 1979; Arrigoni 2013). In the late spring of 2021, on a fieldtrip for collection of germplasm, we found seven specimens of this species on a calcareous slope on the south-eastern side of the island of Tavolara. This finding serves to validate earlier reports and significantly expands the known distribution area of the species to the north-eastern area of Sardinia (Fig. 2).

Rarity and threats: the species is quite rare and has been classified as VU (Vulnerable) by Orsenigo & al. (2018). To a restricted occupancy area, threats like grazing of wild and feral animals, together with tourism activities and natural cliffs' evolution were considered (Congiu & al. 2014). Specifically, the extremely limited number of plants occurring on the Tavolara site prompt us to propose *in situ* interventions to support reinforcement of this population.

Nuphar lutea (L.) Sm. (*Nymphaeaceae*)

Distribution update

Findings: Berchidda (Sassari) Rio di Berchidda in loc. Tamuri (40.772435°N - 9.196622°E). Piscine naturali. 185-190 m, 17-09-2007, *G. Calvia* (Herb. Calvia); Perfugas/Bortigiadas (Sassari) fiume Coghinas presso la traversa di Donigazza (40.838635°N - 8.996166°E). Nelle piscine naturali dallo sbarramento a salire per oltre 4 km. 60 m s.l.m. 16-09-2023, *G. Calvia* (Herb. Calvia).

Observations: *Nuphar lutea* is a floating aquatic plant native to Eurasia, widespread across Europe and in many temperate-cold regions of Asia, also known in Algeria (POWO 2024). In Italy, the species is found in almost all northern and central regions and in Sardinia, but it is considered alien in Liguria and Marche (Bartolucci & al. 2018). *N.*

lutea is absent in Val d'Aosta, Abruzzi, Molise, Apulia, Basilicata, and Calabria, and not confirmed in Sicily (Bartolucci & al. 2018).

In Sardinia, *N. lutea* was first reported "*in rivo lente fluente, circa Mores*," meaning Rio Mannu of Mores (Moris 1837-1859). Subsequent reports came from "Badu Oschiri," (Mola 1919), from the "stagni di Oschiri e Berchidda e Riu Mannu di Mores-Ozieri" (Arrigoni 2006), and from Poggio dei Pini (Capoterra, Cagliari) (Bacchetta 2006). Later, Desfayes (2008), not having directly found the species, included it in a list of taxa worthy of confirmation. This might have led to the status of casual alien species assigned by Bartolucci & al. (2018). The definitive confirmation of its presence as a native species in Sardinia came from Bacchetta & Calvia (in Bartolucci & al. 2019a).

The species is locally common in the Coghinas River basin, especially along the Riu Mannu of Ittireddu, Mores, and Ozieri, the Riu Mannu of Berchidda, and the Rio Badu Alzolas (Berchidda). Further downstream, it forms extensive colonies along the Coghinas River (Perfugas, Bortigiadas). The small population of the Riu Mannu of Oschiri is here confirmed.

In southern Sardinia, the only small population currently existing is found along some small canals in the locality San Genesio (Assemini, Cagliari) (Fig. 2).

Rarity and threats: the species is limited to a few watercourses' stretches, covering a relatively small area of occupancy. The threats for the species are the increased frequency of extreme floods and, conversely, droughts. Alien species, such as *Procambarus clarckii* and *Myocastor coypus*, represent local threats. *Ex situ* actions are needed, and the species should be evaluated for a regional assessment according to IUCN criteria.

Silene inaperta L. (*Caryophyllaceae*)

Distribution update

Findings: Berchidda (Sassari) Rio Badu Pedrosu a monte del ponte di Osseddu. Pratelli sabbiosi prossimi al corso d'acqua (40.741909°N - 9.245905°E) 235-245 m s.l.m. 28-07-2021, *G. Calvia* (Herb. Calvia); Berchidda (Sassari) Rio Badu Pedrosu tra Rattacasu e Badu Chelvinu. Dune fluviali. (40.753095°N - 9.213505°E) 190-200 m s.l.m. 18-08-2019. *G. Calvia* (Herb. Calvia); Berchidda (Sasssari) Riu Mannu tra San Marco e Silvani. Pratelli aridi sabbiosi e ciottolosi tra le dune fluviali (40.758390°N - 9.132132°E). 165-170 m s.l.m. 10-07-2022. *G. Calvia* (Herb. Calvia).

Observations: the species has a western Mediterranean distribution and is documented in Portugal, Spain, southern France, Morocco, Algeria (POWO 2024), Liguria (Pignatti 1982), Corsica (Briquet 1910; Jeanmonod & Gamisans 2013), and Sardinia. In the latter region, the first and only discovery so far dates back to Bianchini & Di Carlo (1988), who found it between Arco dell'Angelo and Arcu Neridu, along the old SS 125 road (Burcei, Cagliari).

The occurrence of the species in south-eastern Sardinia is here confirmed, in the first site, on the floodplain sandy soils along the Riu Ollastu (San Vito, Sud Sardegna) and at Rocca Arricelli (Burcei). In northern Sardinia, we have found the species between Rio Badu Pedrosu and Riu Mannu of Berchidda (Berchidda, Oschiri), on river dunes and in sandy meadows that are colonized by numerous psammophilous species, including prominent ones like *Linaria flava* subsp. *sardoa* (Sommier) A.Terracc., *Marcus-kochia ramosissima* (Desf.) Al-Shehbaz, and *Silene canescens* Ten. These findings confirm the presence of the

species in Sardinia and expand its range to the north of the island after 36 years of no new records (Fig. 2).

Rarity and threats: the area of occupancy of this species in Sardinia is restricted to a few hectares, and its environments are typically sandy places on flooded areas, which are frequently subjected to floodings that can disrupt partially the growing stations. *Ex situ* actions are needed, and the species should be evaluated for a regional assessment according to IUCN criteria.

Spirodela polyrrhiza (L.) Schleid. (*Araceae*)

Distribution update

Findings: Galtellì (Nuoro) Località Logheri/Pappadosa (40,355654°N - 9.571574°E). Pozze del fiume Cedrino, 28-05-1999, *M. Manca* (Herb. Manca); Chiaramonti (Sassari) Bados de Lovè (40.782462°N - 8.887132°E). Pozze del torrente. 165-170 m s.l.m. 07-09-2022, *G. Calvia* (Herb. Calvia)

Observations: this cosmopolitan species is distributed across all continents and is present in nearly all European countries (POWO 2024). In Italy, it was considered rare but can be found in all regions (Pignatti, 1982; Bartolucci & al. 2018). Locally, it is even classified as CR (critically endangered) (Prosser & al. 2020).

The species was first reported in Sardinia by Moris (1827), under *Lemna polyrrhiza* L., in stagnant waters near Riola (Oristano). Nicotra reported it "al Rio scala di Cioca" near Sassari (Nicotra, 1895). This data was not confirmed by Bagella & Urbani (2006). Then, a sample was collected by Cavara & Cossu near Berchidda (specimen seen in SASSA). However, this data was not confirmed by Calvia & Ruggero (2020). More recently, Arrigoni (2015) documented its presence in Oschiri, Ozieri, Bosa, and Oristanese, emphasizing its abundance in the last area only.

In the last decades, we have found the species in a few additional locations, in standing and slow flowing waters, specifically along a stream in the countryside of Chiaramonti (Sassari), Lake Coghinas, Riu Mannu of Berchidda, near Oschiri, Riu Mannu of Mores and Ittireddu, Coluna basin (Alà dei Sardi), and Cedrino River (Galtellì, Orosei - Nuoro) (Fig. 1).

Rarity and threats: despite being rare at a regional level, the species is locally abundant and does not appear threatened, with the sole exception of rare watercourses that can experience the increased frequency of extreme floods, especially when they occur off-season.

Trifolium clusii Gren. & Godr. (*Fabaceae*)

New data and confirmation

Findings: Masainas (Sud Sardegna) (39.019202°N - 8.577555°E). Dune di Is Solinas, 15-20 m 08-04-2022, *G. Calvia* (Herb. Calvia); San Teodoro (Sassari) (40.787735° N - 9.669821°E). Dune di La Cinta, 5 m a.s.l. 08-03-2023, *G. Calvia* (Herb. Calvia).

Observations: this Mediterranean species is predominantly found on the eastern side of the basin (Bulgaria, East Aegean Islands, Turkey, Lebanon-Syria, Palestine, Egypt, Iran), while its occurrence on the western side is rarer, including Morocco, France, Sardinia, and Sicily (Pignatti & al. 2017-2019; POWO 2024).

The presence of this species in Sardinia has been a topic of debate for a long time.

Arrigoni (2010b) considered it as a vicariant of *Trifolium resupinatum* L. in arid meadows, sporadic in the island. He mentioned Moris (1827) as the "*primus inventor*", but the species is absent in either Moris (1827) or Moris (1837-1859). Conversely, Pignatti (1982) did not include it in his flora. More recently, Bartolucci & al. (2018) regarded its presence in Sicily and Sardinia as doubtful, while Pignatti & al. (2017-2019) confirmed its presence on the island following Arrigoni (2010b).

Confirmation of this species in Sardinia was made based on two accidental findings, one in the south-western and one in the north-eastern part of the island. Both growing stations are situated in sandy dunes within coastal, extremely dry environments (Fig. 2).

Rarity and threats: the distribution of the species in Sardinia is undefined because of the lack of information. Consequently, nothing can be said about the threats that the species faces in the island. Given its rarity, *ex situ* actions such as collection of germplasm should be applied.

Utricularia australis R.Br. (*Utriculariaceae*)

Distribution update

Finding: Torpè (Nuoro), Rio Posada (40.632513°N - 9.647790°E). Pozza, 7 m s.l.m., 15-09-2008, *M. Manca* (Herb. Manca); Torpè (Nuoro), (40.640000°N - 9.646667°E). Cave di sabbia sul Rio Posada, 10 m s.l.m., 08-09-2012, *M. Manca* (Herb. Manca, specimens preserved according to Taylor 1989); Torpè (Nuoro), Rio Posada, fra la vegetazione fluviale in tratti a debole corrente (40.628374°N - 9.661389°E e 40.634137°N - 9.675657°E) 6 e 4 m s.l.m., 4-10-2013, *M. Manca* (Herb. Manca); Bitti (Nuoro) Rio Posada loc. Piras, pozza temporanea (40.648645°N 9.479703°E). 123 m s.l.m. 21-05-2023, *M. Manca* (Herb. Manca); Torpè (Nuoro), Foresta Demaniale Usinavà, laghetto artificiale collinare di P.ta Colloredda (40.700560°N - 9.583357°E) 707 m s.l.m. 23-09-2016, *M. Manca* (Herb. Manca); Bitti (Nuoro) Rio Posada, pozza con ninfee ai piedi della SP 95 (40.650653°N - 9.492125°E). 114 m s.l.m. 22-07-2023, *G. Calvia* (Herb. Calvia).

Observations: *Utricularia australis* has a distribution spanning various European countries, Levantine regions (Turkey, Syria, Lebanon, Palestine, Israel), Morocco, Algeria, and Tunisia (Uotila, 2013). In Italy, *U. australis* has been reported in nearly all regions, with the exception of Marche, Molise, Basilicata, and Calabria (Bartolucci & al. 2018). The presence of *U. australis* in Sardinia was initially documented in the lower course of the Coghinas River by Camarda (1995), later cited by Arrigoni (2013) and confirmed by recent personal observations. Desfayes (2008) discovered the species between 1999 and 2000 on the Rio S'Eleme (Monti, Alà dei Sardi), a finding here confirmed. In 2008, the species was further identified along Posada River, then cited into the Italian Flora Red List-II database (Rossi & al. 2020). Ongoing field research within the Tepilora Regional Nature Park has updated the species' distribution in the area. Orrù & al. (2020) provided additional confirmation of its presence in the Posada River, at 53 m a.s.l. (Lodè, Nuoro). Moreover, in the summer 2023, a new station was identified at 114 m a.s.l. (Bitti, Nuoro), along with five growing sites in semi-permanent pools on clay-arenaceous substrates (Alà dei Sardi, Buddusò). A unique finding in southern Sardinia was made in Quirra (Villaputzu, sud Sardegna) in a pool formed by furrows created by the passage of agricultural vehicles, on silty-arenaceous soils (Fig. 2).

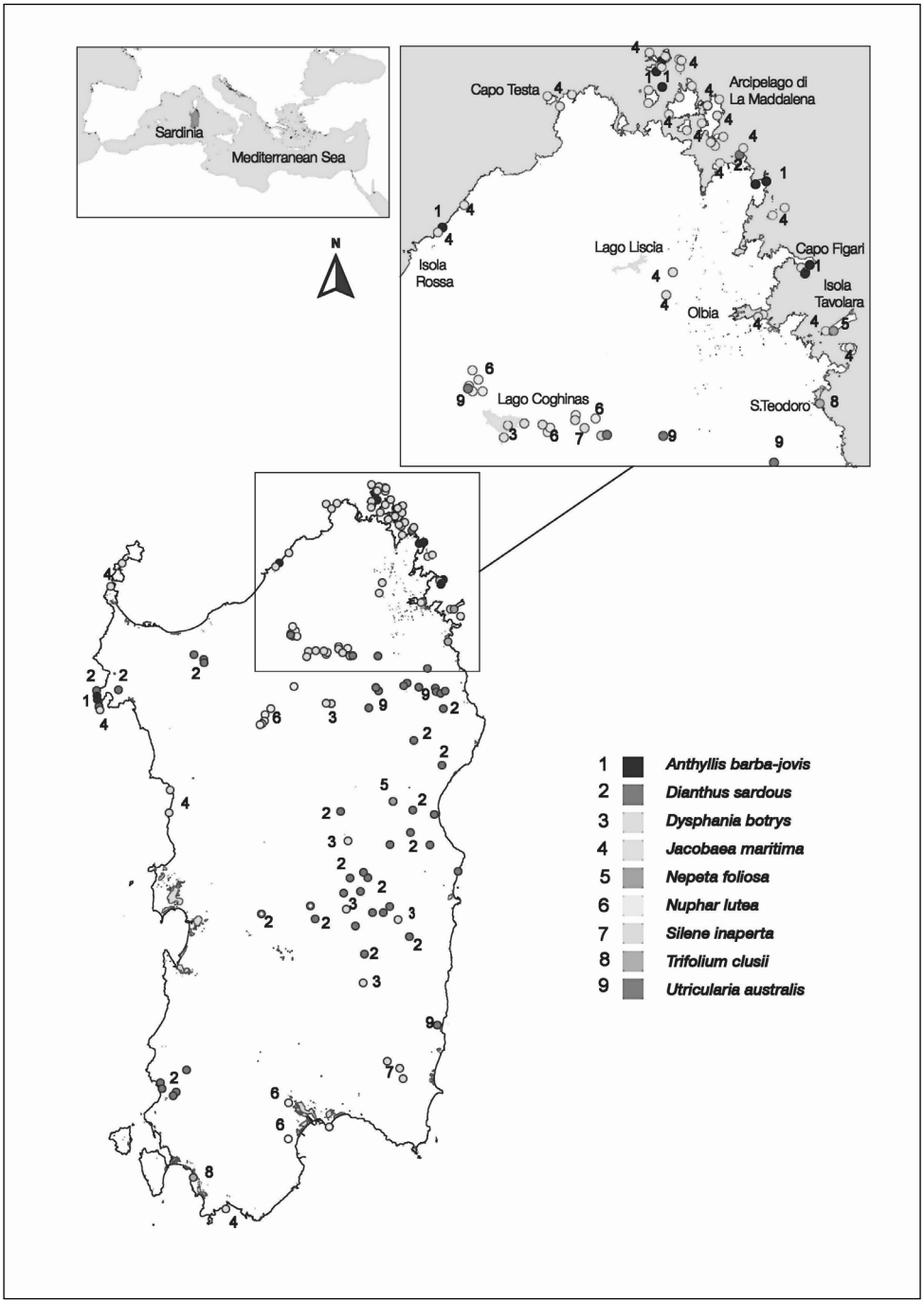


Fig. 2. Distribution map of some native species cited in this article. Pointed circles refer to not confirmed data.

Rarity and threats: despite being categorized in the Red List of Italian flora as Least Concern (LC) (Rossi & al. 2020), *U. australis* is very rare in Sardinia and warrants protective measures. Threats to specific locations encompass habitat alteration, fragmentation, and loss due to changes in hydrological regimes from dam construction, cementification of riverbeds and embarkments, and pollution altering water chemical and physical characteristics. Furthermore, natural events such as extreme floods and droughts can impact certain populations. It is imperative to conduct further research and implement conservation strategies to provide a comprehensive distributional overview and ensure the safeguard of the species on the island.

Alien taxa

Asparagus asparagoides (L.) Druce (*Asparagaceae*)

New station of an invasive species.

Finding: Badesi (Sassari) Li Fughilaggi (40.964392°N - 8.871859°E). Siepe a margine di un coltivo, 30-04-2023, *A. Ruggero* (Herb. Ruggero).

Observations: the species is native to South Africa, considered a naturalized neophyte in Italy, and reported in Calabria, Campania, Liguria, Sardinia, and Sicily (Galasso & al. 2018a; Mariotti & Zappa 2022; Spampinato & al. 2022). Its presence in Sardinia was first noted by Podda & al. (2010), sub *Elide asparagoides* (L.) Kerguélen, in the central-southern part of the island (Cagliari, and Pauli de Sali, Cabras, Oristano), then confirmed by Lazzeri & al. (2013) in the Molentargius-Saline Regional Natural Park (Cagliari).

This report extends the taxon' distribution range to the northern part of the island, where it grows on hedgerows close to cultivated fields. It is challenging to determine in this specific location whether the species has spread naturally or was cultivated and subsequently naturalized (Fig. 3).

Invasiveness: over the past decade, the species has widely naturalized and displays a strong tendency to colonize, notably in the Molentargius Park, where it can be now considered invasive.

Brachychiton populneus (Schott & Endl.) R.Br. (*Malvaceae*)

New casual taxon for the flora of Sardinia

Finding: Cagliari, "Fossa di S. Guglielmo" (39.220724°N - 9.115218°E). 70 m s.l.m. 05-05-2018, *L. Podda*, *G. Calvia*, *G. Bacchetta* (CAG)

Observations: this tree has an eastern Australia origin (Buist & al. 2001) and has rarely become naturalized in some countries such as California, Ecuador, Greek islands, Pakistan, Spain, and Trinidad and Tobago (POWO 2024). In Italy, the species is reported as naturalized in Sicily (Galasso & al. 2018a).

During a study on the old walls and ramparts of Cagliari, we first recorded the presence of the species in Sardinia through the finding of a few small trees naturally growing in fallow lands, close to the historical center of Cagliari. We also observed a few seedlings growing close to a planted tree, in fallow lands in the suburbs of Carbonia (Sud Sardegna) (Fig. 3).

Cenchrus setaceus (Forssk.) Morrone (*Poaceae*)

New stations of an invasive species.

Findings: Sarroch (Cagliari) strada privata nei pressi incrocio strada statale 195 e deviazione per Cagliari (39.054412°N - 08.992222°E). Margini stradali. Substrato alluvioni quaternarie. Bioclima termomedit. sup./secco sup., 57 m s.l.m., 14-10-2018, *G. Bacchetta*, *I. Orrù*, *L. Podda* (CAG); Berchidda (Sassari) (40.782001°N - 9.169127°E): Ingresso del paese, sul marciapiede 223 m s.l.m. 31-08-2023, *G. Calvia* (Herb. Calvia); Olbia (Sassari) Capo Ceraso (40.909028°N - 9.606412°E). Cigli stradali e vialetti verso la spiaggia di Li Cuncheddi, 10-20 m s.l.m. 14-09-2023, *G. Bertotto* (SS).

Observations: this species, native to northern and eastern Africa, the Arabian Peninsula, and Afghanistan (POWO 2024), has been introduced worldwide for ornamental purposes and soil stabilization, rapidly spreading in dry climates such as Mediterranean regions (Spampinato & al. 2019). In Italy, it is considered invasive in Calabria, Sicily, and Sardinia, naturalized in Apulia and Campania, and casual alien in Tuscany and Latium (Galasso & al. 2018a, 2018b). In Sardinia, *Cenchrus setaceus* was first reported in Pula (Caglairi) by Bocchieri (1981, specimen seen in CAG) and is now widespread in several municipalities of the metropolitan city of Cagliari.

The species is listed in the European Union's regulation on invasive alien species (EU Regulation 1263/17) since 2017 (Brundu & al. 2020) this controls and prohibits the introduction, or disposes the eradication of alien taxa if they threaten ecosystems, habitats, or species (referring to Article 4 of EU Regulation 1143/2014). Nonetheless, in north Sardinia, various florists and garden designers seem to continue commercializing and using it, especially as an ornamental plant in coastal villas and along roadside flowerbeds, as observed in the Municipality of Olbia.

Between 2017 and 2023, *C. setaceus* has been observed in various areas of Sardinia. The species colonizes ruderal, fallow lands, sidewalks, road margins, and paths, in the municipalities of Arzachena (La Celvia), Berchidda, Olbia (Rudalza, Cugnana, industrial zone, Li Cuncheddi), San Teodoro (Vacciledi, Punta Aldia-Lu Impostu), Oristano (industrial docks), Assemini (SS 130), Elmas (outskirts, industrial zone, airport), Monserrato (outskirts), Selargius (industrial zone, SS 554), Sestu (industrial zone, SP 8), Capoterra (Frutti d'Oro, Torre degli Ulivi), Sarroch, Pula (Is Molas, Santa Margherita, SS 195), Domus de Maria (Chia), Carbonia (along SP 2 near Genna Corriga, city center, bike path to San Giovanni Suergiu) (Fig. 3).

Invasiveness: the species exhibits aggressive spreading capabilities and can colonize new areas in very short periods (Pasta & al. 2010; Spampinato & al. 2019). Therefore, a joint effort from the scientific community, gardeners and private nurseries, public authorities, and regulatory bodies is essential to eradicate the species before it becomes an irreversible problem and further compromises the already fragile coastal ecosystems, strained by rampant tourism, negligence, and underestimation of the impact of invasive species on natural environments.

Chloris gayana Kunth (*Poaceae*)

New station of a naturalized species

Finding: Alghero (Sassari) lungomare Valencia (40.549490°N - 8.320826°E). Scarpata, bordo strada. 10 m s.l.m. 16-08-2023, leg. *D. Locci*, det. *L. Podda* (CAG).

Observations: this robust, stoloniferous herbaceous plant, native to Africa (POWO 2024), has been previously reported as casual only in southern Sardinia, in Villa S. Pietro (Podda & al. 2010), in Sicily (Di Gregorio & al. 2017), and Calabria (Galasso & al. 2022a), but it is considered invasive in many parts of the world (Rojas-Sandoval 2022). The new site is located on the waterfront of Alghero, where it was likely used as an ornamental species or for slope stabilization, from which it escaped, spreading in the surrounding areas. It is also confirmed the presence of the species in the southernmost site, where the species can be currently considered as naturalized (Fig. 3).

Invasiveness: given its potential invasive nature (Mahklouf 2019) it would be advisable to monitor its presence in the future.

Convolvulus sabatius subsp. ***mauritanicus*** (Boiss.) Murb. (*Convolvulaceae*)

New naturalized taxon for the flora of Sardinia

Finding: Luras (Sassari) Li Espi (41.009359°N - 9.264838°E). A margine della strada, naturalizzata, 20-11-2016, *A. Ruggero*, *G. Calvia* (Herb. Ruggero).

Observations: *Convolvulus sabatius* Viv. has a western Mediterranean distribution. In Italy, the typical subspecies is known as native only from a few sites in Liguria (Bartolucci & al. 2018). On the other hand, the subspecies *mauritanicus* is native to the mountains of Morocco and Algeria (Carine & Robba 2010; Wood & al. 2015). Both subspecies have been utilized in gardens and have escaped cultivation over time (Carine & Robba 2010; Wood & al. 2015). In Italy, the subspecies *mauritanicus* is a naturalized neophyte found in Liguria, Tuscany, Latium, and Apulia (Carine & Robba 2010; Lazzeri & al. 2017; Galasso & al. 2019; Longo & al. 2022).

This is the first record for Sardinia and involves a small population likely escaped to cultivation near a resort close to Lake Liscia (Luras, Sassari). Here, the species is slowly colonizing fallow land, some country road margins, dry meadows, and the base of granitic rocks (Fig. 3).

Cyperus brevifolioides Thieret & Delahouss. (*Cyperaceae*)

New naturalized alien species for the flora of Sardinia

Finding: Arzachena (Sassari) Cala di Volpe (41.095445°N - 9.537895°E). Presso una villa privata, su prato ornamentale di *Cynodon* spp., substrato irrigato. 16-09-2023, *A. Lallai* (CAG); San Teodoro (Sassari) Capo Coda Cavallo (40,841079°N - 9.698305°E). Pratelli e avvallamenti umidi, 14-09-2023, *G. Bertotto* (SS).

Observations: this perennial herbaceous plant, originally from East Asia, has been reported as an alien species in the eastern United States, the Caucasus region (POWO 2024), the Iberian Peninsula (Luceño & al. 2008, sub *Kyllingia brevifolia* Rottb.), and Italy (Galasso & al. 2018a). In Italy, it is noted as naturalized in Lombardy, where it was first discovered in 1950 as a species infesting rice fields (Galasso & al. 2006).

This is the first record of the species in Sardinia, and it has to be considered a naturalized alien. During the summer 2023 the species has been identified in irrigated ornamental meadows in Costa Smeralda (Arzachena), likely arriving as impurities in grass seeds. It was also found in the localities Cugnana (Olbia), and Capo Coda Cavallo (San Teodoro) and close to Bari Sardo (Nuoro), along a small canal near a country road (Fig. 3). In the Capo Coda Cavallo site, the species displays a strong tendency to colonize nearer wet environments.

Digitaria ciliaris (Retz.) Koeler (*Poaceae*)

New stations (certain) of a naturalized species

Finding: Arzachena (Sassari), presso Hotel Romazzino (41.099609°N - 9.562951°E). In aiuola, 01-10-2023, *A. Ruggero* (Herb. Ruggero).

Observations: this species, originally widespread in tropical and subtropical regions of Asia and Africa, has become globally distributed (POWO 2024). In Italy, it is considered a naturalized alien species found in all regions except Val d'Aosta, Apulia, and Marche (Galasso & al. 2018a, 2020). While the presence of this taxon in Sardinia was reported multiple times (Celesti-Grapow & al. 2010; Podda & al. 2012; Puddu & al. 2016; Galasso & al. 2018a), these reports have been general and lacking specific references to its actual distribution, except for the detailed report by Pau G.B. on the Acta Plantarum forum (Topic_id: 115784) concerning Siniscola (Nuoro).

The station here reported is located in Costa Smeralda (Arzachena) in a flowerbed planted with *Lantana* sp. and irrigated (Fig. 3).

Invasiveness: this growing station borders for several hundred meters the sidewalk leading to the Hotel Romazzino. The population is extensive, potentially invasive, but with slender plants. Therefore, monitoring its future development is necessary. Identifying species within the genus *Digitaria* is complex and requires careful examination of spikelet morphology, thus the distribution of several species is often not well understood (Wilhalm 2009). The observed population is characterized by slender plants with few culms and an inflorescence with only two sub-digitate racemes, a habit more fitting for *D. ischaemum* (Schreb.) Muhl. and *D. radicosa* (J. Presl) Miq. However, the former has ternate spikelets, at least in part of the spike, rather than paired, and the latter has narrower spikelets and a smaller upper glume (Verloove 2008; Wilhalm 2009).

Eclipta prostrata (L.) L. (*Asteraceae*)

New station of an invasive species

Finding: Luras (Sassari), Li Espi (41.009393°N - 9.271096°E). Lago Liscia, prati temporanei sulle rive del lago, 15-06-2016, *A. Ruggero* (Herb. Ruggero).

Observation: this species, native to the tropical Americas, is considered an invasive neophyte in Italy, where it is found in all regions except Val d'Aosta, Friuli-Venezia Giulia, and Molise (Galasso & al. 2018a). In Sardinia, this taxon was initially reported by Marchioni Ortu & al. (1988) in rice fields in the areas of Oristano and Muravera (Sud Sardegna). Subsequently, it was confirmed in the same environment (Brundu & al. 1998; Cossu & al. 2014; Arrigoni 2015a). More recently, Lazzeri & al. (2015) indicated the taxon for the mouth of Rio di Pula (Cagliari) a more natural habitat, confirming that the species is gradually expanding.

In south Sardinia, we observed the species widespread at the rice fields of San Gavino Monreale, at the mouth of Rio Foxi and Villasimius along with some sparse plants near Assemini and in the meadows of the Terramaini Park (Cagliari).

The species, at the northernmost station, is invading temporary meadows that form on the shores of the artificial lake on the Liscia River when the water level drops in the summer months, in a semi-natural context (Fig. 3).

Invasiveness: this species, whose invasiveness is well known (Shengjing & al. 2021), was already cited as invasive in Sardinian rice fields by Cossu & al. (2014). Later, this infor-

mation was not recorded by Galasso & al. (2018a). Here we confirm that the species is to be considered invasive in the island, not only in rice crops, but also in natural and semi-natural environments.

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

New growing stations of a naturalized species

Finding: Monti (Sassari) SS 729, 111 m s.l.m. (40.837654°N - 9.380276°E). 02-05-2023, leg. *G. Bertotto*, det. *G. Calvia* (SS); Oschiri (Sassari) SS 729 tra Su Campu e Rio Paulu ‘e Carru (40.682795°N - 9.026600°E). Scarpate, cigli stradali. 185 m s.l.m. 20-9-2023, *G. Calvia* (Herb. Calvia).

Observations: this species, originating from sub-Saharan Africa, is now spread in the Americas, Australia, New Zealand, China, India, Japan, and Europe (Roberts & al. 2021). It has been reported in several Italian regions: Piedmont, Veneto, Tuscany, and Calabria as naturalized; Trentino-Alto Adige, Latium, and Sardinia as casual (Galasso & al. 2018a).

In Sardinia, it was first reported in 2013 (Lazzeri & al. 2013) along the SS 131 DCN road, between the municipalities of Oniferi and Orotelli (Nuoro). After that, the species was not reported for several years. However, in the last two years, its presence has become increasingly widespread along the SS 729 Sassari-Olbia Road, where it appears extensively along the embankments and road edges, especially between Olbia and Monti, Berchidda, and between Oschiri and Tula (Fig. 3).

Invasiveness: given its known invasive potential (Muranaka & Washitani 2004; Han & al. 2012), the creation of the mentioned new road junction is likely facilitating its spread in various parts of northern Sardinia. Its presence should be closely monitored in the future.

Halophila stipulacea (Forssk.) Asch. (*Hydrocharitaceae*)

Distribution update of an invasive species.

Finding: Olbia (Sassari) spiaggia delle Vecchie Saline (40.907447°N - 9.573255°E). Fondali bassi sabbiosi. 31-07-2022, leg. *G. Calvia* - det. *E. Trainito*, *G. Calvia* (Herb. Calvia).

Observations: this tropical species is native to the Red Sea and Indian Ocean (Winters & al. 2020). Due to the opening of the Suez Channel, the species easily colonized the Mediterranean Sea, eventually reaching the Italian and Tunisian coasts (Georgiou & al. 2016). In Italy, it is currently recognized as naturalized in Apulia, Calabria, Campania, Sicily (Galasso & al. 2018a) and Sardinia (Galasso & al. 2022b).

The initial record in Sardinia dates back to 2018, in shallows near Razza di Juncu beach (Arzachena, Olbia). Subsequently, in 2020 the species was identified near the harbor of Golfo Aranci, in sandy sea floors (Pica & al. 2021). Further surveys along the north-eastern Sardinian coasts highlighted the invasiveness of the species, which has greatly extended its distribution in the area of Golfo Aranci, in the external portion of the Gulf of Olbia and up to the Tavolara-Punta Coda Cavallo Marine Protected Area, as far as the Porto San Paolo cove and Tavolara Island (Fig. 3).

Invasiveness: the species prefers sandy seabed areas at depths ranging from 1.5 to 10 meters, often occupying substantial areas, which can span tens of square meters. In the

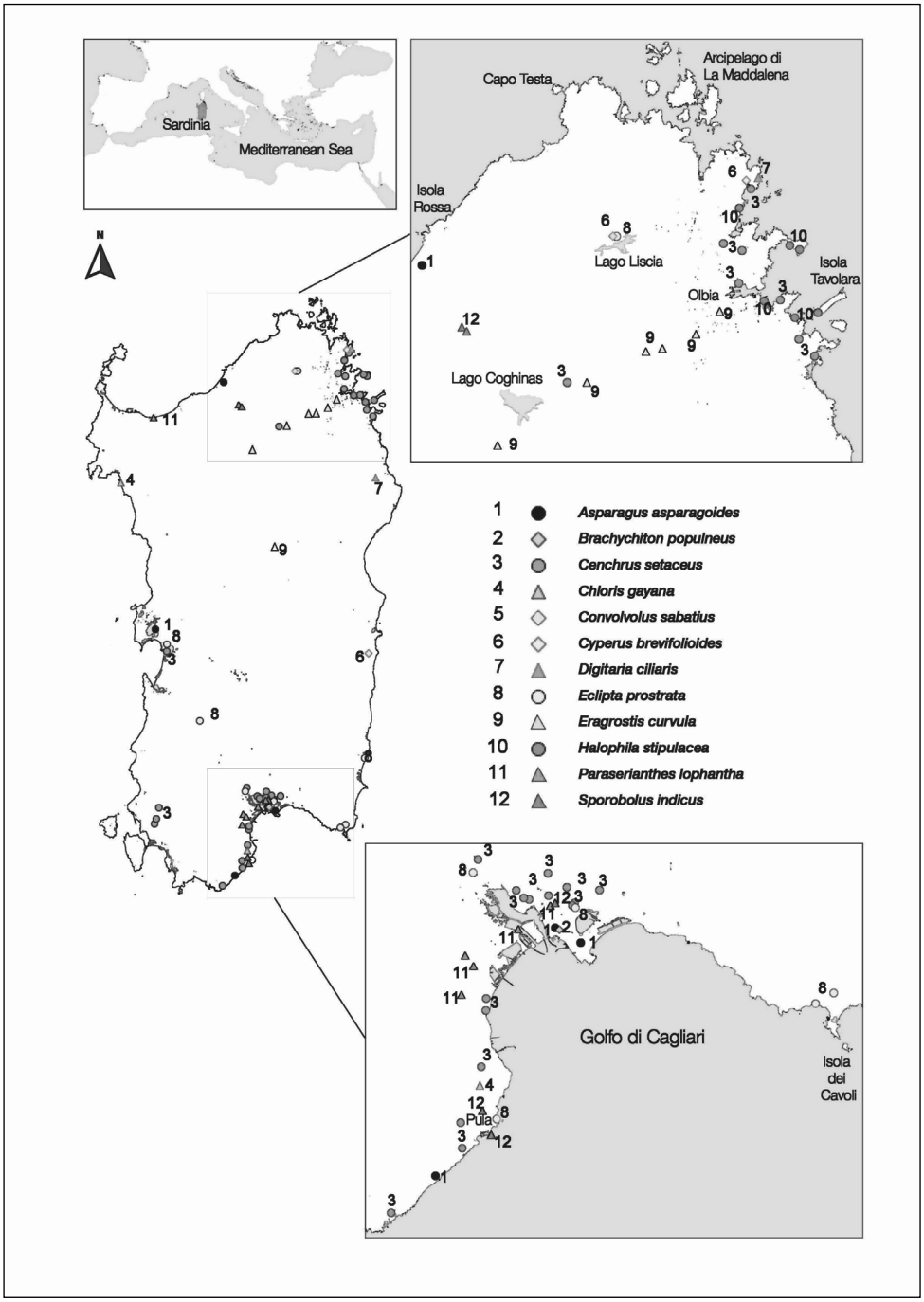


Fig. 3. Distribution map of the alien taxa cited in this article. Rhombuses refer to new taxa from Sardinia, triangles to naturalized taxa, and circles to invasive taxa. Pointed symbols refer to not confirmed data.

Spalmatore di Terra bay at Tavolara, where the *Posidonia oceanica* (L.) Delile meadow has been deeply impacted by small and large vessels anchoring, the muddy seabed is crossed by deep furrows and dug up with scattered large blocks of dead matte and deep holes; at lower depths, it is colonized by the native *Caulerpa prolifera* (Forsskål) J. V. Lamouroux and by the alien algae *C. cylindracea* Sonder and *C. taxifolia* (M. Vahl) C. Agardh, while at the unusual depth of 25-27 m there is a dense and extended prairie of *Halophila stipulacea.*

Paraserianthes lophantha (Willd.) I.C.Nielsen (*Fabaceae*)

New station of a naturalized species

Finding: Sorso (Sassari) stagno di Platamona, riva settentrionale (40.816498°N - 9.487831°E). Naturalizzata in pineta artificiale a *Pinus pinea*, 15-12-2019 *A. Ruggero*, *A. Di Giacomo* (Herb. Ruggero).

Observations: originally native to West Australia, Java, Sumatra, and the Sunda Islands, this taxon has subsequently spread to various regions globally (Thompson & al. 2013; POWO 2024). In Italy, it is regarded as a naturalized neophyte, found in Liguria, Tuscany, Campania, Apulia, Sicily, and Sardinia (Galasso & al. 2018a). In Sardinia, it was broadly reported as a naturalized neophyte without precise locations (Celesti-Grapow & al. 2010; Podda & al. 2012; Puddu & al. 2016; Galasso & al. 2018a), then specifically along Rio Santa Lucia in Capoterra (Galasso & al. 2021). Arrigoni (2010) reported it as cultivated and tending to naturalize. To our knowledge, additional locations where the species is naturalized in southern Sardinia include new sites along Rio Santa Lucia (Assemini and Capoterra), Porto Canale (Cagliari) and Poggio dei Pini (Capoterra).

This current report expands its distribution further North on the island. The population is situated in the northern part of the Platamona pond (Sorso), within the narrow strip separating the waterbody from SP 81 road, in an artificial pine grove predominantly composed of *Pinus pinea* L. and invasive *Acacia saligna* (Labill.) H. L.Wendl. (Fig. 3).

Invasiveness: this population consists of several dozen specimens of various ages, potentially posing an invasive threat in the near future, as also observed along the lower part of Rio Santa Lucia. Monitoring its expansion is crucial to prevent potential ecological impacts since the species is known to have a great invasiveness potential (Thompson & al. 2013).

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

New station of a naturalized species

Findings: Bortigiadas (Sassari) fiume Coghinas presso Scala Ruja (40.866615°N - 8.953762°E). Sponde fluviali, su sabbie umide, 12-08-2004, *A. Ruggero* (Herb. Ruggero), sub *Sporobolus poiretii* (Roem. & Schult.) Hitchc.; Bortigiadas (Sassari) fiume Coghinas, Middinu (40.860331°N - 8.963111°E). Incolti aridi a margine di una pista, 01-05-2012, *A. Ruggero* (Herb. Ruggero), sub *Sporobolus poiretii* (Roem. & Schult.) Hitchc.

Observations: this North American species is considered a naturalized neophyte in Italy and is present in all regions except Apulia and Val d'Aosta (Galasso & al. 2018a, 2019, 2020). Its presence in Sardinia was initially reported at Brotzu Hospital in Cagliari (Campus & De Pascali 2017). Subsequently, other populations were discovered in arti-

ficial meadows near Nora and Pula (Cagliari), from which it is spreading to surrounding areas (Galasso & al. 2022).

Our discovery, predating the first report on the island but still confirmed, expands the taxon's range in Sardinia and places it in a more natural context, similar to the population found in Marche (Galasso & al. 2019). The species was found near the Coghinas River, on its riverbanks, in a humid environment, and occasionally nearby, on dryer pastures and fallow fields (Fig. 3).

Invasiveness: as far as we know in northern Sardinia, after 20 years from the first finding, the species is naturalized, but does not show any tendency to invade the habitats it occupies. About the diffusion of the taxon in this area, it can be hypothesized an origin of this population linked to the transportation of seeds by migratory birds (Viana & al. 2016).

Conclusions

In the course of extensive research aimed at deepening our knowledge of the vascular flora of Sardinia, with specifical focus on its northern side, three new taxa have been recorded for the flora of the island, two naturalized (*Convolvulus sabatius* subsp. *mauritanicus* and *Cyperus brevifolioides*) and one casual alien taxa (*Brachychiton populneus*). Several other taxa of phytogeographic interest or endemic, along with naturalized or invasive alien species, have been identified. When deemed noteworthy, their distribution has been updated for Sardinia. We report 27 taxa for which knowledge in northern Sardinia was previously incomplete or sometimes not existent. We have clarified or updated the distributional aspects regarding several taxa not previously reported in north Sardinia (*Allium savii*, *Asparagus asparagoides*, *Butomus umbellatus*, *Chloris gayana*, *Disphania botrys*, *Paraserianthes lophantha*, *Sporobolus indicus*), rare taxa for which the range has been extended or clarified (*Allium sardoum*, *Anthyllis barba-jovis*, *Asplenium marinum*, *Bellevalia romana*, *Cladium mariscus*, *Dianthus sardous*, *Jacobaea maritima* subsp. *maritima*, *Leersia oryzoides*, *Nepeta foliosa*, *Nuphar lutea*, *Spirodela polyrrhiza*, *Utricularia australis*), rare taxa for which scarce data left doubts about their current persistence on the island (*Fuirena pubescens*, *Silene inaperta*, *Trifolium clusii*), and a taxon generically reported as a naturalized alien without any distributional reference in previous publications (*Digitaria ciliaris*). Furthermore, for some naturalized or invasive alien taxa (*Cenchrus setaceus*, *Eclipta prostrata*, *Eragrostis curvula*, *Halophila stipulacea*), the distribution has been expanded, emphasizing the need for future monitoring, control, and even eradication efforts in areas where such invasions are occurring. Finally, highlighting the importance of field research, we emphasize the need for further studies to make the knowledge of the Sardinian floristic heritage more comprehensive.

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Article

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Floristic and phytogeographic analysis of Moulay Driss Zerhoun massif (Prerif), Morocco

Abstract

Boudik, S., Benkhnigue, O., Magri, N., Khamar, H., Belahbib, N., Zidane, L. & Dahmani, J.: Floristic and phytogeographic analysis of Moulay Driss Zerhoun massif (Prerif), Morocco. — Fl. Medit. 34: 47-61. 2024. — ISSN: 1120-4052 printed, 2240-4538 online.

The region of Moulay Driss Zerhoun, located north of the city of Meknes, hosts a remarkable plant diversity. The sampling conducted in 2022, resulted in the inventory of 407 taxa belonging to 257 genera and 67 families. The objective of the present work is to proceed to the floristic analysis of the species list elaborated to facilitate the implementation of conservation strategy of natural heritage. Thus, the overall biological spectrum shows a dominance of therophytes (49.38%) over other life forms. The endemic element is well represented (8.6%). Also, the rare or threatened flora is estimated at 6.63%. The chorological spectrum indicates a significant dominance of Mediterranean species (60%).

Key words: Fes Meknes region, N Africa, flora, endemism, rarity, chorology, conservation.

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Introduction

By its geographical position, between the two seas, Morocco offers, compared to other circum-Mediterranean countries, an original orography and climate, to which respond an original flora and vegetation. Indeed, the high mountain ranges that can exceed 4,000 m in altitude have a complex and highly compartmentalized structure, and the plateaus and plains are extensive (Benabid 1985). Morocco is the richest country in the southern Mediterranean region in terms of biodiversity, due to its different ecological systems, ranging from humid mountains to a Saharan environment (Benabid 2000; Benzyane & al. 2010). Indeed, the Moroccan flora currently includes nearly 4500 species and subspecies belonging to 940 genera and 135 families (Benabid 2000). More recent statistics established by Fennane & al. (2023), speak instead of 3800 species, 80 hybrids and 1400 of subspecies, divided into 140 families and 979 genera. These authors explain these differences by taxonomic rearrangements since at the family level, only that of *Dracaenaceae* is new

for Morocco (Benabid & Cuzin 1997). Also, there are taxa of doubtful presence or whose chorology remains to be clarified (Fennane & al. 1999-2014). The flora of Morocco is still poorly estimated and requires further study. In this context, we are interested in the study of the flora of the Moulay Driss Zerhoun massif located in the north of Morocco, in the region of Fes-Meknes, Province of Meknes. The city, bearing the same name, located in the center of the massif, was built around the tomb of My Driss the First, founder of the dynasty of Idrissides. The area is therefore of great historical interest. That's why it has been registered by Morocco in the tentative list of the UNESCO world heritage. The scientific interest that we have in this region comes after preliminary surveys that have revealed a little polluted area, with a rich and remarkable biodiversity and not yet deeply explored. Indeed, Studies carried out in the region include Sauvage (1933), Emberger (1939), Montserrat & al. (2006) and Valdés & al. (2002) and an ethnobotanical study (Slimani & al. 2016) that identified 111 medicinal plants used by the natives in phytotherapy. In addition, the frequency and the important coverings of lichens show the originality of the region whose plant heritage still seems well preserved. Thus, the objective of this study is a floristic analysis and to evaluate the rate of endemism, threatened taxa, geographical distribution in Morocco and chorology. of the Moulay Driss Zerhoun massif.

Materials and Methods

Study area

The Zerhoun region covers a total area of 55,800 ha (Dpam 2010) north of the city of Meknes. It is part of the Wilaya of Meknes and is bordered to the north by the provinces of Sidi Kassem and Taounate, to the south by the Dkhissa area, to the east by the province of Zouagha Moulay Yaakoub and to the west by the area of Ain Jemaâ (Fig. 1). The climate is Mediterranean, characterized by mild, wet winters and very hot, dry summers. The average annual precipitation of the area is estimated at 580 mm and is characterized by high interannual variability (CCA 2018). Indeed, the year 2021 had a low rainfall not exceeding 345.5 mm (Table 1), while the year 2018 was very rainy with a rate of 770 mm (Infoclimat 2022), this in the city of Meknes, which is the closest point to the study area (18 km) and for which climatic data are available. The difference between maximum and minimum temperatures during the same year is significant (Tab. 1).

Already in 1930, Dresch had described the My Driss Zerhoun massif as an entity formed essentially by two folds that extend southward. The southern bundle includes, on the one hand, the Kannoufa and Takerma djebels and, on the other hand, the Nosrani and Takouch djebels, constituted by domerian limestones and extended towards the West by the Zerhoun djebel, constituted by sandstones undoubtedly Jurassic.

Methodology

The sampling adopted is stratified. The division into homogeneous strata was made according to three criteria: geological substratum (sandstone, marl, or limestone), exposure (north or south) and vegetation facies (*Calycotome intermedia* facies and *Zizyphus lotus* facies of the *Oleo-lentiscetum*, *Pistacia Terebinthus* facies and

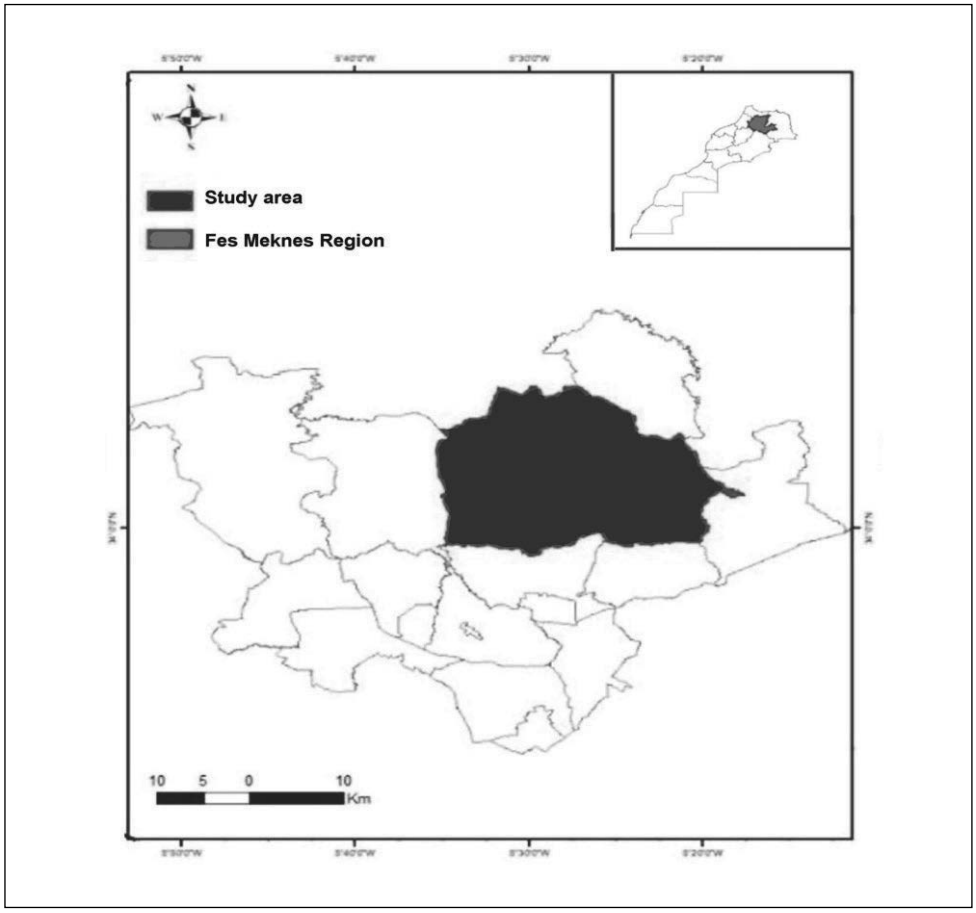


Fig.1. Location of Moulay Driss Zerhoun Region.

Adenocarpus-telonensis facies of the holm oak grove) Sauvage (1933-1934), Benabid (2000). Without forgetting special habitats such as cliffs (ex. Cliff Limestone El Kifane Jbel Abdelkarim, Cliff Karmos).

Data collection on the chorological types of the various taxa is based on (Quézel & Santa 1962-1963; Valdés & al 2002; Fennane 2021; Fennane & Ibn Tatou 2005, 2008) when data are available and then completed from Telabotanica (2022), threatened and endemic species are indicated after consultation of the red book (Fenanne 2021). The practical flora of Morocco (Fennane & al. 1999, 2007, 2014) is used to determine the flowering season, bioclimate and range in the geographical divisions of Morocco. The data collected is recorded on cards for analysis and study at the end. These data were then entered and analyzed using Microsoft Excel 2016.

Table 1. Temperatures and precipitations of the city of Meknes for the year 2022 (Infoclimat 2022).

Average maximum temperature	25.1°C
Average minimum temperature	11.1°C
Average temperature	18.1°C
Extreme maximum temperature	46.8°C recorded on July 10
Extreme minimum temperature	-1.2°C recorded on January 4
Précipitation annuelle	345.5 mm

Results and discussions

Floristic composition

Taxonomic analysis yields 407 plant species, 257 genera and 67 families (Boudik & al. 2024), or 7% of the Flora of Morocco estimated by Fennane & Ibn Tattou (2012) to be 5211 species and subspecies, 26% of the total genera (981; Fennane 2012) and 42% of the total families recorded in Morocco (155 families) Fennane (2012). The observed species belong to 50 Dicotyledons, 12 Monocotyledons, 4 Pteridophytes and 1 Gymnosperm. *Asteraceae* is the most represented family (50 species) followed by *Fabaceae* (47 species), *Poaceae* (39 species) and *Lamiaceae* (25 species). The other families are represented by only one taxon (Tab. 2). The three families specifically with the highest diversity are also the most diverse on the Moroccan territory and occur in the same order established by Fennane (2012).

Life form spectrum

Raunkier (l905), defines the life form according to the position of of the survival organs (persistent buds) in relation to the ground, during the unfavorable period; the life forms considered in the present work are: Phanerophytes, Chamephytes, Hemicryptophytes, Geophytes and Therophytes. For each taxon presented in the catalog, is assigned a biological type.

Analysis of the life form (Fig. 3) shows the specific dominance of Therophytes (Th) with a percentage of 49.38%. Then come the Hemicryptophytes (Hem) with 16.21%, followed by the Phanerophyte (Ph) with 12.53% and finally the Geophytes and Chamephytes with respectively 11.30% and 10.56%. At the scale of the Mediterranean basin and particularly in Morocco, the dominance of therophytes (Aafi 2005; Bammi 2004) is thought to be linked to the climate characterized by a dry and hot summer period (Daget 1980; Barbero & al.1990) and the opening of vegetation (Daget 1980). Thus, these authors agree to present Therophytes as a form of resistance to drought and high temperatures of arid environments.

Table 2. Generic and specific richness of the families recorded in Moulay Driss Zerhoun (**NbG:** Number of genera; **Nbsp:** Number of species and subspecies).

Family	**NbG**	**Nbsp**	**Family**	**NbG**	**Nbsp**
Aspleniaceae	1	3	*Convolvulaceae*	2	5
Polypodiaceae	1	1	*Crassulaceae*	4	7
Pteridaceae	1	1	*Cucurbitaceae*	1	1
			Ericaceae	1	1
Selaginellaceae	1	1	*Euphorbiaceae*	2	5
Cupressaceae	1	1	*Fabaceae*	20	47
Amaryllidaceae	2	4	*Fagaceae*	1	2
Araceae	1	1	*Gentianaceae*	3	3
Arecaceae	1	1	*Geraniaceae*	2	10
Ericaceae	1	1	*Hypericaceae*	1	4
Asparagaceae	6	10	*Lamiaceae*	15	25
Asphodelaceae	1	1	*Linaceae*	1	3
Cyperaceae	1	1	*Lythraceae*	1	1
Dioscoreaceae	1	1	*Malvaceae*	1	2
Iridaceae	1	1	*Moraceae*	1	1
Liliaceae	1	2	*Oleaceae*	4	4
Orchidaceae	2	4	*Oxalidaceae*	1	1
Poaceae	30	39	*Papaveraceae*	4	4
Smilaceae	1	1	*Plantaginaceae*	7	9
Acanthaceae	1	1	*Plumbaginaceae*	2	2
Adoxaceae	1	1	*Polygonaceae*	1	3
Amaranthaceae	1	1	*Primulaceae*	2	2
Anacardiaceae	2	5	*Ranunculaceae*	4	8
Apiaceae	16	23	*Resedaceae*	1	2
Apocyanaceae	1	1	*Rhamnaceae*	2	3
Aristolochiaceae	1	2	*Rosaceae*	7	7
Asteraceae	35	50	*Rubiaceae*	9	13
Boraginaceae	7	9	*Rutaceae*	1	2
Brassicaceae	7	12	*Santalaceae*	1	1
Campanulaceae	3	5	*Scrophulareaceae*	1	1
Capparaceae	1	1	*Solanaceae*	3	4
Caprifoliaceae	3	5	*Tamaricaceae*	1	1
Caryophyllaceae	9	19	*Thymelaeaceae*	2	2
Cistaceae	4	8	*Urticaceae*	2	4
Convolvulaceae	2	5	*Verbenaceae*	1	1
Total : 67 families ; 257 genres et 407 species					

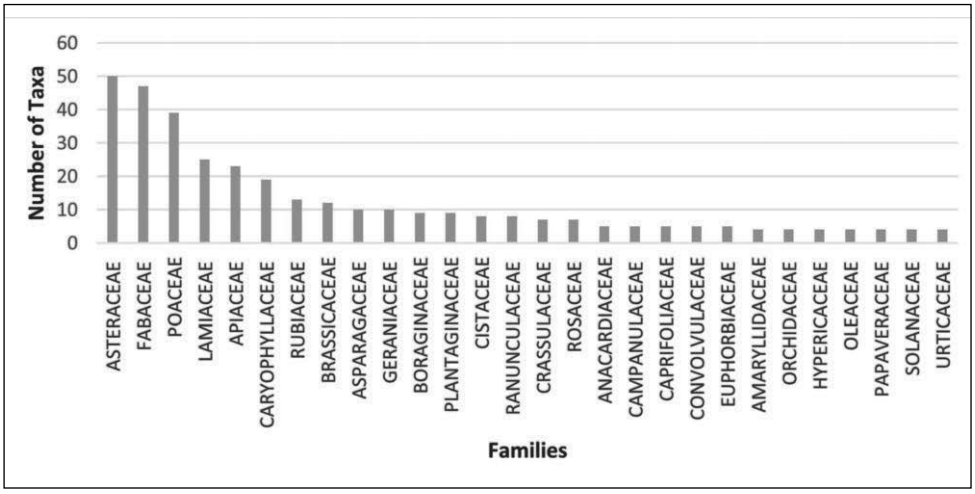


Fig. 2. Specific richness of botanical families in Moulay Driss Zerhoun.

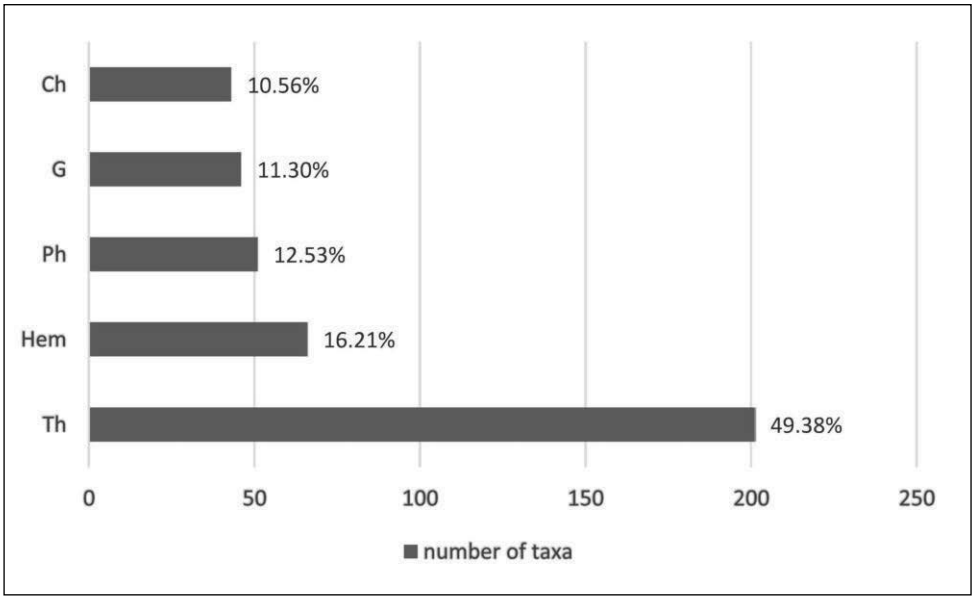


Fig. 3. Life form spectrum of the vegetation of the Zerhoun region.

Flowering period

The majority of species inventoried in the region flower in spring (46%) followed by 34% in summer, 15% in winterand 5% in autumn (Fig. 4). The latter are mainly therophytes such as *Bromus rubens* L.*, Brachypodium distachyon* (L.) P. Beauv.*, Briza minor*

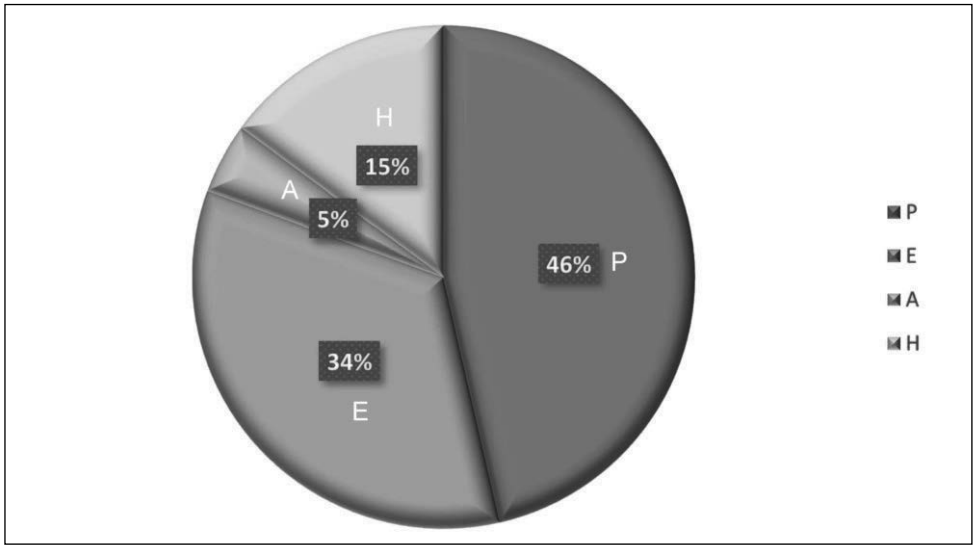


Fig. 4. Distribution of plant species in the Moulay Driss Zerhoun region according to their flowering period. P: Spring; E: Summer; A: Autumn; H: Winter.

L., *Bellis annua* L., *Scorzoneroides muelleri* (Sch.Bip.) Greuter, *Alyssum alyssoides* (L.) L., etc. The landscape in the region is characterized by this flowering whose quantification can be characteristic of the types of vegetation encountered.

Endemic species

The development of endemic species from a biogeographic point of view can be of great importance. Indeed, the territory of each of these species should be carefully circumscribed and its range specified. This would facilitate the preservation of this remarkable biodiversity. In this context, the present study has identified 36 endemic taxa among the 407 that make up the catalog of the Moulay Driss Zerhoun region (Boudik & al. 2024). These species are endemic to Morocco or shared with neighboring countries such as Algeria, the Iberian Peninsula, or the Canary Islands.

The endemic flora encountered in the area belongs to 19 families. *Asteraceae* and *Lamiaceae* hold the largest numbers with 5 species each, followed by *Brassicaceae*, *Crassulaceae* and *Fabaceae* with 3 species each.

The analysis carried out on the endemic encountered in the study area shows that of the 36 species found, 15 are specific to Morocco with a number (E) of about 4 4%, 5 are shared with Algeria (EA) or about 15%, 10 are shared with Morocco, Algeria, and the Iberian Peninsula (EIA) or 26 %. There are also species common to Morocco and the Iberian Peninsula (EI) which are 4 or 9% and only one species common to Morocco, Algeria, the Iberian Peninsula, and the Canary Islands, or 3%. The latter species remains doubtful in both Algeria and the Canary Islands (Fennane & al. 2014). Finally, only one endemic e of Morocco and the Canary Islands (EC) is recorded, or 3%.

We identified 36 taxa, a rate of 8.8% (36/407×100%) compared to the total species of the massif. This rate of endemism is much lower than that of the entire Moroccan vascular flora (16.3 % according to Fennane 2023), while it is relatively high than that recorded in other parts of Morocco such as of the Achach forest where 15 species have been noted (Bammi & Douira 2004), the average Moulouya with 18 endemic taxa (Douiri & al. 2007) and Izarene massif with 20 endemic taxa (Orch 2013).

Among the endemic species encountered in the study area, two are Critically endangered (CR): *Cirsium ducellieri* Maire, *Ononis jahandiezii* Maire & Weiller. Two are Endangered (EN): *Thymus bleicherianus* Pomel, *Teucrium barbarum* Jahand. & Maire. Five are Least concern (LC): *Stachys saxicola* subsp. *villossima* (Ball) Maire, *Sedum wilczekianum* Font Quer, *Filago duriaei* Lange, *Dianthus sylvestris* subsp. *longibracteatus* (Maire) Greuter & Burdet and *Linaria tristis* subsp. *pectinata* (Pau & Font Quer) Maire and one vulnerable (Vu): *Ceratocnemum aphanoneurum* (Maire & Weiller) Al-Shehbaz. These taxa, in addition to their endemism, are vulnerable, critically endangered, or Endangered. Their confinement in the area would be beneficial to them insofar as some localities difficult to access because of the rugged relief and therefore little anthropized would be a precious refuge for these plants.

Considering all the endemic species recorded in the area, their presence in the phytogeographic divisions of Morocco is mainly noted in North Atlantic Morocco (36 taxa), the Middle Atlas (26 taxa), the Rif (24 taxa), Middle Atlantic Morocco (22 taxa) and the High Atlas (22 taxa) (Fig. 6). The other phytogeographical divisions come after with the Mediterranean coast (17 taxa), the Anti-atlas (14 taxa), the eastern Moroccan mountains (13 taxa), the eastern Moroccan plateaus (9 taxa), Saharan Morocco (4 taxa) and the Saharan Atlas (2 taxa) (Fig. 5). The species from our area encountered in Saharan Morocco are: *Coronilla viminalis* Salisb., *Pulicaria paludosa* Link, *Modesciadium involucratum* (Maire) P. Vargas & Jim. Mejías, *Asparagus latissimus* Munby. Those encountered in the Saharan atlas are: *Chaenorhinum villosum* (L.) Lange, *Dianthus lusitanus* Brot. The endemic species of Morocco and the Canary Islands are found in all the phytogeographic divisions except the Saharan Atlas, the mountains of eastern Morocco, the Mediterranean coast, and the Rif, those shared with the Iberian Peninsula are found in HA, MA, Mam, Man, R. Those shared with Algeria are found in AA, HA, Mam, Man, R.

Rare or threatened species

The examination of the species list of the Moulay Driss Zerhoun region allowed us to note many species considered by previous work (Fennane 2021) as vulnerable, critically endangered, endangered, near threatened, least concern or with doubtful presence. Indeed, among the 407 taxa, 25 are threatened, or 6.39% of which 10 are least concern (LC) (Fig. 6).

These species should be the subject of safeguard strategies at the scale of Morocco and the region such as the creation of seed banks and the installation of protected areas. Awareness campaigns and training should be conducted with local residents for a better exploitation of these other resources. Thus, this heritage would be preserved and would also benefit future generations in a spirit of sustainable development (Kahouadji 2022).

All this brings us to an analysis of the geographical distribution of these threatened species (Fig 7). This analysis shows that North Atlantic Morocco has 26 species threatened. The other phytogeographical regions come next with the Middle Atlas (18 species),

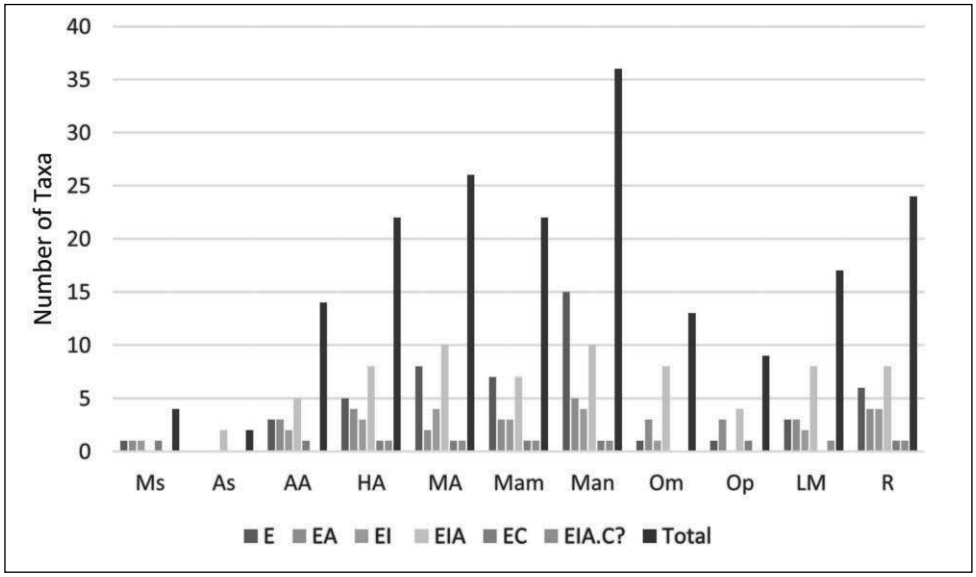


Fig. 5. Distribution of endemic species recorded in Moulay Driss Zerhoun according to phytogeographical division. E: endemic to Morocco; EA: endemic to Morocco and Algeria; EI: endemic to Morocco and Iberian Peninsula; EIA: Endemic to Morocco, Algeria, and the Iberian Peninsula; EC: Endemic to Morocco and Canary Islands; EIA.C?; As: Saharan Atlas, AA: Anti-Atlas; HA: High Atals, MA: Middle Aatlas; Mam: Middl Atlantic Morocco; OP: Plains and Plateau of Morocco; OM: Eastern Morocco Mountains; LM: Mediterranean Littoral; R: Rif.

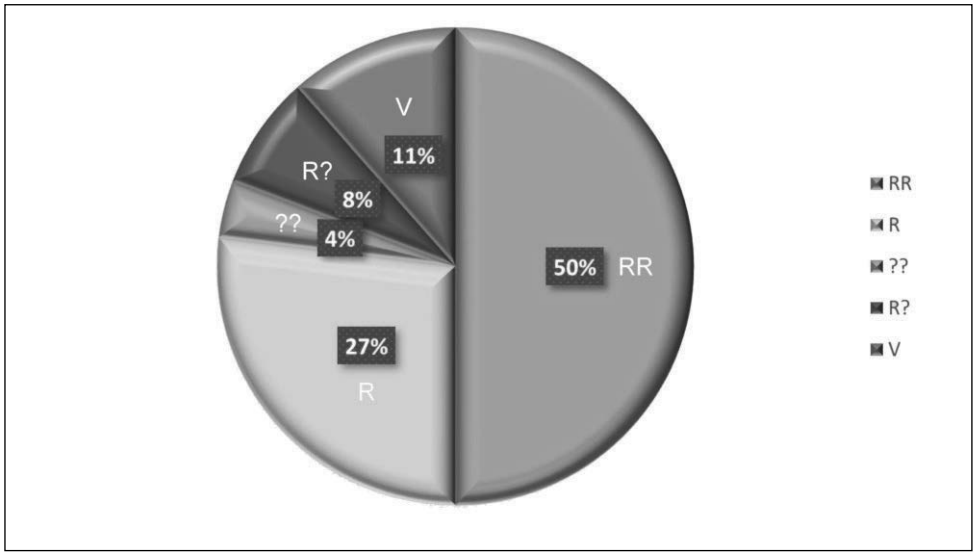


Fig. 6. The rare and endangered species of the Zerhoun region. RR: Extremely rare; R: Rare ; ??: Extinct or doubtful taxon; R?: suspected rare; V: vulnerable.

the Rif (13), the Mediterranean Coastline (10), the Middle Atlantic Morocco (9), the Eastern Moroccan Mountains and the High Atlas (7 species), Eastern Morocco Plateau (6 species), Anti-Atlas (4 species) and Saharan Atlas (1 species). The number of species in common with the other geographical divisions is all the lower as these divisions are distant from the area, example with the Saharan atlas a single species in commune.

Geographical distribution in Morocco

The distribution of the 407 taxa recorded in the Moulay Driss Zerhoun region in the phytogeographic divisions that make up the national territory would provide valuable information on the range of the taxa, their ecology, and their status.

North Atlantic Morocco (Man) occupies the first place with 407 taxa (Boudik & al. 2023). The species found in the region and shared with the Rif (R) are 378 species, those shared with the Middle Atlas (MA) are 352 species and those in common with the Mediterranean Littoral (LM) are 341 species. In fifth place, the Middle Atlantic Morocco (Mam) has 333 species, followed by the High Atlas (HA) with 331 species, the Eastern Moroccan Mountains (Om) with 308 species, the Anti-Atlas (AA) with 255 species, then the Plains and Plateau of Eastern Morocco (Op) with 212 species, and finally the Saharan Atlas (As) and Saharan Morocco (Ms) with 130 and 107 species respectively.

Chorology

The biogeographical origin or chorology is one of the main parameters that reflect the originality of the flora. Several works deal with the biogeography of the North African flora among others (Quézel 1957, 1995, 2000; Pignatti 1978; Galàn de Mera & al. 2003), complemented by documents that contain lists of plants with their biogeographic distributions (Quézel& Santa 1962, 1963; Mateo Sanz & Crespo 2001; Valdés & al. 2002; Fennane 2021; Fennane & Ibn Tatou 2005, 2008). The flora of Morocco, like that of the entire Mediterranean basin, has diverse origins. Several elements contribute to its development (Quézel 1964, 1978, 2002; Valdés & al. 2002): the southern origin, the native plants with Mediterranean origin and the northern origin. The flora of the region of Zerhoun includes the main phytogeographical elements which are at the origin of the establishment of the flora of the Maghreb (Tab. 3).

The Mediterranean elements in the large sense count 232 taxa, 57% of the counted flora. This element includes several subsets, the most represented of which is formed by taxa originating from the Mediterranean region in the strict sense (134 species) which occupies a share of nearly 33% of the total number of species. Then come the West-Mediterranean species with 26 species and the Macaronesian-Mediterranean taxa with 21 representatives. The other subsets are only weakly represented.

The northern element is the second set represented by 114 species, or nearly 28%. It includes European, Eurasian, paleo-temperate and circumboreal species. Other species correspond to transitional elements between the Mediterranean group and this chorological group. The most important lot corresponds to the European with 40 species, followed by the Euro-Mediterranean with 18 species, the Eurasian with 17 species, Paleo-temperate with 14 species and Atlantic-Mediterranean with 6 species. The other categories are poorly represented.

The endemic set occupies the third place with 36 taxa or 8.84% of the flora inventoried in the Zerhoun region. This rate corresponds to 3.91% of the total species and subspecies,

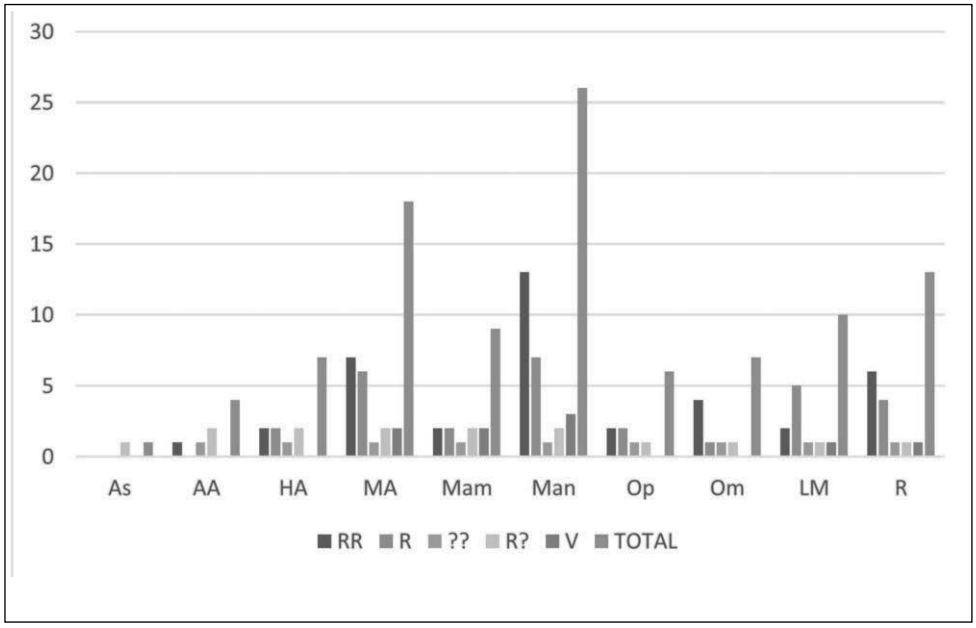


Fig. 7. Distribution of rare or vulnerable species according to the phytogeographic division. As: Saharan Atlas, AA: Anti-Atlas; HA: High Atals, MA: Middle Atlas; Mam: Middl Atlantic Morocco; Op: Plains and Plateau of Morocco; Om: Eastern Morocco Mountains; LM: Mediterranean Littoral; R: Rif; RR: Extremely rare; R: Rare ; ??: Extinct or doubtful taxon; R?: suspected rare; V: vulnerable.

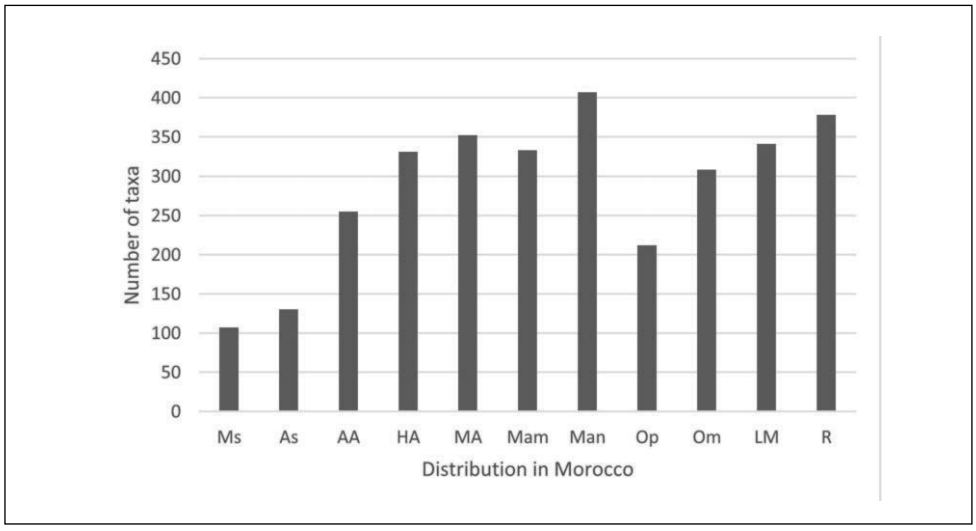


Fig. 8. Distribution of the flora of Moulay Driss Zerhoun according to the phytogeographical divisions of Morocco. Abbreviations as in Fig.7.

Table 3. Chorological types of the Zerhoun region (Galàn de Mera & al. 2003 ; Quézel & Santa 1962, 1963; Mateo Sanz & Crespo 2001; Valdés & al. 2002; Fennane 2021; Fennane & Ibn Tatou 2005, 2008).

Chorological types	Number of taxa	%	Chorological types	Nombre de taxa	%
-Mediterranean (large sense).	**232**	**57**	**-Septentrional**	**114**	**28**
Mediterranean (strict sense).	134	32.9	Euro-Mediterranean	18	4,42
Western Mediterranean	26	6.38	Eurasian	17	4,17
Central Mediterranean	3	0.73	Paleo-temperate	14	3,43
Sub-Mediterranean	3	0.73	Atlantic-Mediterranean	6	1,47
Ibero-Mauretanian	13	3.19	Circumboreal	5	1,22
Macaronesian-Mediterranean	21	5.15	Eurasian-Mediterranean	1	0,24
Mediterranean-Atlantic	6	1.47	Macaronésien-eurasiatique	4	0,98
North Africa-Sicily	1	0.24	North American	1	0,24
Iranian-Turanian Mediterranean	5	1.22	Eurasian-North Africa	2	0,49
Canary-Mediterranean	4	0.98	Eurasian-temperate	1	0,24
Mediterranean-European	1	0.24	European	40	9,82
North Africa- Italian	1	0.24	Temperate	2	0,49
Mediterranean-Asian	2	0.49	Atlantic	3	0,73
Circum-Mediterranean	15	3.68	**-Wide distribution and**	**25**	**6,14**
Southern Mediterranean	1	0.24	**cosmopolitan**		
-Endemic	**36**	**8.84**	Cosmopolitan	10	2,45
1 Endemic to Morocco	15	3.68	Sub-cosmopolitan	9	2,21
2 Endemic Morocco-Iberian Peninsula	10	2.46	Paleo-subtropical	4	0,98
3 Algerian - Moroccan endemic	5	1.23	Paleo-tropical	1	0,24
4 Endemic Morocco-Algerian-iberian	4	0.98	Tropical	1	0,24
5 Endemic Morocco and Canary Islands	1	0.24			
6 Endemic to Morocco, Algeria, Canary Islands, and Iberian Peninsula.	1	0.24			
	Total			**407**	**100**

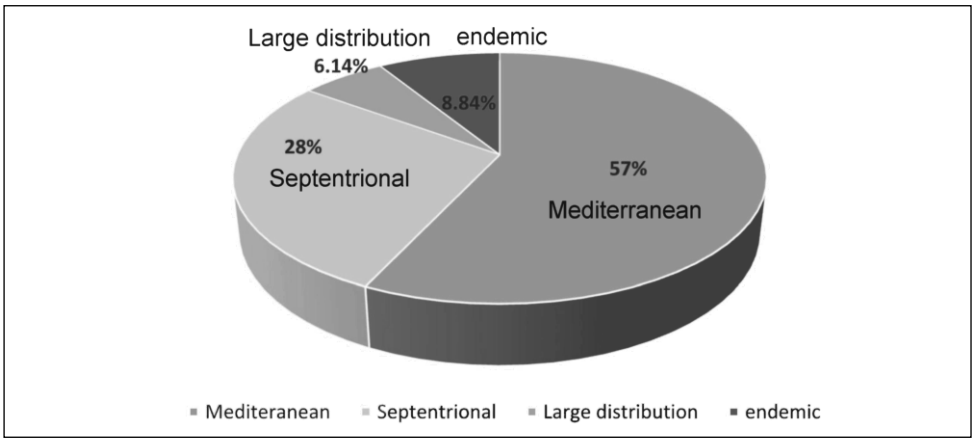


Fig. 9. Chorology of the plant species of the Moulay Driss Zerhoun region.

endemic to Morocco estimated at 920 Fennane & Ibn Tattou (2012). Among these 36 taxa, 32 are strictly species or a rate of 5.16% of endemic species of Morocco estimated at 620 Fennane & al. (2023). This category will be the subject of a future publication.

Wide-ranging species total 25 species or nearly 6.14% of the flora counted in the area. Cosmopolitans and sub-cosmopolitans have 10 and 9 species respectively. The paleo-subtropical element is very weakly represented, with only 4 species.

Conclusion

The study of the flora of the study area has shown a considerable richness of plant biodiversity, especially in the families of *Asteraceae*, *Fabaceae*, *Poaceae*, *Lamiaceae*, and *Apiaceae* which dominate the area. The dominance of therophytes followed by hemicryptophytes in the biological spectrum (Th>Hem> Ph >G>Ch), testifies to the dryness of the summer season and a strong anthropic pressure. It is the image of Mediterranean vegetation. The present work has also made it possible to present a list of rare or threatened species that deserve to be considered for safeguarding and preservation.

The Mediterranean element is important, estimated at more than half of the total number of taxa recorded, followed by the septentrional element which occupies more than a quarter of the total number. Similarly, we were able to inventory 36 taxa endemic to Morocco and shared with neighboring regions. All these data deserve to be capitalized for the benefit of the Moulay Driss Zerhoun region which has a very varied vegetation that can qualify it as a biodiversity hot spot at the regional scale. Thus, the region could be proposed as a new important area for plants.

This would surely contribute to the safeguarding of all threatened, and endemic species resent as well as the development of the region.

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Article

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Stoyan Stoyanov & Yulian Marinov

Cirsium eriophorum (*Asteraceae*), a new record of *Cirsium* sect. *Eriolepis* for the Bulgarian flora

Abstract

Stoyanov, S. & Marinov, Y.: *Cirsium eriophorum* (*Asteraceae*), a new record of *Cirsium* sect. *Eriolepis* for the Bulgarian flora. — Fl. Medit. 34: 63-72. 2024. — ISSN: 1120-4052 printed, 2240-4538 online.

Cirsium eriophorum is reported for the first time to the Bulgarian flora. It was found in the Eastern Rhodope Mts, south of Strazhets village (Krumovgrad District), in the area of Mount Golata Chuka, adjacent to the Bulgarian-Greek border. The species occurs in middle high mountain pastures, in open *Fagus sylvatica* forests and along forest roads, mainly on serpentine substrates, at 900–1200 m altitude. The recorded localities are the southeasternmost limit of the species range in Europe.
The article presents data on distribution, habitats and population of *Cirsium eriophorum* in Bulgaria. A brief review of the key features of Bulgarian representatives of *Cirsium* sect. *Eriolepis* is provided. The recently published phylogeny of *Cirsium* concerning the restoration of genera *Lophiolepis* and *Epitrachys* is also commented on.

Key words: *Compositae*, *Cardueae*, *Lophiolepis*, Balkans, floristics.

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Introduction

According to Delipavlov (2003), the genus *Cirsium* Mill. is represented by 14 species in Bulgarian flora. Two more species were later reported as new to the country–*Cirsium rivulare* (Jacq.) All. (Hájek & al. 2006) and *C. palustre* (L.) Scop. (Vladimirov & Niketić 2017) both discovered in the vicinity of the Bulgarian-Serbian border. Here, we added a new *Cirsium* record to Bulgaria, *C. eriophorum* (L.) Scop., also found in a poorly studied region of the country, the Eastern Rhodope Mts, near the Bulgarian-Greek border. The access of non-local people (including botanists) was restricted in this area between 1945 and 1990, and special permission was required from the Border authorities. For this reason, as well as due to the presence of rare and specific serpentine habitats in the Eastern Rhodope Mts, many new obligate serpentinophytes have been recorded for Bulgarian flora in recent years (Pavlova & al. 2003; Pavlova 2007, 2014; Stoyanov & Marinov 2020; Kunev 2020).

Cirsium eriophorum belongs to *Cirsium* sect. *Eriolepis* (Cass.) Dumort. It is a large and taxonomically intricate section represented by 29 species in Europe, accounting for half of the European members of the genus (Werner 1976). The representatives of this section are all monocarpic biennials (except *C. vulgare* (Savi) Ten.), with erect stems, branched above, coriaceous deeply pinnatifid leaves, rigid setae above, arachnoid-tomentose beneath, leaf segments in pairs (divaricate) with the basal lobe directed upwards and apical lobe ± flat or downwards, with revolute margins and spiny apex (Tofts 1999; Del Guacchio & al. 2021). According to *Flora Europaea* account, *C.* sect. *Eriolepis* is represented in Bulgaria by four species: *C. bulgaricum* DC., *C. italicum* (Savi) DC., *C. ligulare* Boiss., and *C. vulgare* (Werner 1976). Later, one more species of this section was described from Bulgaria, namely *Cirsium stojanovii* Kuzmanov (1988), so far known only for its original material. However, the taxonomic identity and status of that species needs to be clarified. It morphologically resembles *C. italicum* and probably is conspecific with the latter and therefore a further investigation is required.

Cirsium eriophorum was mentioned a long time ago for Bulgarian flora by the Serbian botanist Pančić (1883). However, due to the lack of a herbarium voucher Velenovský (1891) deemed this record doubtful. Subsequently, Achtarov (1950) also believed that Pančić (1883) erroneously reported this species for Bulgaria, in this case instead of *C. ligulare*.

The aim of the present article is to report the first reliable data on the occurrence of *Cirsium eriophorum* in Bulgarian flora and to provide details on the main distinguishing features of the Bulgarian members of *Cirsium* sect. *Eriolepis*.

Material and methods

Field surveys were carried out in July–August 2022 in the Eastern Rhodope Mts. The plant materials gathered were deposited in the herbarium SOM (acronyms follow Thiers 2023+). Morphological features of *Cirsium eriophorum* were studied from the personal collections and compared with selected specimens kept in herbaria B and SOM as well as with relevant literature (Nyárády 1964; Gajić 1975; Werner 1976). Data on the population and habitats are noted in the field. Comparison of Bulgarian members of *C.* sect. *Eriolepis* is based on the authors' observations and presented through photos in nature. Nomenclature of *Cirsium* follows Greuter (2006+). Abbreviations of the authors of plant names are according to Brummitt & Powell (2004).

Results and discussion

In the summer of 2022, during a botanical trip in the Eastern Rhodope Mts, a new native species for Bulgarian flora, *Cirsium eriophorum*, was discovered. By its habitus, leaf shape and large capitula (usually more than 4 cm in diameter) it is similar to *C. ligulare*, a widespread species in the country. *Cirsium eriophorum* differs from the latter species by its much denser arachnoid-lanate covering of the involucrum, totally hidden phyllaries, and narrower, lanceolate to narrowly rhombic appendages (vs the phyllaries sparsely arachnoid-lanate, more or less visible, and the appendages obovate below the apex in *C. ligulare*).

In the Bulgarian flora, another member of *C.* sect. *Eriolepis*, a close relative of the two above-mentioned species is *C. bulgaricum*. Similar to them, it is a robust plant, usually more than 1 m tall and with non-decurrent stem leaves. *Cirsium bulgaricum* is a glaucous plant, well distinguishing by its arachnoid-tomentose stem indumentum (vs stem shortly patent-hairy in *C. eriophorum* and *C. ligulare*), smaller capitula (less than 4 cm in diameter) and sparsely arachnoid phyllaries with short, up to 5 mm appendages (vs capitula more than 4 cm in diameter, phyllaries ± densely arachnoid-lanate with appendages more than 10 mm long, ± widened below the apex in *C. eriophorum* and *C. ligulare*) (Figs. 1, 2).

Cirsium vulgare has been traditionally placed in *C.* sect. *Eriolepis*, but the most recent phylogenetic studies revealed it is nested in *C.* sect. *Cirsium* clade (Ackerfield & al. 2020; Del Guacchio & al. 2022). Its morphological characters also do not clearly match with the *C.* sect. *Eriolepis* circumscription – e.g. *C. vulgare* is a perennial plant (not a monocarpic biennial), leaves completely decurrent, with true spine above (not with rigid setae) (Fig. 3).

The placement of *C. italicum* in *C.* sect. *Eriolepis* is also controversial. Both phylogenetic trees (Ackerfield & al. 2020; Del Guacchio & al. 2022) separate it in a sister clade to *C.* sect. *Eriolepis* clade. Morphologically, *C. italicum* also has features not typical for *C.* sect. *Eriolepis* in general – e.g. it is an annual plant, leaves short decurrent, smaller involucrum (up to 15 mm in diameter), presence of vittae on phyllaries (Fig. 4).

Since *C.* sect. *Eriolepis* is resolved as monophyletic in the phylogeny of Del Guacchio & al. (2022), which is congruent with earlier data from Ackerfield & al. (2020), they proposed to treat it as a separate genus *Lophiolepis* Cass. On the other hand, for *C. italicum*, which is a sister clade to *C.* sect. *Eriolepis* clade (such as the monotypic genera *Picnomon* Adans. and *Notobasis* (Cass.) Cass.), they proposed to segregate it into a monotypic genus *Epitrachys* (DC. ex Duby) K.Koch.

In conclusion, based on the latest re-circumscription of *Cirsium* and the transfer of most of the species of *C.* sect. *Eriolepis* (except *C. italicum* and *C. vulgare*) into *Lophiolepis*, many new combinations have been provided (Del Guacchio & al. 2022). Four of them concern the above-mentioned Bulgarian species of *C.* sect. *Eriolepis* – *Lophiolepis bulgarica* (DC.) Del Guacchio, Bureš, Iamonico & P.Caputo, *L. eriophora* (L.) Del Guacchio, Bureš, Iamonico & P. Caputo, *L. ligularis* (Boiss.) Del Guacchio, Bureš, Iamonico & P. Caputo and *Epitrachys italica* (DC.) Bureš, Del Guacchio, Iamonico & P. Caputo.

Distribution. – *Cirsium eriophorum* is widespread, mainly in the mountain belt of Western, Central and Southern Europe (Werner 1976). The species range in Europe is presented and commented in detail by Tofts (1999). Outside Europe, the species is known only in a few localities in Bursa Province of Turkey (Daşkın & al. 2006). In the neighboring countries, Romania and Serbia, where the northeastern periphery of its area is, *C. eriophorum* has a limited distribution (Nyárády 1964; Gajić 1975), whereas in Greece it occurs throughout the country (Dimopoullos & al. 2013).

In Bulgaria, *C. eriophorum* has been found in the Eastern Rhodope Mountains floristic region, south of Strazhets village (Krumovgrad District), in the area of Mount Golata Chuka, which orographically is middle high mountains (Table 1). It is a rare species in Bulgaria and its Bulgarian localities together with these in adjacent territories of Greek part of Rhodope are the southeasternmost limit of the species range in Europe.

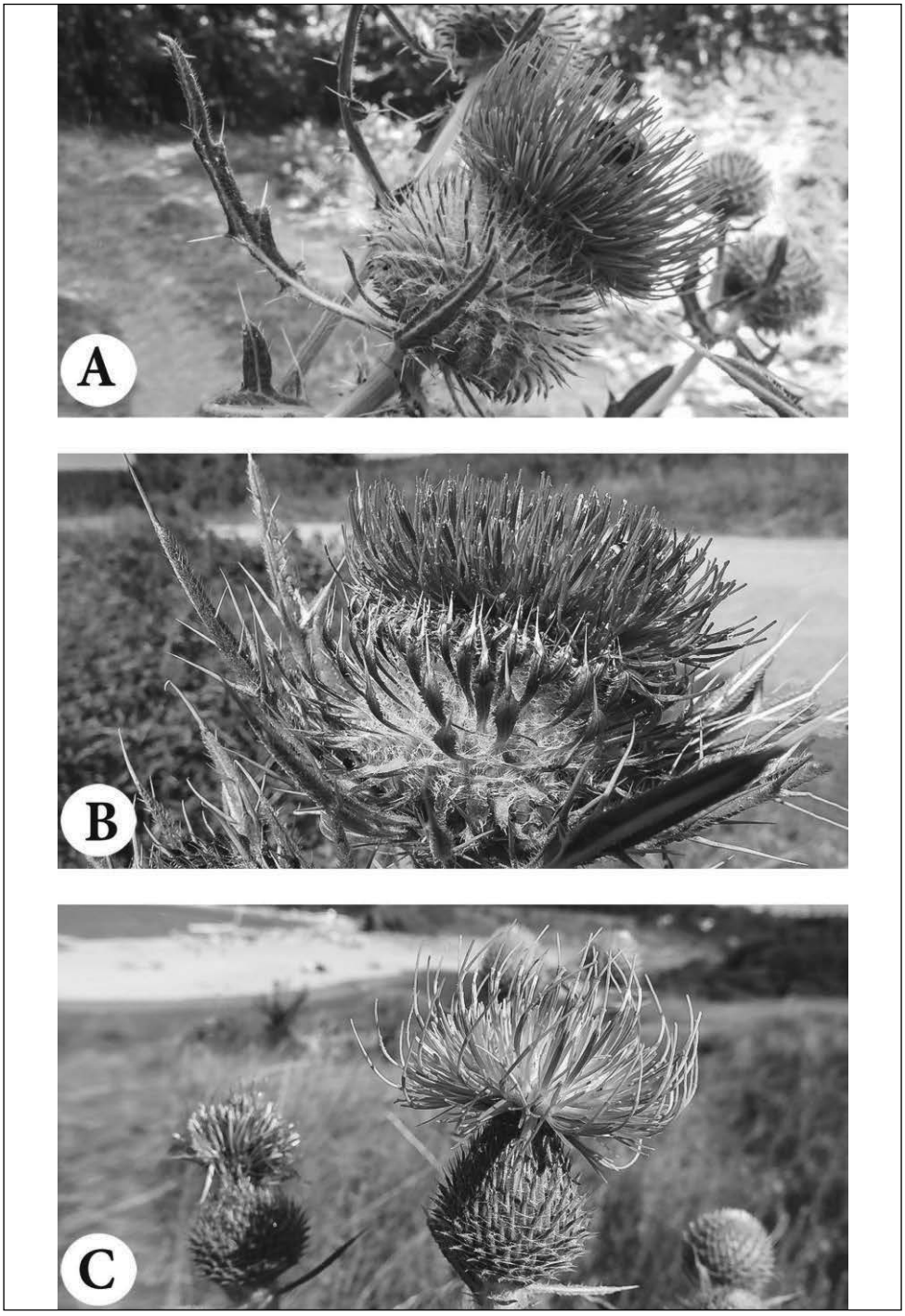


Fig. 1. Capitula of *Cirsium eriophorum* (A), *C. ligulare* (B) and *C. bulgaricum* (C).

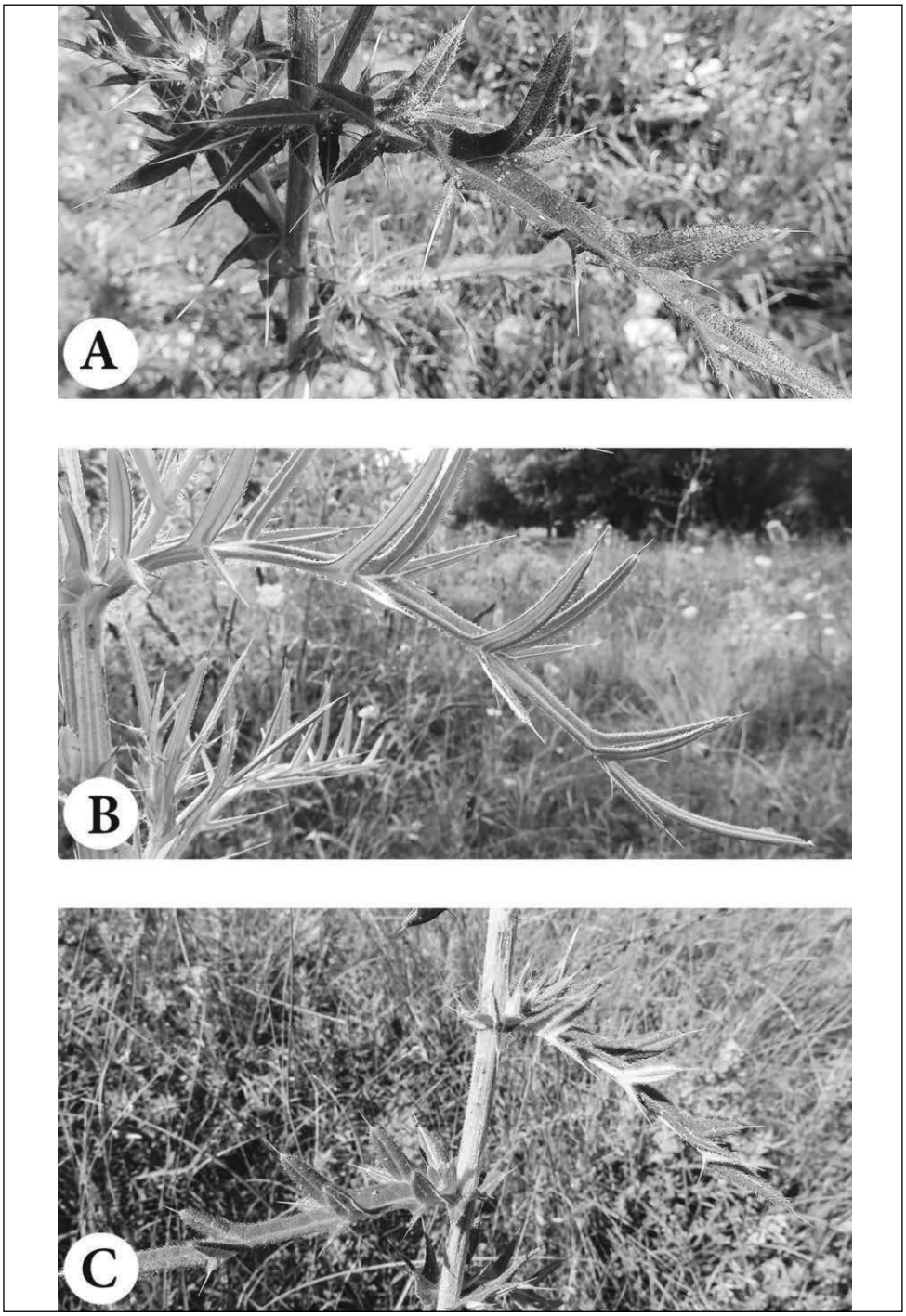


Fig. 2. Stem leaves of *Cirsium eriophorum* (A), *C. ligulare* (B) and *C. bulgaricum* (C).



Fig. 3. *Cirsium vulgare* – A. Upper part with capitulum; B. Decurrent stem leaves.



Fig. 4. *Cirsium italicum* – upper part with capitula.

Table 1. Localities and GPS data of *Cirsium eriophorum* in Bulgaria.

Locality	GPS data
Along forest road towards Mount Golata Chuka, 880 m	41.33625°N, 25.84802°E
Northern slope of Mount Golata Chuka, at the upper forest line, *Fagus sylvatica* forest glades, 990 m	41.32898°N, 25.85400°E 41.32944°N, 25.85429°E
Eastern slope of Mount Golata Chuka, clearings for wood storage, 1180 m	41.32615°N, 25.87581°E
Northeastern slope of Mount Golata Chuka, clearings for wood storage, 1130 m	41.33160°N, 25.87622°E

Habitats and population. – The only Bulgarian population of *C. eriophorum*, located on the northern and eastern slopes of Mount Golata Chuka, is represented by several patches including a total of *ca.* 100 individuals. Small groups, consisting of 5–10 individuals, are found mainly along the forest roadsides, as well as in trampled and ruderal clearings for wood storage. The largest subpopulation occupies an area of 0.3 ha on the northern slope of Mount Golata Chuka, near the upper forest line, and numbering *ca.* 60 individuals. Here, the species inhabits middle high mountain pastures and glades among sparse *Fagus sylvatica* L. forests, on serpentine (Fig. 5). The co-occurring species in the locality are *Allium flavum* L., *Alyssum murale* Waldst. & Kit., *Briza media* L., *Danthonia alpina* Vest, *Dorycnium herbaceum* Vill., *Filipendula vulgaris* Moench, *Fritillaria gussichiae* (Degen & Dörfl.) Rix, *Genista carinalis* Griseb., *Hypericum perforatum* L., *Juniperus deltoides* R.P. Adams, *Potentilla rupestris* L., *Pteridium aquilinum* (L.) Kuhn, *Sanguisorba minor* Scop., *Sesleria latifolia* (Adamović) Degen, *Tephroseris papposa* (Rchb.) Schur, *Thalictrum aquilegiifolium* L., *Thymus jalasianus* Stoyanov & Marinov, etc.

The free movement of cows in the area of Bulgarian-Greek border has probably supported expansion of the species. The presence of *C. eriophorum* in sites with nitrophilous vegetation is indicative of this process.



Fig. 5. *Cirsium eriophorum,* glades in *Fagus sylvatica* forest.

Specimina visa

BULGARIA: Eastern Rhodope Mountains. South of Strazhets village, Krumovgrad District, along the forest road to Mount Golata Chuka , in sparse *Quercus* forests, 41.33625°N, 25.84802°E, 880 m, 06.07.2022, *S. Stoyanov & Y. Marinov* (SOM 177738, 177739); *loc. ibid.* East of Mount Golata Chuka , in meadows among *Fagus sylvatica* forests, 41.32615°N, 25.87581°E, 1180 m, 31.08.2022, *S. Stoyanov & Y. Marinov* (SOM 177740, 177741).

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Article

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Contributions to the Flora Palaestina Region

Abstract

Ben-Natan, D., Fragman-Sapir, O. & Shemesh, B.: Contributions to the Flora Palaestina Region. — Fl. Medit. 34: 73-94. 2024. — 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 new findings in several new areas that were not studied before. In this paper we collect some of these important findings reporting 28 new floristic records for the region.

Key words: floristics, 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 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 2400 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 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. Species newly documented in the region were recorded in the past 20 years and especially in the last five years, when almost every year new floristic discoveries were made during field surveys and botanical expeditions. Some of these findings were reported by surveyors and field botanists or by amateurs, some new findings are based on new identifications of known plants or new treatments of previously documented species. None of these new floris-

tic 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.

The purpose of this paper is to publish the new findings of all the species that are previously undocumented for the region. We have collected data on all the newly recorded species from the region from the last ±20 years, and assembled the data, along with extensive collections of plant materials which were dried, deposited in the HUJ and the TELA herbaria (Holmgren & al. 1990), and are included here as vouchers from each newly reported species. We hope that this paper will be the first of many, which will help form a revival of the floristic research of the region.

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.**

Sagittaria subulata (L.) Buchenau

Sagittaria subulata was first recorded in Israel by Ruediger Prasse in Ein Yered in the Shfela in 1994, and identified as *Alisma gramineum* Lej. due to the similarity of its phyllode to *A. gramineum*'s submerged leaf form. Prasse's unpublished record was confirmed during the Israel Rare Plant Survey conducted by "Rotem" (the Israel Plant Information Centre) and published by Fragman-Sapir in Euro+Med-Checklist Notulae 18 (Greuter & Raus 1999). These plants were later collected as a rare native species and grown from root shoots in several local botanical gardens and sanctuaries. In 2012 the species was located by Oz Golan in an additional location: Ein Roíim (and also, allegedly, in two other additional unconfirmed nearby sites) in the eastern Upper Galilee, and reported in the Flora of Israel and adjacent regions website forum. In 2015 the Ein Yered population, which was previously thought to be extinct in the early 2000's, was seen in bloom by Amit Mendelson. Later that year, both the Ein Roíim and the Ein Yered populations were recorded by Dar Ben-Natan, who later reidentified the plants, with the generous help of Ruediger Prasse, as *Sagittaria subulata*, and confirmed that this is the same species observed in Ein Yered in the 1990's. According to Zohary (1989), *Alisma gramineum* occurs in the Golan Heights and Sinai, but the basis for this claim is unknown, since no known records of this species currently exist from Israel. It is possible that some of the Golan Heights populations of *Alisma* attributed currently to *A. lanceolatum* With, belong in fact to *A. gramineum*, but this has as yet to be verified.

Sagittaria subulata is an American species, popularly grown in aquariums. It has, most likely, arrived at these locations due to fish owners dumping their aquariums into the water.

Reference material: ISRAEL, Shfela, Ein-Yered near Gezer, in an old well near Tel Gezer, shallow water on top of clay, shadowed by a *Ficus carica* L. tree and a thicket of *Phragmites australis* (Cav.) Trin. ex Steud., 6.11.2015, *Dar Ben-Natan* (HUJ133391!, HUJ134784!).

Asteraceae Bercht. & J. Presl

Achillea falcata L.

Achillea falcata is quite common in the higher parts of Mt Hermon and Edom Mts in Jordan, but has never been previously recorded from other parts of Israel. In 2018, during a Deshe OLI rare plants survey for the INPA (Israel Nature and Parks Authority) to locate populations of the locally rare *Achillea aleppica*

DC., old herbarium material from upper Nahal Arugot was identified by Merav Lebel as *Achillea falcata* (Lebel, 2018), and during the survey, a large population of this species was located in the same area as the material collected in 1985, on cliffs and hard limestone in the Nahal Canub Reserve. This is currently the only known locality of this species in Israel, outside Mt Hermon.

Reference material: ISRAEL, Judean Mts, wadi entering Nahal Arugot below Hirbet Knub, 1698.1118, alt: 500 m, rock ledges and cliffs, 7.1985, *Aaron Liston* (134820!), ISRAEL, Nahal Knub Reserve, below Ibey Hanahal settlement, 31.5997641 N 35.2139131 E, cliffs and rocks in northern exposures, 4.6.2020, *Dar Ben-Natan* (HUJ134818!).

Andryala dentata Sm.

A. dentata was discovered in Israel by Yair Ur in 2018, and identified by Shimon Cohen-Sivan. The species has been found so far in two locations in the NE Golan Heights in 2018 and 2020 (Ben-Natan, 2023) and hundreds of plants were observed there again in 2023. Further monitoring will reveal whether it is a casual occurrence, or if the populations are stable and self-sustained.

Reference material: ISRAEL, Golan Heights, Kuneitra reservoir, near the old Syrian army headquarters, 945m alt., 16.7.2019, *Yair Ur* (HUJ133388!).

Brocchia cinerea (Delile) Vis.

The species was first discovered in Israel in 2020 by Dudi Rivner in Wadi Paran in the S Negev Desert. The plants were identified by Ori Fragman-Sapir, and have been observed in the same locality every year since. In 2022 the species was further located by Rivner in upper Wadi Paran, west of the original locality. The plants were found growing along silt-sandy banks of a large wadi and it is assumed that their origin is in the sands of eastern and central Sinai Peninsula, Egypt, drained by Wadi Paran, where *B. cinerea* is common. Further monitoring of these populations in the coming years is required in order to ascertain whether they are self-sustained or casual, occurring along Wadi Paran after strong floods only.

Reference material: ISRAEL, S. Negev, Wadi Paran, near road 10, 15.4.2021, *Daphna Carmeli* and *Dudi Rivner* (HUJ134770!).

Siebera nana (DC.) Bornm.

While common in upper Mt Hermon, and also known from Edom in southern Jordan, *Siebera nana* has never been recorded in Israel and the West Bank, outside Mt Hermon, until a small population numbering a total of about 50 plants was discovered by Dar Ben-Natan during a Deshe OLI survey for the INPA in the southern Judean Desert. The plants grow there in limestone crevices in the northern exposure of Mt Hardon, together with another newly documented species for Israel, reported here as well – *Minuartia intermedia* (Ben-Natan & Ron 2021). This is currently the only population known in Israel outside Mt Hermon, although this inconspicuous species may be further found in the future in the higher Judean Mts, known to inhabit several other Irano-Turanian relicts found more easily on Mt Hermon and Edom (Feinbrun-Dothan 1978; Feinbrun-Dothan & Danin 1998).

Reference material: ISRAEL, Judean Desert, Mt Hardon, northern exposure on a steep rocky slope pacing north towards Nahal Adasha, 31.3439140 N 35.1910670 E, 31.3427120,35.1938170, 31.3417030,35.1934740, More than one hundred individuals across the slope, together with *Minuartia intermedia* (Boiss.) Hand.-Mazz., *Bromus danthoniae* Trin., *Boissiera squarrosa* (Banks & Sol.) Nevski, *Loliolum subulatum* (Banks & Sol.) Eig, *Descurainia sophia* (L.) Webb ex Prantl, *Coridothymus capitatus* (L.) Rchb.f. and others, 28.4.2020, *Dar Ben-Natan* (HUJ133346!).

Boraginaceae Juss.

Myosotis discolor Pers. (Fig. 1a)

This slender annual was first recorded by Shmuel Mazar in 2016, growing in a wet *Eucalyptus camaldulensis* Dehnh. grove at the upper part of Mesil A'sania – a small stream in the northern Golan Heights, known to local plant enthusiasts and botanists as a hotspot for many locally rare, wet habitat species. It was collected later the same year in the same site by Mimi Ron, Yair Ur and Bar Shemesh, and was observed there annually up to 2022, when it was recorded further down the stream during a field survey for Deshe OLI and Shamir institute for the research of the Golan Heights, and collected and identified by Dar Ben-Natan (Lev-Ramati & al. 2022; Ben-Natan 2023). Previously, this population was misidentified by Mazar (Mazar 2016) as *M. stricta* Link ex Roem. & Schult., and later as *M. congesta* Shuttlew.

This species is very rare in Israel and is currently known only from two other sites in the N Golan Heights, found by Shmuel Mazar as well.

Reference material: ISRAEL, Golan Heights, Mumsia ruins, N. of Alonei HaBashan, N. of the spring in *Eucalyptus* grove, 20.4.2016, *Shmuel Mazar* (HUJ134765!), ISRAEL, Golan Heights, upper Mesil A'sania (=Mumsia), herbaceous vegetation in a damp meadow on the banks of a small, shallow stream (Mesil), 33.0764730 N 35.8178940 E, 33.0784070 N 35.8219720 E, 18.4.2022, *Dar Ben-Natan* (HUJ134764!, TELA4100!)

Myosotis laxa subsp. *cespitosa* (Schultz) Hgl. ex Nordh. (Fig. 1b)

This species was apparently collected by Armitage from Haifa in 1891 and deposited in the Syrian Protestant Collage of Beirut, later identified in the HUJ herbarium by Aaron Liston in 1984 and noted as "probably adventive", which is most likely why this record was previously overlooked. In 2019, photographs of this species taken somewhere near Hadera were posted on Facebook by Oz Golan, but no evidence of this species was found in the Hadera regional council survey that took place that same year (Mendelson & al. 2020). In 2022, during a Deshe OLI field survey for the KKL-JNF in the Hadera Forest Vernal Pond, blooming patches of *M. laxa* were discovered in knee-high water by Dar Ben-Natan and Dvora Lev-Ramati (Lev-Ramati & al. 2022), where they grow among a dense herbaceous vegetation of *Butomus umbellatus* L., *Scirpus maritimus* L. and *Alisma lanceolatum* With. *Myosotis laxa* is very different to other *Myosotis* species native to the region, and is easily distinguished from them by its relatively large corolla and habit, calyx shape and glabrescent leaves, calyces and stems.

Reference material: ISRAEL, Haifa, 2.4.1891, Armitage (HUJ134967!), ISRAEL, Sharon Plain, Hadrera forest, vernal pond, in water about 30 cm deep, 32.4302220 N 34.8938870 E, 32.4325830 N 34.8951420 E, In association with *Butomus umbellatus* L., *Scirpus maritimus* L. and *Alisma lanceolatum* With., 10.4.2022, *Dar Ben-Natan* (HUJ134767!, TELA4101!), ISRAEL, Sharon Plain, Hadera forest, vernal pond, in mostly dry places at time of collecting, 32.4325870 N 34.8951570 E, end of bloom, 24.5.2022, *Dar Ben-Natan* (TELA4102!).

Neatostema apulum (L.) I.M. Johnst.

This small annual was first discovered during a Rotem field excursion to upper Nahal Grar, on a small slope on sandy clay-loess, where it was misidentified as *Arnebia decumbens* (Vent.) Coss. & Kralik. Later on it was identified as *Buglossoides sp*. By Dar Ben-Natan, and estimated as a possible new color variant of *B. tenuiflora* (L.f.) I.M.Johnst., or an undescribed new species. In the spring of 2020 and the spring of 2022, two new populations were discovered by Dar Ben-Natan during field

surveys for Deshe OLI in the lower Nahal Bsor basin (Shalev & al. 2021; Ben-Natan & al. 2022), both on sandy regosols near outcrops of Pleistocene calcareous sandstone (Kurkar), and later that year finally identified as *Neatostema apulum* (Shemesh & al. 2023). All three populations appear to be small and very local, and although *N. apulum* is known around the Mediterranean from various habitats, and growing on different sediments, the Israeli populations seem exclusive to relatively quite arid sandy-clay habitats in the Coastal Negev – a rare habitat, rich in endemics and in locally endangered species. These habitats are threatened by cattle grazing, motor vehicles, agriculture, afforestation and urban expantions. Endemic and endangered species, such as *Anthemis philistea* Boiss. and *Galium philistaeum* Boiss. are relatively abundant in all three sites where *N. apulum* is currently known from in Israel. Interestingly, this pattern is very similar to another Mediterranean, locally extremely rare species with a similar global habitat range, which is also new to the region and is reported from Israel for the first time in this paper: *Valerianella pumila* (Willd.) DC., which in fact grows together with, or nearby, *N. apulum* in two out of three currently known sites.

In all three sites, most specimens examined in the field were cleistogamous, in agreement with Johnston's remark on this matter mentioned in the Flora of Cyprus (Meikle 1985). Some plants produce both chasmogamous and cleistogamous flowers. The cleistogamy in these populations can possibly be attributed to the aridity of the habitat and low-sporadic annual rainfall, as most examined cleistogamous specimens were much smaller than the few chasmogamous ones. In 2023, a year of little rainfall in southern Israel, in each of the Nahal Grar and Nahal Bsor populations less than 10 out of several hundred specimens observed in the field during a Deshe OLI rare plants survey for the INPA were chasmogamous.

Reference material: ISRAEL, Negev Coastal Plain, northern bank of upper Nahal Grar, badlands SE of Tel Haror, sandy clay regosol, 31.378202 N 34.611955 E, 114 m. Many dozens in a local patch, growing along a few meters. Very similar to *Buglossoides tenuiflora* (L.f.) I.M.Johnst. but differs in the yellow corolla and in its internal indumentum which isn't arranged in rows, in the five hairy patches in the corolla throat, lower anther insertment, the annulus of 10 quadrate lobes below the anthers, acute cauline leaves and basal leaves arranged in a pseudo-rosette, and both stiff bristles growing out of small warts and softer hairs. Differs from *Arnebia* Forssk. In the shape of the pistil, placement of anthers and shape of the ripe calyx. 27.2.2019, Dar Ben-Natan (HUJ134893!, TELA4396!), ISRAEL, Negev Coastal Plain, Be'eri nature reserve, southern basin, 31.4267 N, 34.4696 E, 100 m. Kurkar and sandy clay regosol with high concentration of sulfur. Batha of *Coridothymus capitatus* (L.) Rchb.f., *Fumana thymifolia* (L.) Webb, and *Thymelaea hirsuta* (L.) Endl. with elements of sand and Kurkar vegetation. Local patch with small and short plants, most of them showing cleistogamy. 23.3.2022, *Dar Ben-Natan* (HUJ134894!), ISRAEL, North Negev, Nahal Gerar, Park Sharsheret, 31.3786044 N 34.6122005 E, Sandy-silt soil, with Kurkar parts of Pleshet formation. Hundreds of plants, mostly Cleistogamic, 9.5.2023, *Dar Ben-Natan* (HUJ135047!), ISRAEL, North Negev, Nahal Besor badlands, 31.347124 N, 34.472787 E, 31.348563 N 34.472965 E, 31.349996 N 34.474218 E, Kurkar and Loess-sandy soil. East of Mitzpor Shay. Three clusters found at the top of north-south ridges. Patches of 1-3X2-10 m. together with *Valerianella pumila* and *Galium philistaeum*. Several hundreds of plants, mostly Cleistogamic, 13.5.2023, *Dar Ben-Natan* (HUJ135048!).

Caprifoliaceae Juss.

Valerianella discoidea (L.) DC.

Valerianella discoidea is one of the most common *Valerianella* species in Israel and the west bank, occurring from the southern Shfela to Mt Hermon in the north, and until recently was mistaken

for *Valerianella coronata* (L.) DC., which is much rarer locally, and occurs mostly in the northern parts of Israel. The first to notice this mistake and to identify *V. discoidea* from Israel was Oz Golan, who published several posts on the matter on social media in 2019, followed by Shmuel Mazar later that year. Further examination of herbarium material from the HUJ collection found very few collections of the real *V. coronata*, all from the Upper Galilee and lower Mt Hermon.

Reference material: ISRAEL, Jerusalem, Matsleva, batha, *N. Naftulsky* (HUJ134844!), ISRAEL, Upper Galilee, Mt Meiron, wadi, 4.5.1926, *N. Naftulsky* (HUJ134842!), ISRAEL, Upper Galilee, Kirbet Tsemah, W wall of wadi, 16.3.1940, M. Zohary and *N. Feinbrun-Dothan* (HUJ134838!), ISRAEL, Mt. Carmel, Carmel Forest, 26.3.1952, *N. Feinbrun-Dothan* (HUJ134848!), ISRAEL, Lower Galilee, Mt Tevor, N slope, maquis, 31.3.1954, *D. Yaffe* and *C. Sherikar* (HUJ134949!), ISRAEL, Coastal Carmel, Atlit, Kurkar hill, assoc. of Ceratonia-Pistachia lenticus, 5.4.1956, *G. Orshan* (HUJ134839!), ISRAEL, Mt. Hermon, 1200 m, 28.5.1969, *Yael Eshel* (HUJ134835!), ISRAEL, S. Hermon, Qala'at Nemrod, Banias – Majdal-Shams road, among the fortress ruins, hard Jurassic limestone , degraded maquis of *Quercus calliprinos*, alt: 750 m, 22.4.1975, *Avi Shmida* and *E. Noi-Meir* (HUJ134837!), ISRAEL, Upper Galilee, Mt Shazor, *Quercus calliprinos – Pistachia palaestina* sparse maquis, on hard limestone rocks and terra rosa, 26.4.1982, *R. Berliner* (HUJ134841!), ISRAEL, Golan Heights, hill N of Susita, on Susita Chalk, 14.3.1983, *A. Liston* (HUJ134847!), ISRAEL, Mt. Hermon, Namneman ridge, between Yif'at and Man Valley, rocky slope, 28.5.1984, *A. Liston* (HUJ134836!).

Vallerianella coronata (L.) DC. Reference material: ISRAEL, Upper Galilee, Jebel El Arus (Mt. Hilel), 4.6.1926, A. Eig and M. Zohary (HUJ134833!), ISRAEL, Upper Galilee, Mt Jermak (Mt Meiron), 20.5.1959, *Lea Pruzbul* (HUJ134831!), ISRAEL, Mt Kata (lower Mt Hermon), sandstone, 1.6.1983, *Avi Shmida* (HUJ134830!), ISRAEL, Upper Galilee, Dovev, 15.5.2017, *Smuel Mazar* (HUJ134832!).

Valerianella obtusiloba Boiss.

A slender eastern Mediterranean annual, differing from all other local *Valerianella* species by its strikingly large and fringed fruiting calyces.

Valerianella obtusiloba was discovered in the Upper Galilee and reported as a species new to the region by Oz Golan (Golan 2018), but no specimens were deposited in any local herbaria. The plant was re-collected in its main locality in 2023, specimens were deposited in HUJ herbarium and seeds were grown in the Israel Gene Bank as well as in the Jerusalem Botanical Gardens.

Reference material: ISRAEL, Upper Galilee. South of Neve Ziv, 35.1890454N 33.0140018 E, dark-brown soil pockets in Eocene chalk, SW facing slope, garigue of *Calicotome villosa*, *Rhamnus lycioides* and *Quercus calliprinos*, 9.4.2023, *Mimi Ron* and *Dar Ben-Natan* (HUJ 135051!), ISRAEL, Upper Galilee. South of Neve Ziv, 35.1802271 N 33.0219383 E, near a dirt road in the woods, 9.4.2023, *Mimi Ron* and *Dar Ben-Natan* (HUJ 135053!), ISRAEL, Upper Galilee, south of Neve Ziv, 35.1797584 N 33.0216187 E, small shallow pockets of Terra-Rosa soil, in Eocene colcareous outcrops, dense garigue of *Calicotome villosa*, *Pistacia lenticus* and *Quercus calliprinos*, with planted *Pinus halepensis* forest above, and open patches of *Cistus salviifolius* and *Sarcopoterium spinosum*, 9.4.2023, *Mimi Ron* and *Dar Ben-Natan* (HUJ 135054!).

Valerianella pumila (Willd.) DC. (Fig. 1c)

A minute herb, occurring around the Mediterranean and W Irano-Turanian. *Valerianella pumila* was cited from Moav, Jordan, in the Flora Palaestina (Feinbrun-Dotan 1978) and from the Syrian parts of Mt Hermon in the Analytical Flora of Eretz-Israel (Feinbrun-Dotan & Danin 1991). The first record of this species from within the borders of Israel is from 2015, when Dror Melamed found a

small population near Nahal Grar, on a Loess flat in the badlands above the wadi's bank, and published a short note in Hebrew in the Kalanit online magazine (Melamed & Fragman-Sapir 2015). Two further populations were discovered in lower Nahal Grar and in the Nahal Bsor badlands by Dar Ben-Natan in 2020, during a field survey for Deshe OLI (Shalev & al 2021). All three populations are small and extremely local, occurring on loess or calcareous sandstone (Kurkar).

Curiously, in two of these three sites, *V. pumila* occurs in association with *Neatostema apulum* (which is also recorded from Israel for the first time in this paper), as well as several endemic and endangered species, restricted to sandy habitats along the Coastal Plains of Israel. The extremely local and fractured nature of these populations, far away from the closest known populations in northern Jordan and southern Syria, and together with the highly specific habitat in a small and geographically defined area of distribution in spite of the much wider global range of distribution and habitats – all shared by *V. pumila* as well as *N. apulum*, suggests that these populations are relics left by some trend of climate changes that may have affected these species' distribution, probably in the Holocene epoch, considering the sediment's age.

Reference material: JORDAN, Moav, west of Zizeh, alt: 720 m, 4.1925, *Fred S. Meyers* et *J. E. Dinsmore* (HUJ134970!), ISRAEL, N. Negev – Park Nahal Grar near Rahat, alt: 62 m, 20.2.2015, *Dror Melamed* (HUJ125989!), ISRAEL, bank of Nahal Grar, west of Ruhama, small loess slopes covered with herbaceous vegetation, near a path, a small clearing in a *Eucalyptus* grove, 27.2.2019, *Dar Ben-Natan* (HUJ134785!), ISRAEL, lower Nahal Grar, southern bank, 31.4000631,34.4454599, coarse Kurkar sandstone outcrops with a patch of *Sarcopoterium spinosum* (L.) Spach Batha, 18.2.2020, *Dar Ben-Natan* (HUJ134889!).

Caryophyllaceae Juss.

Cerastium brachypetalum Desp. ex Pers.

Found and identified in 2019 on Mt. Kata (lower Mt. Hermon) by Oz Golan, who published the finding on Facebook without sharing an exact location for verification. The species was found again and verified by Dar Ben-Natan during the 2020 Deshe OLI rare plant survey for the INPA (Shemesh & al, 2020). In 2022, a second locality was found by Ben-Natan in Mas'ade Forest during a survey in the northern Golan Heights for Deshe OLI and Shamir institute for the research of the Golan Heights, in very short herbaceous vegetation in a small *Quercus calliprinos* Webb forest clearing, on Ein-Zivan Basalt scree (Ben-Natan 2023). Interestingly, several other locally very rare small annuals, occurring in Israel in relatively large populations on Jurassic sandstone on Mt Kata, occur also in small stony basalt patches in clearings of Mas'ade forest: *Teesdalia coronopifolia* (J.P.Bergeret) Thell., *Linaria pelisseriana* (L.) Mill., *Aira elegantissima* Schur, and *Moenchia erecta* (L.) P.Gaertn. et al. Some of these are recorded from other areas in Israel as well, but some, like *Cerastium brachypetalum* and *Teesdalia coronopifolia*, haven't been found outside these two habitats.

Reference material: ISRAEL, Mt Kata, 33.2439650 N 35.7497670 E, Sandstone, *Sarcopoterium spinosum* Batha in the slope below Nimrod, together with *Cerastium glomeratum* Thuill. And *Cerastium comatum* Desv., 3.5.2020, *Dar Ben-Natan* (HUJ133355!, TELA2056!), ISRAEL, N. Golan Heights, Mas'ade Forest, Basalt, stony open places in *Quercus calliprinos* Webb forest, 33.2222790 N 35.7536320 E, 9.5.2022, *Dar Ben-Natan* (HUJ134806!).

Minuartia intermedia (Boiss.) Hand.-Mazz. (Fig. 1d)

Small, densely glomerate annuals growing in semi-arid habitats. Large populations were already known (and unidentified as of that time) to the local botany community in Mt Hermon, sometimes



Fig. 1. a) *Myosotis discolor*, photo by D. Ben-Natan; b) *Myosotis laxa* subsp. *cespitosa*, photo by O. Fragman-Sapir; c) *Valerianella pumila*, photo by O. Fragman-Sapir; d) *Minuartia intermedia*, photo by O. Fragman-Sapir.

regarded as a glomerate form of *Minuartia decipiens* (Fenzl) Bornm., when the species was first identified in the region by Oz Golan, who discovered a population in Mt Kata (lower Mt Hermon) in 2019 (Shemesh & al. 2021). In 2019-2021, several further populations were found by Dar Ben-Natan in the Judean Mts and the Judean Desert (Ben-Natan & Ron 2021). The species was already recorded in Jordan by Danin in 2004 (Taifour & El-Oqlah 2019), where it is sparsely abundant on rocky sandstone hills in Edom. The species is quite abundant in Mt Hermon between altitudes of 1200 and 1600, and much rarer in the Judean Mts.

Reference material: ISRAEL, Judean Mountains, Mt Amassa, on the slopes of the wadi East of the road going up the mountain to Beit Yatir, rocks, West facing slope, Nahal Tov, 30.3.2012, *Dar Ben-Natan* (HUJ134972!), ISRAEL, Mt Hermon, Bir Ansuba, roadside, 16.5.2018, *Dar Ben-Natan* (HUJ134974!), ISRAEL, Judean Mts, top of Mt Amasa, 31.3309671 N 35.0970000 E, a rocky Batha, 2.4.2019, *Dar Ben-Natan* (HUJ133345!, HUJ134973!), ISRAEL, Mt Kata, 33.2445450 N 35.7501410 E, Sandstone slopes, in exposed places and scree, 5.3.2020, *Dar Ben-Natan* (HUJ133341!, TELA2070!), ISRAEL, Judean Desert, Mt Hardon, northern exposure on a steep rocky slope pacing north towards Nahal Adasha, 31.3427520 N 35.1941870 E, together with *Siebera nana* (DC.) Bornm., *Bromus danthoniae* Trin., *Boissiera squarrosa* (Banks & Sol.) Nevski, *Loliolum subulatum* (Banks & Sol.) Eig, *Descurainia sophia* (L.) Webb ex Prantl, *Coridothymus capitatus* (L.) Rchb.f. and others, 28.4.2020, *Dar Ben-Natan* (HUJ133357!, TELA2059!),

Silene marschallii subsp. *marschallii* C.A.Mey. (Fig. 2a)

Silene marschallii was first discovered in the region in Upper Nahal Arugot by Ofra Friedmann and Ohad Binyamini in 2020 and identified the following year by Dar Ben-Natan. It is known in Israel from one location only, where it grows in a Batha of *Sarcopoterium spinosum* (L.) Spach at an altitude of 800 m. The local population is very small and highly endangered. It is the southern-most population for this species, hundreds of kilometers from the nearest known population in Turkey.

Reference material: ISRAEL, Judean Desert, Nahal Canub Reserve, near Ibei Hanahal settlement, 31.6002370 N 35.2154199 E, 31.6000791 N 35.2152559 E, 31.6006931 N 35.2153588 E, upper part of a northern exposed slope, in a Batha of *Sarcopoterium spinosum* (L.) Spach and *Coridothymus capitatus* (L.) Rchb.f., about five specimens together with *Consolida scleroclada* (Boiss.) Schroedinger and *Astragalus cretaceu*s Boiss. & Kotschy, 4.6.2020, *Dar Ben-Natan* (HUJ133353!), ISRAEL, Judean Desert, upper Nahal Arugot, 4.6.2020, *Ohad Binyamini, Ofra Fridmann, Ori Fragman-Sapir*, and *Dar Ben-Natan* (HUJ134811!).

Cistaceae Juss.

Fumana scoparia Pomel

This species was discovered in Israel on Mt Carmel (Carmiya) by Oz Golan, who did not deposit any plants in a local herbaria nor shared the location for verification, but reported the discovery in the Kalanit Israel Botanical Magazine (Golan & Shmida 2021). Since then, the species was further recorded and collected by other botanists in several localities in the Upper and Lower Galilee, Judean Mts and NE Shefela (Lev-Ramati & al. 2022.)

It is surprising how this shrublet went unnoticed for so long in the central areas of Israel. It is readily distinct from all other local *Fumana* species by its large, bright yellow flowers, woody branches and dense, summer deciduous leaves, semiterete and spirally arranged around the sterile shoots. These findings draw a new southernmost border for this species' distribution in the Middle East.

Reference material: ISRAEL, Judean Mts, Neve Illan Forest, 31.8085331,35.0474402,

Horizontal lime rock, together with *Satureja thymbra* L. and *Micromeria fruticosa* (L.) Druce, 3.6.2020, *Dar Ben-Natan* (HUJ133340!), ISRAEL, Judean Mts, south of Maoz Zion Alef, 31.7858720 N35.1489560 E, Horizontal lime rock at the margins of a planted pine forest, 5.11.2019, *Dar Ben-Natan* (HUJ133348!,TELA2054!), ISRAEL, Judean Mts, south of Maoz Zion Alef, 31.7tbh 858720 N 35.1489560 E, Horizontal lime rock at the margins of a planted pine forest, 18.5.2020, *Dar Ben-Natan* (HUJ133351!), ISRAEL, Shfela, near industrial area of Shilat, 31.9178611,35.0256667, 4.9.2019, *Nogen Tsabari* (HUJ133390!), ISRAEL, Lower Galilee, Tur'an Ridge, env. of Mitzpe Netofa, 32.8010 N 35.3862 E, alt: 365 m. Limestone outcrops in open batha and garrigue, 24.2.2021, *Dar Ben-Natan* (HUJ134939!), ISRAEL, Upper Galilee, Sulam ridge, 33.083722,35.162487, alt: 180 m. Calcareous rock in sunny clearing, 16.3.2021, *Dar Ben-Natan* (HUJ134979!), ISRAEL, Ahihud Forest, hard limestone outcrop, 32.9224930,35.1650920, 24.4.2022, *Dar Ben-Natan* (HUJ134805!).

Cleomaceae Airy Shaw

Cleome chrysantha Decne. (Fig. 2b)

The species was known from the region in the eastern Sinai Peninsula (Egypt). It is an annual or short-living perennial of the extreme desert. *Cleome chrysantha* was discovered in Israel for the first time by Dudi Rivner in the year 2016-7, which had good precipitation in S Israel, on a steep gravelly wash, where *Anticharis glandulosa*, another locally extremely rare species was found. The habitat is similar to some of its habitats in Sinai. The population was monitored since and was found to be self-sustained, germinating and blooming only in rainy years. The find was reported in the Kalanit Israel Botannical Magazine (Rivner & Shmida 2017).

Reference material: ISRAEL, Eilat Mts, Mt Zfahot, 25.5.2018, *Dudi Rivner and Ori Fragman-Sapir* (HUJ134812!).

Crassulaceae J. St.-Hil.

Sedum assyriacum Boiss. (Fig. 2c)

A rare annual that was discovered by Yair Ur near Revaya Water-Reserve in the Golan Heights in 2017, and initially misidentified as *Sedum palaestinum* Boiss. because of its bright yellow petals that are 3-4 times as long as the tepals. In 2019 it was reidentified as *S. assyriacum* Boiss. by Dar Ben-Natan. It is distinct from other local species by yellow petals, glabrous filaments and follicles and spatulate, notched nectariferous scales, as well as by the straight, semi-erect fruiting follicles.

S. assyriacum is a poorly known species, described originally in the mid-19th century from NE Iraq. Later it was collected in the Anti-Lebanon, around Rashaya and Zebadani, and in southern Syria in the Hauran and Djebel Druze (Mouterde 1966). Already in the *Nouvelle flore du Liban et de la Syrie*, Mouterde mentions *S. assyriacum* as extinct in the Rashaya – Zebadani area, possibly due to changes to drainage systems, or agriculture taking over its habitats. *S. assyriacum* hasn't been collected in Iraq since its description, and it is now possibly extinct in the country (Ghazanfar & Edmondson 2013). If these estimations are correct, southern Syria and the Golan Heights could be the main areas of occurrence for this species today. Although further surveys may locate it again in the Anti-Lebanon and Iraq. Ghazanfar & Edmondson (2013) consider *S. assyriacum* as a doubtful species similar to *S. pallidum* M.Bieb, due to the reddish petal midrib, which is visible in some of the plants in the Golan Heights population as well. However, the bright yellow petals, along with the follicles' and the nectariferous' shapes, clearly separate *S. assyriacum* from *S. pallidum*. Van Ham & 't Hart's 1998), and Messerschmid & al (2020) place *S. assyriacum* and the related *S. nanum* Boiss.

close to the genus *Petrosedum* Grulich, which emphasizes the distance between these unique species and the diverse *S. pallidum* complex, suggesting both species might warrant a new combination.

Sedum assyriacum occurs in the Central Golan Heights in vernal ponds on wet basaltic soil, together with other plants typical to this habitat such as *Damasonium polyspermum* Coss., *Elatine macropoda* Guss., *Myosurus minimus* L. and annual *Lythrum* species. Although *S. assyriacum* is already recorded from Syria, this is the first record of this species in the Flora Palaestina region.

Reference material: ISRAEL, Golan Heights, east of Revaya Reservoir, north of Ramat Magshimim, south of Yonatan and west of Nahal Elal's bend, 32.8840990 N, 35.7981280 E, vernal pond, wet mud, 20.4.2018, *Dar Ben-Natan* (HUJ133392!, HUJ134828!), ISRAEL, Golan Heights, vernal pool on basaltic soil, east of Revaya Reservoir and west of Nahal El-al, 32.884099 N 35.798128 E, atl: 460 m. 6.5.2021, *Dar Ben-Natan* (HUJ134905!).

Juncaceae Juss.

Juncus pygmaeus Rich. ex Thuill. (Fig. 2d)

This minute annual was discovered By Mimi Ron and Dar Ben-Natan in 2020 during an SPNI survey in Hadera, in a vernal pond on sandy clay sediment, in association of *Juncus acutus* L., and together with other pygmy annuals, typical of this habitat and locally endangered – such as *Schoenoplectiella supina* (L.) Lye, *Isolepis cernua* (Vahl) Roem. & Schult. and *Oldenlandia capensis* L.f. (Mendelson & al. 2020). Since then, it was sighted in the same location in 2021 and again in 2022. The population consists of several hundred plants. On several occasions, as well as in other rare plants surveys conducted in the immediate vicinity of the known site in 2021 and 2022, no further extensions of that population were located. Most of the vernal ponds area linked to the pond where the plants were originally found were destroyed due to construction work in the last decade. A surprising second population was discovered in 2022 by Noam Segev in a vernal pond in the N Samaria, on clay sediments and in association of mostly small annuals. This population, observed again in 2023, consists of several hundred plants as well, and is under threat of being lost due to urbanization.

Reference material: ISRAEL, Hadera, Samar vernal pond, on the wet bottom of the pond, in open spaces between *Juncus acutus* L. clumps, 32.4342231,34.8939021, together with *Schoenoplectiella supina* (L.) Lye, *Isolepis cernua* (Vahl) Roem. & Schult., *Juncus articulatus* L. and others, several hundred specimens, 27.4.2019, *Dar Ben-Natan* (HUJ134762!), ISRAEL, Shomron, Bar'on industrial area, N of Kdumim. Alt: 390 m. Vernal pond in calcareous area, cley, 21.4.2022, *Noam Segev* (HUJ134975!), ISRAEL, Sharon Plain, Samar vernal pond, margins of vernal pond in association with *Juncus acutus* L. and *Scirpus maritimus* L., 11.5.2022, *Dar Ben-Natan* (HUJ134798!, TELA4107!).

Linaceae DC. ex Perleb

Linum trigynum L. (Fig. 3a)

A slender, branched annual, that has been considered extremely rare and endangered locally, and is known only from Mt Kata in the lower Mt Hermon, where it grows on Jurassic sandstone and only rarely observed (the species was not found in rare plats surveys conducted on Mt Kata between 2020 and 2022, but was observed there again in 2023) (Shemesh & al. 2020). A single doubtful sighting was recorded from Illanot Forest in the Sharon Plain in 1989 (Shmida, Pollak and Fragman-Sapir 2012). In the spring of 2019, a large population consisting of hundreds to thousands of specimens was observed by Dar Ben-Natan in Tel-Yitzhak North Nature Reserve in the Sharon Plain, and was



Fig. 2. a) *Silene marschallii* subsp. *marschallii*, photo by O. Fragman-Sapir; b) *Cleome chrysantha*, photo by O. Fragman-Sapir; c) *Sedum assyriacum*, photo by D. Ben-Natan; d) *Juncus pygmaeus,* photo by D. Ben-Natan.

considered at first to be *Linum corymbulosum* Rchb. After being visited again a year later, it was identified by Dar Ben-Natan as *Linum trigynum*. A further, smaller population was discovered that same year by Dar Ben-Natan and Ori Fragman-Sapir during an IPNI survey for the Regional Council of Hadera (Mendelson & al. 2020), and another one in Liman Nature Reserve in the Coastal Galilee by Merav Lebel. A fourth population was photographed in dry fruit in 2022 by Yael Orgad in the Sergeant's Grove in Netanya, and identified by Dar Ben-Natan. In 2023 its previously reported occurrence in Illanot Forest was confirmed by Bar Shemesh.

In all coastal populations, *Linum trigynum* grows on red sandy loam, locally called hamra, in association with many other rare and highly endangered species, exclusive to this habitat in Israel and critically threatened by the mass urbanization of the Coastal Plains of Israel in recent decades. All five sites are locally known as important hotspots for endangered hamra species.

Most likely, this species wasn't noticed in the Coastal Plain up until now due to its resemblance to *Linum corymbulosum*, which is very common on clay and clay-loam soils on calcareous rocks in the inland areas of central and northern Israel, and is absent, as far as we know, from sandy habitats in the Coastal strip of Israel. Further populations of *Linum trigynum* might be discovered in other coastal hotspots in the future.

Reference material: ISRAEL, Sharon Plain, Tel Yitzhak North Reserve, 32.2510840 N 34.8629190 E; 32.2504250 N 34.8618660 E, Hamra soil, moist niches between tall grasses and in the shade of bushes in margins of *Calicotome villosa* (Poir.) Link garrigue, together with *Paronychia echinulata* Chater, *Centaurium maritimum* (L.) Fritsch, *Silene papilosa* Boiss., and *Lavandula stoechas* L., thousands, 26.4.2020, *Dar Ben-Natan*, (HUJ133368!, HUJ134781!), ISRAEL, Sharon Plain, Hadera, Zeita Hill ("The Tulip Hill") south of Neve Elazar neighborhood and north of road 9, 32.4163890 N, 34.9415510 E, Hamra soil, moist niches between tall grasses and in the shade of bushes in margins of *Calicotome villosa* (Poir.) Link and *Sarcopoterium spinosum* (L.) Spach garrigue, together with *Juncus capitatus* Weigel, *Paronychia echinulata* Chater, *Medicago murex* Willd., *Ornithopus pinnatus* (Mill.) Druce, *Tolpis umbellata* Bertol., *Lupinus luteus* L., and *Riccia gaugetiana* Durieu & Mont., Hundreds, 26.4.2020, Dar Ben-Natan (HUJ133343!, HUJ134782!), ISRAEL, Sharon plain, Ilanot woods, 32.292721, 34.902318, A garigue of *Cistus salviifolius* L. & *Calicotome villosa* (Poir.) Link on clay-loam soil, 9.4.2023, Dar Ben-Natan and *Bar Shemesh* (HUJ135031!), ISRAEL, Mt Hermon, Mt Katta, 33.2435234,35.7491986, Sandy loam near sandstone outcrops, damp soil, 18.5.2023, *Dar Ben-Natan* (HUJ135052!).

Orchidaceae Juss.

Himantoglossum comperianum (Steven) P. Delforge

A disjunctive, rare E Mediterranean orchid. *Himantoglossum comperianum* was first discovered in Israel by Sakra Jen in the spring of 2020, and identified by Ori Fragman-Sapir. So far, a single plant was recorded in bloom in the Northern Golan Heights in 2020, and again in 2022, on the roof of a deserted bunker inhabited by an herbaceous plant community for a few decades. The finding was published in Hebrew in the Kalanit Israel Botanical Magazine, but no specimens were collected (Shifmann 2020).

Himantoglossum comperianum is already recorded from Syria (Peri 2015), which makes its occurrence in the Golan Heights somewhat unsurprising. We hope that further surveys might reveal larger, sustained populations in the area – although no such population was found during the survey conducted in the Northern Golan Heights in 2022 by Deshe OLI and Shamir institute for the research of the Golan Heights (Ben-Natan 2023). It is difficult to ascertain whether this single individual on

Tel Ram represents a larger population, as yet undiscovered by local botanists or otherwise mostly extinct, or a recent casual occurrence, dispersed from across the Syrian border. The natural habitats on the eastern parts of the N Golan Heights are heavily threatened, and most of the area outside of old minefields was already lost to rapid expansion of agricultural terraces and military activity.

Interestingly, a single specimen of *Himantoglossum robertiaum* (Loisel.) P.Delforge, identified by Ori Fragman-Sapir, was discovered in the Judean Mts by Gaby Peleg, Ofra Laron and Ofra Negev in March 2023. No specimen was collected and currently opinions differ as to its indigenousness. Further surveying and monitoring are required in order to see whether this individual represents a nearby sustained and yet undiscovered population, or a casual occurrence (natural or otherwise).

Reference material: ISRAEL, Golan Heights, Mt Ram, on top of a deserted bunker on the mountain's western top, 33.2458000 N 35.7876280 E, Herbaceous vegetation typical to volcanic cones in the northern Golan Heights, only one individual, 21.5.2020, *Dar Ben-Natan* (HUJ133339!), ISRAEL, N. Golan Heights, on a deserted bunker's roof at the top of Tel Ram's western peak , in association with *Vicia tenuifolia*, *Eryngium glomeratum*, an *Peltaria angustifolia*, 33.2457770 N, 35.7876780 E, a single individual, 19.5.2022, *Dar Ben-Natan* (HUJ134793!).

Papaveraceae Juss.

Fumaria officinalis subsp. *cilicica* (Hausskm.) Liden

Collected in 1926 from the Upper Galilee by Eig and Zohary, and again from Mt Hermon in 1986 by Liston and Shmida, but excluded from the Flora Palaestina (Zohary & Feinbrun-Dothan 1966-1986) and the Analytical Flora of Eretz-Israel (Feinbrun-Dotan & Danin 1991), *Fumaria officinalis* was observed, collected and identified again in the region only in 2011, by Shimon Cohen-Sivan and Shauli Bekerman, who found it again on Mt Hermon. Since then, further, large populations were found by several botanist and surveyors in the Northern Golan Heights, Upper Galilee and Mt Hermon, on basalt, scoria or limestone. As suggested by Shmida in the Hebrew publication on this matter in the Kalanit online magazine (Shmida 2015), it is possible that *Fumaria officinalis* is expanding its range in northern Israel, and that it is now much more common than it used to be. It is now fairly abundant in the NE Golan Heights (Ben-Natan 2023), but still uncommon in the region as a whole.

Reference material: ISRAEL, Upper Galilee, garden's sides, 2.6.1926, *A. Eig* and *M. Zohary* (HUJ124994!), ISRAEL, Mt Hermon, 5.5 km NNW of Majdal-Shams, roadside, alt: 1600 m, 4.6.1986, *A. Liston* and *A. Shmida* (HUJ124993!), ISRAEL, Mt Hermon, 24.5.2011, *Shauli Bekerman* (HUJ130097!), ISRAEL, Golan Heights, Mt Bental, open forest of *Quercus boissieri*, alt: 110 m, 9.5.2012, *A. Shmida* and *Sh. Klein* (HUJ126323!), ISRAEL, Mt Hermon, lower cable-car station, 9.4.2013, *Shimon Cohen-Sivan* (HUJ130094!).

Plantaginaceae Juss.

Limosella aquatica L.

Delicate hydrophyte, growing in shallow ponds. First discovered in Israel by Bar Shemesh in 2019 in the northern margins of the Shomron Mts (Shemesh & al. 2022), and by Siko Bechor in 2020 in the Upper Galilee, and identified by Ori Fragman-Sapir in 2020. In both localities, the plants occur on calcareous rocky hills, in small and shallow rock ponds (about 15 cm deep) in caliche outcrops, layered with thin clay mud at the bottom, and in small shallow vernal ponds on grey rendzina soil.

Contrary to the title of the Hebrew publication in this matter in the Kalanit Israel Botanical Magazine (Bechor & Fragman-Sapir 2020), we believe that most likely *Limosella aquatica* arrived

at these habitats naturally, by long-distance seed dispersal, probably carried by birds.

Reference material: ISRAEL, Upper Galilee, Ahihud Forest, small vernal pools in hard calcareous rocky outcrops, 12.4.2022, *Siko Bechor* (HUJ134817!).

Poaceae Barnhart

Molineriella minuta (L.) Rouy (Fig. 3b)

Discovered and identified for the first time in the region by Bar Shemesh from Mt Kata (lower Mt Hermon) in 2021 (Shemesh & al. 2021), this delicate grass was apparently previously known from Mt Kata (although only a single specimen was found in the HUJ herbarium, collected by Yair Ur in 2009) and has been misidentified repeatedly as *Zingeria biebersteiniana* (Claus) P.A.Smirn. Several additional specimens collected in the same area by Dar Ben-Natan, Mimi Ron and Ori Fragman-Sapir the previous year (Shemesh & al. 2020) were later identified as *Molineriella minuta* as well. This delicate species is currently known in Israel only from that single location, where it occurs on Jurrasic sandstone outcrops together with *Aira elegantissima* Schur, whereas *Z. biebersteiniana* occurs in the region almost exclusively in dolines on the higher parts of Mt Hermon. Only a single collection of this species from Israel outside Mt Hermon exists in the HUJ herbarium: collected by Yair Ur in a vernal pond near Tsuriman in the northern Golan Heights.

Reference material: ISRAEL, Mt Kata (Lower Mt Hermon), 2704/7945, alt: 1050 m, 29.6.2009, *Yair Ur* (HUJ134819!), ISRAEL, Mt Hermon, Mt Kata, sandstone outcrops, 33.2479 N, 35.7552 E, alt: 1080m. Together with *Aira elegantissima* Schur and *Moenchia erecta* (L.) P.Gaertn. & al., 3.5.2020, *Dar Ben-Natan* (HUJ134899!).

Phleum pratense L.

A perennial grass, erect to ascending, reaching a height of up to 80 cm, with thickened bulbous basal internodes. *Phleum pratense* was collected from Mt Hermon by A. Shmida in the 1970s, and identified as *P. bertolonii* DC. (synonym). On this basis, it was included in Shmida's Field Guide for the Mt Hermon Plants (Shmida 1981). The species was not included in the Analytical Flora of Eretz-Israel (Feinbrun-Dotan & Danin 1991). This addition to the flora of Mt Hermon wasn't reported in scientific literature up to the present.

In 2018, three *Pleum* sp. specimens were discovered by Re'ut Luria, Dar Ben-Natan and Merav Lebel during a Deshe OLI rare plants survey for the INPA, in upper Mesil A'sania in the northern Golan Heights. The plants found growing in a vernal stream (called Mesil locally) bank on alluvial basaltic clay soil, together with *Alopecurus arundinaceus* Poir. and *Carex divisa* Huds., and later identified as *P. pratense* by Dar Ben-Natan, Ori Fragman-Sapir and Yuval Sapir. The plants were observed again in the same location in 2019. In 2022, during a botanical survey in the northern Golan Heights for Deshe OLI and Shamir institute for the research of the Golan Heights, a larger population, consisting of several dozen individuals, was located further downstream from the original location (Ben-Natan 2023).

The difference between the plants growing in Mesil A'sania and those of the Mt Hermon populations, growing on glacial silt clay in dolines at an altitude of 2000+ m, is solely in habit and spikes and spikelets dimensions: while plants from A'sania reach 40 cm or more and have generally larger spikes and spikelets, the Mt Hermon populations consist of short plants (up to 15 cm) generally bearing smaller spikes and smaller spikelets. This leads us to follow Stewart & al. (2011) in regarding the two as conspecific. The same pattern can be observed in the *Alopecurus arundinaceus* populations of the Golan Heights wet habitats and Mt Hermon dolines at 2000+ m, which in both habitats occur together with the much rarer *P. pratense*.



Fig. 3. a) *Linum trigynum,* photo by O. Fragman-Sapir; b) *Molineriella minuta*, photo by D. Ben-Natan; c) *Pholiurus pannonicus*, photo by D. Ben-Natan; d) *Lycium petraeum*, by photo O. Fragman-Sapir.

Reference material: ISRAEL, S Mt Hermon,: 3.5 km N of Majdal Shams, alt: 1850 m., 7.1975, *A. Shmida* (HUJ134965!), ISRAEL, S. Hermon: 4.5 km NE of Majdal Shams, Bolan Valley, alt: 2000 m, hard Jurassic limestone, 26.7.1975, *A. Shmida* (HUJ134960!, HUJ134962!, HUJ134963!, HUJ134964!), ISRAEL, S. Hermon, 5 km NW of Majdal Shams, alt: 1450 m. Brown soil in dolina, 22.5.1969, *A. Danin* (HUJ134961!, HUJ134966!), ISRAEL, S. Hermon, Gebel Majdal Shams, alt: 1700-2100 m. Limestone, Jura, 12.9.1967, *D. Pery* (HUJ134959!), ISRAEL, Golan Heights, upper Mesil A'sania (west of Ein Mumsia and road 98), 33.0763551 N 35.8178219 E, Stream's bank, tall herbaceous vegetation, together with large clumps of *Alopecurus arundinaceus* Poir., very few specimens, 4.6.2018, *Dar Ben-Natan* (HUJ134768!), ISRAEL, Golan Heights, upper Mesil A'sania (west of Ein Mumsia and road 98), 33.0763551,35.8178219, Stream's bank, tall herbaceous vegetation, together with large clumps of *Alopecurus arundinaceus* Poir., very few specimens, observed for the second consecutive year, probably perennial, horned glumes, lacking cilia at margins, 23.6.2019, *Dar Ben-Natan* (HUJ133383!), ISRAEL, Golan Heights, upper Mesil A'sania, 33.0748410 N 35.8153500 E, 33.0754470 N, 35.8163760 E, moist meadow in the banks of a small stream (Mesil), 19.5.2022, *Dar Ben-Natan* (HUJ134772!, TELA4103!).

Pholiurus pannonicus (Host) Trin. (Fig. 3c)

Spreading-ascending annual grass, very similar to *Parapholis incurva* (L.) C.E.Hubb., and differing in the much larger habit, 2-flowered spikelets and venation on the glums and lemmas.

Pholiurus pannonicus was first discovered in Israel by Dar Ben-Natan during a botanical survey in the northern Golan Heights for Deshe OLI and Shamir institute for the research of the Golan Heights, in May 2022. The plants were found growing in a dense patch on the shallower margins of a vernal pond (dry at the time of the finding) on basalt clay soil, about 1 km west of the Syrian border (Ben-Natan 2023). *Pholiurus pannonicus* is recorded in the NE Mediterranean from western Turkey and Greece. To our knowledge, it has not been reported southeastwards of that area, which makes this the first record of this species not only from the Golan Heights, but the entire Middle East. It is most probably present in southern Syria as well, in the Quneitra Valley, which the Tsuriman vernal ponds are a part of.

Reference material: ISRAEL, Golan Heights, near ruins of Tsuriman, dry bottom of vernal pond, basalt clay soil covered with herbaceous vegetation, 33.096521 N 35.836719 E, 20.5.2022, *Dar Ben-Natan* (HUJ134936!, HUJ134937!, HUJ134938!).

Rubiaceae Juss.

Galium tenuissimum M. Bieb.

Low herbs growing in Israel in margins of plantations on pyroclastic ash soils in the northern Golan Heights, and readily distinguishable from the very similar *Galium chaetopodum* Rech.f. by the absence of long awns at the edge of the petals. *G. tenuissimum* was identified in a single location at the margins of a plantation near Buk'ata, where it is highly threatened by agricultural activity. Another locally extremely rare species with similar circumstances and habitat (*Crambe alutacea* Hand.-Mazz.) became extinct in 2022 after the plot where it used to grow was repurposed and cultivated (Ben-Natan 2023).

Galium tenuissimum was discovered as a species new to the Flora Palaestina region by Dar Ben-Natan during a Deshe OLI survey for the KKL-JNF in 2023, and identified by Bar Shemesh and Dar Ben-Natan. Similar plants were discovered the same year in two other locations, but their identification is not certain.

Reference material: ISRAEL, N Golan Heights, east of Tel Sha'ifri, near Buk'ata 33.1991635,35.7934923, alt: 1080m, next to a plantation of fruit trees. Deep caly-loam soil, 15.5.2023, *Dar Ben-Natan* (HUJ 135049!).

Solanaceae Juss.

Lycium petraeum Feinbrun (Fig. 3d)

A rare, poorly known species, described by Feinbrun-Dothan (1978) from Jordan, where it grows at the margins of irrigated plots on the Edom Mts, and is probably a relic of ancient agriculture, the natural origins of which are as yet unknown.

This species is largely similar to *L. depressum* Stocks in its short corolla tube and many flowered flower-clusters, and can be distinguished by the pubescent lower part of the filaments, brighter red berries, viscous young branches and leaves, and habitat. *L. petraeum* was recorded in Israel for the first time in Arad in 2008, by Dar Ben-Natan, and was misidentified at first as *Lycium shawii* Roem. & Schult., then as *L. depressum* Stocks, and later as an unidentified *Lycium sp*. The plants were reidentified by Dar Ben-Natan as *L. petraeum* only in 2022, after comparing the live plants from Israel to herbarium material from Jordan, kept in the HUJ herbarium, and to photographs taken By Ori Fragman-Sapir in Edom Mts the same year.

By then, *L. petraeum* was recorded by Dar Ben-Natan in four localities in the Central Negev and Judean Desert. In three of these four locations, *L. petraeum* grows near old historically irrigated plots (Nabataean terraces, wells and agriculture in Nahal Haro'a, Nahal A'ro'er and Be'erotayim). In all of those places, *L. petraeum* was probably brought and planted by nomad tribes that used to cultivate the loess terraces in the Central Negev, such as late Nabataeans or Bedouin, similar to the Jordanian populations.

Reference material: HOLOTYPE, JORDAN, Edom, Wadi Musa, Hedge rows, alt: 1200 m, 29.3.1936 (HUJ29819!), PARATYPE, JORDAN, Wadi Musa, alt: 1200 m, hedge rows, *A. Eig*, *M. Zohar*y & *N. Feinbrun-Dothan*, 29.3.1936 (HUJ29820!), TURKEY, B5 Yozgat: Yozgat to Kirikkale, 5 km from Yozgat, alt: 1060 m, *A. Baytop*, 7.6.1974 (HUJ134969!), TURKEY, B3, Eskisehir: 3 km S. of Cifteler, alt: 870 m, *A. Baytop*, 28.8.1974 (HUJ134968!), ISRAEL, Nahal Ezuz, Be'erotayim, probably a remnant of planted by local Bedouins for plot bordering, 30.7923510 N, 34.4686278 E, 11.3.2020, *Dar Ben-Natan* (HUJ134883!), ISRAEL, Negev, Nahal Ha'roah, near a picnic area, in the vicinity of Nabbatic terraces, on Loess, 30.8758052 N, 34.7849143 E, alt: 450 m. 13.8.2022, *Dar Ben-Natan* (HUJ134895!, HUJ134896!, HUJ134897! HUJ134898!).

Discussion

In the last two decades, and increasingly so in recent years, the renewed interest in the diversity and taxonomy in Israel have led to the discoveries of more than 60 previously unrecorded or misidentified species in the local flora. 28 of which are included here and 32 more will be reported in upcoming papers. These species were found all across the region, from the Eilat Mountains in the south to Mt Hermon in the north, and from the Golan Heights in the northeast to the western Negev Desert in the southwest.

An analysis of the new findings presented in this paper shows that they are mostly herbaceous plants (25 species out of 28 in total), of which 21 are annual, and only three species are woody. This corresponds with the rich herbaceous and particularly annual flora of the region (Fragman & al.

1999), which is unique in a global perspective (Poppenwimer & al. 2023). It is assumed that more than half of the local flora is annual and in many cases one can find dozens or even hundreds of annual species in small areas (Shmida 1985), hence the complexity and importance of conservation of such microhabitats.

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. Lycium petraeum*, *Cleome chrysantha* and *Sedum assyriacum*), or from the higher Mt Hermon (*Siebera nana*, *Linum trigynum*). Some of the examples presented in this paper were previously regarded as doubtful records that went unpublished or that were not accepted by local authorities, and only a few of them are misidentifications of already recorded species (*Valerianella discoidea*, *Sagittaria subulata*, *Achillea falcata*, *Molineriella minuta* and *Minuartia intermedia*). Some of the new species recorded here, mostly from wet habitats, are likely to have recently been bird- or wind-dispersed into the region and establish new populations, but many are putative relicts that survived in small and scattered populations.

While some of the new discoveries' absence from local literature are the result of the relative absence of survey and botanic activities in some remote areas of the region, many new discoveries were made in relatively densely surveyed areas. These were achieved mainly by increased observation and identification capabilities, both in the field and in the herbaria, and a rise in interest in plant taxonomy and diversity.

The findings in this paper contribute to the updated list of the local flora (in preparation). They showcase the vast diversity that can be found in such small regions in the eastern Mediterranean, and demonstrate the importance of thorough biodiversity surveys. Habitat conservation is of great importance for the conservation of this plant diversity, with special emphasis on the conservation and interface of small and vulnerable ecosystems in densely populated areas such as central Israel, and in densely cultivated areas such as the northern Golan Heights and western Negev.

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 are conserved in the Jerusalem Botanical Gardens, as well as other botanical gardens, sanctuaries and the Israel Gene Bank.

This paper is part of efforts to update the Flora Palaestina checklist. It is hoped that more studies and publications on the local flora, and that of the eastern Mediterranean as a whole will follow.

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Article

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Checklist updating and analysis of the flora of Sifnos Island and Kitriani Islet (Kiklades, Greece) with new noteworthy floristic records

Abstract

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The aim of this work is to provide a contribution to the flora of Sifnos Island and Kitriani Islet by analyzing the distribution patterns and endemism of their vascular flora. The total flora of Sifnos Island consists of 95 families, 381 genera and 776 taxa including alien species. A comparison, albeit partial, with the first florula of the island compiled by Malakates in 1933 was also made, highlighting the landscape changes that have occurred over the years due to the dessication of the island following human exploitation of its resources. Also in the present paper, 26 additional species for both islands are added as new records. In particular for the island of Sifnos, *Gagea pseudopeduncularis*, *Limonium oligotrichum* and *L. sitiacum* new for the phytogeographic region of the Kiklades, *Campanula heterophylla* and *Galanthus ikariae*, endemic species with a rather restricted distribution in the Aegean area.

Key words: floristics, endemism, aliens, Mediterranean.

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Introduction

Sifnos lies in the western Kiklades. It belongs to the administrative region of South Aegean and to the regional unit of Milos. It is located between Serifos, Kimolos and Antiparos (36° 58’ N 24° 45’ E) and is 80 nm from Piraeus. The island covers an area of 74 km² and the coastline is approximately 70 km. The main bays are Kamares, Faros, Vathy, and Herronisos (Fig. 1). Sifnos shows the typical Cycladic landscape characterized by land terraces cultivated with cereal crops, vineyards and olive trees interspersed with bushy vegetation. The western side of the island and precisely the area between Kamares and Vathy is a Special Protection Area and a Site of Community Importance according to European directives (GR 4220008) mostly occupied by Profitis Ilias, the highest peak of the island (682 m a.s.l.) with the springs of Agia Marina, Agios Ioannis and Panagia. The most relevant element of this site is the *Juniperus turbinata* Guss. maquis interspersed with



Fig. 1. Sifnos Island and Kitriani Islet.

phrygana whose most representative elements are: *Sarcopoterium spinosum* (L.) Spach, *Thymbra capitata* (L.) Cav., *Salvia fruticosa* Mill., *Origanum onites* L., and *Genista acanthoclada* DC. The northern section of the island is one of Greece's most important areas for birds, breeding raptors and passage migrants (https://old.ornithologiki.gr/; http://datazone.birdlife.org/site/factsheet/northern-sifnos-iba-greece). Not too far from the southernmost Kontou Cape lies the uninhabited islet of Kitriani, which administratively belongs to Sifnos. It is under one kilometre long with a maximum elevation of 136.8 m a.s.l. From a floristic point of view, it is mainly characterized by dense low scrub of *Juniperus turbinata* and *Pistacia lentiscus* L. The islet can only be reached by private boats from Plati Yalos located on the opposite cost of Sifnos.

The botanical explorations of Sifnos

John Sibthorp and Ferdinand Bauer passed Sifnos when sailing north from Crete to the Greek mainland in the summer of 1786, but do not appear to have set foot on the island. Instead, Sibthorp's associate John Hawkins visited Sifnos in 1787, but probably did not collect plants since there are no records in Florae Graecae Prodromus (1806-1816). The first published records from Sifnos appear in Chaubard & Bory: Nouvelle flore du Péloponnèse et des Cyclades (1838), based on their own collections around 1830. At least three species were mentioned, viz. *Colchicum variegatum* L., *Euphorbia dendroides* L. and "*Salsola brevifolia*" (now *Caroxylon aegaeum* (Rech. f.) Akhani & Roalson). Josef Sartori, a plant collector in Athens at the time of King Otto, collected at least one interesting species on Sifnos, the Aegean endemic *Hymenonema graecum* (L.) DC. (Halácsy 1901-1904).

Theodor von Heldreich collected on some Kikladian islands in the late summer of 1881. In spite of the advanced season, he gathered some interesting species on Sifnos, including at least *Carthamus leucocaulos* Sm., *Centaurea spinosa* L., *Heliotropium dolosum* De Not. and *Limonium ocymifolium* (Poir.) Kuntze.

During the twentieth century, there was an increase in the floristic exploration of the Kiklades and the Aegean area on the whole. An extensive floristic catalogue for Sifnos was published by Malakates (1933). A Swedish group (Hans Runemark, Sven Snogerup, Bengt Bentzer, Mats Gustafsson and Arne Strid) collected on Sifnos 13–16 May 1958, 12–13 April 1967, 20 June 1967 and 9–10 April 1969, gathering a total of 457 species. Specimens are mostly at LD. Heiselmeyer & Pilsl (1983) published Vegetationskundliche Studien an Brandflächen unterschiedlichen Alters auf Siphnos. Several coastal and wetland species were reported from Sifnos by Koumpli-Sovantzi & Yannitsaros (1993).

Heinz Kalheber collected on Sifnos in 1997 and 1998, gathering around 390 species. No details are available, but the species have been registered for the Flora Hellenica Database from a list supplied in 2011. A new species, *Allium apolloniensis* Biel, Tan & Tzanoudakis, was recently described (Biel & al. 2006). So far it is known only from the island of Sifnos. Burkhard Biel published additions to the orchid flora of the Kiklades, including Sifnos (2008). Finally, Biel & Tan (2016) published several additions to the flora of Serifos and Sifnos. Material regarding the flora of Kitriani derive from the collections of Runemark, Bentzer and Hansen (LD). Literature data were retrieved from all these published sources and from Runemark (1969, 1970, 1971a, 1971b), Runemark & al. (1960), Strid (1965, 2016). Rechinger (1950, 1955) and Rechinger & Rechinger-Moser (1951) were also consulted.

Study area

Sifnos is a semi-mountainous island. The northern part is rocky and less productive than the southern and western parts, which are characterized by vast cultivated plains around Vathy, Platys Yalos (south) and Kamares (west). Sifnos lacks permanent water courses, there are only small streams, the most important of which is Leivadas River (almost completely waterless at certain times of the year) which runs through the valley of Kamares. Wells are used to access the aquifer to fulfill the island's water needs. Sifnos was once much richer in water sources as documented by Malakates (1933) who stated that the eastern part of the island was once intensively cultivated with wheat, vines, oil, cotton,

legumes and figs. At present, agriculture has significantly declined due to limited water availability, however extensive areas are still cultivated, mainly with olive groves. Cropland suffered the highest area loss through conversions to semi-natural vegetation or settlements and at the same time the *Juniperus turbinata* maquis vegetation expanded over time, mainly away from settlements (Tzanopoulos & Vogiatzakis 2011). The abandonment of cultivation and subsequent grazing has led to vegetation degradation. Between 1987 to 1999, grazing involved 11,000 animals, including goats and sheep, and this gives us information on how much grazing affected the island (Tzanopoulos & Vogiatzakis 2011). In the past, agriculture and sheep and goat breeding were not enough for the livelihood of the citizens, who also relied on pottery production and mining. Nowadays, there are nineteen pottery workshops all over the island, which produce useful utensils. Unfortunately, the realization of this pottery since ancient times has had its destructive role as the woods were destroyed as fuel for the furnaces (Malakates 1933). The bare slopes and the toponymy itself bear witness to this fact. The occurrence of toponyms such as Kapsalos, whose name means burnt in Greek, on Sifnos and other islands such as Kasos Island (Cattaneo & Grano 2021), is extremely indicative of how much the Aegean islands have suffered a real impoverishment of their original flora for historical and economic reasons, such as the use of wood as fuel not only for the production of pottery but also for the transformation of limestone into lime or for the construction of vessels (Cattaneo & Grano 2016). Another element which has greatly influenced the landscape of Sifnos is mining. Sifnos is rich in minerals and its metal wealth has been known since ancient times. The mining activity of Sifnos is mentioned in the writings of Herodotus and Pausanias, which indicate the existence of productive gold mines on the island until approximately 400 B.C. (Ashton 1991), silver (the richest were in Aghios Sostis), manganese, iron, copper, lead and galanite (Malakates 1933). Iron and lead mines operated on the island from the 16th century until the beginning of the 20th century (Davis 1966). The exploitation of mines has contributed greatly to the degradation of the natural ecosystem and a similar situation also occurred on Serifos Island (Livaniou-Tiniakou & al. 2023). The abandoned mines that have left an indelible mark on the island's landscape are currently clearly visible.

Geology and Paleogeography

During the Pliocene, many of the Cycladic islands were welded together to form a single large unit, which were segregated from the mainland tectonically in the Middle Pleistocene (Foufopoulos & Ives 1999). During the Late Glacial Maximum (ca 20,000 BP) at the end of the last glacial period, when the sea level dropped 120 m, a large number of the eastern Kikladic islands, (Andros, Tinos, Mykonos, Siros, Paros, Antiparos, Naxos, Ios, Folegandros, Sikinos and some smaller islands) formed one large island "Mega-Kiklades palaeo-island", with an area of 6,978 km². To the west of this "mega island", the islands of Kithnos, Serifos and Sifnos, along with the group of Milos, Kimolos and Polyaigos remained distinct from each other as well from the Greek mainland (Gaki-Papanastassiou & al. 2005; Kapsimalis & al. 2009). This palaeo-island fragmented into an archipelago of islands during the subsequent sea level rise at the end of the LGM (Kapsimalis & al. 2009). Hence 18,000 years ago Sifnos was already isolated (Gaki-Papanastassiou & al. 2005). During the LGM, the global sea level was ~135 m lower than present and this led to a major reduction (approximately 70%) of total island area in the

Aegean basin and a rapid increase in the number of islands due to fragmentation (Simaiakis & al. 2017).

Rising sea levels led to island-area reductions and distance increases, causing increased species extinction rates and reduced migration rates. Based on recent studies, it seems that among the Kiklades, the palaeo-islands suffered highest area-reduction rates and distance increase and consequently higher species extinction rates, while islands with smaller area reductions are expected to have suffered lower species extinction rates (Simaiakis & al. 2017). This is the case of Sifnos which seems to have experienced minimal area loss and, in fact, shows good floristic richness, including notable levels of endemism.

With regards to the geology of Sifnos, two main tectonic units can be identified: Chersonissos and Faros. The Chersonissos Unit is further divided into three lithologic subunits which are the Upper Marble Complex, exposed in the north-western part of the island following the Eclogite and Blueschist Unit and the Main Marble Unit that covers almost all of the central southern part of the island. The Faros Unit mainly concerns the southeastern part of the island and is composed of metabasites and metasediments strongly retrograded in the greenschist-facies (Trotet & al. 2001; Roche & al. 2016).

Malakates flora

The first inventory of the vascular flora of Sifnos was drawn up by Malakates (1933) and this paper provides an updated checklist of the flora of Sifnos 90 years later. The authors drew up a checklist grouping all the published floristic data from 1933 to 2023 (also including those of Kitriani) adding their own data on the flora of both islands. The Malakates' checklist amounts to 345 taxa including cultivated species (19 taxa). Thirty of these taxa are no longer confirmed. It is not possible to make a detailed study of the Malakates checklist, as the number of species recorded by the author is too low. Although it was not possible to perform a chorological and biological comparison between the two checklists, it was possible to guess the distinctive features of the flora of Sifnos at the beginning of the 1900s by noticing the changes that occurred in the island landscape over the years. As previously stated, Sifnos was once much richer in vegetation cover and water sources and the flora compiled by Malakates is proof of this. The island was isolated from the other islands and the mainland only in the late Pleistocene. Isolation with the resulting climate change and human impact over time have led to changes in the island's vegetation.

Many of the taxa from Malakates' checklist that are no longer found on Sifnos show a western and northwestern distribution mainly involving the Peloponnese, Sterea Ellas and Western Aegean Islands, which is the case for *Asphodelus tenuifolius* (Cav.) (Sterea Ellas), *Scorzonera crocifolia* Sm. (Sterea Ellas, W. Aegean Islands), *Cerastium illyricum* Ard. (Peloponnese, Sterea Ellas), *Silene corinthiaca* Boiss. & Heldr. (Peloponnese, Sterea Ellas), *Bryonia dioica* Jacq. (Peloponnese, Sterea Ellas), *Hyoseris radiata* L. (Ionian Islands and Peloponnese). This type of distribution has also been observed for some endemic taxa of Sifnos, which is evidence of the connection between Sifnos and mainland in ancient times when it most likely had a different climate and greater water availability that enabled other plant species to grow. The separation of Sifnos from the mainland and the centuries-long impact of human exploitation on the island's resources likely led to its dessication, a fate common to almost all the Aegean islands. This would have led to a loss of some species which were unable to survive in a modified environment. Indeed, most of the taxa no longer confirmed on the island are species linked in vary-

ing degrees to water availability and a landscape featuring greater vegetation cover. Species mentioned by Malakates but no longer encountered on Sifnos, such as *Ammi visnaga* (L.) Lam., *Helminthotheca echioides* (L.) Holub, *Hyoseris radiata*, *Pulicaria dysenterica* L., *Rumex crispus* L., *Cyperus rotundus* L., *Melissa officinalis* L., *Portulaca oleracea* aggr. and *Salix alba* L. are linked to wet environments, riverbanks, grassy pastures, and for some of these, their abundance on the island or their presence along the rivers was emphasized. Malakates also mentions the punctiform presence of *Cotinus coggygria* Scop. and *Erica arborea* L. The former species is mostly linked to thermophilous deciduous woodlands in sub-Mediterranean environments from the coast to hilly and mountainous areas and *E. arborea* grows in evergreen woodlands and scrubs (Pignatti 2017-2019). The presence of *Cotinus coggygria* is exclusively reported along the river Leivadas of the Kamares valley where here was once greater moisture; it is therefore not surprising that the species is no longer found. Malakates indicated *Erica arborea* exclusively at a site on the south-west side of Profitis Ilias Mt. and on Kitriani Islet, but this taxon was also not found by the authors, even on their recent visit to Kitriani.

Materials and Methods

Sifnos was investigated by the authors on two occasions: from 31 July to 17 August 2022 and from 6 to 11 April 2023. Kitriani was visited only once on 13 August. Plant material is deposited in the first author's personal herbarium (Herbarium Cristina Cattaneo). The authors provide an updated checklist of the flora of Sifnos Island and Kitriani Islet, which includes all taxa registered to date Electronic Supplementary File 1 (ESF1). Plant identification mainly relied on Rechinger (1944, 1949), Rechinger & Rechinger-Moser (1951), Tutin & al. (1964-1980, 1993), Greuter & al. (1984-1989), Strid & Tan (1997, 2002), Biel & al. (2006), Greuter & Raab-Straube von (2008), Tison & al. (2013), Brullo & Erben (2016) and Strid (2016). With regard to the status of alien taxa, Arianoutsou & al. (2010) and Dimopoulos & al. (2018) were followed. The distribution of the genus *Limonium* complies with Brullo & Erben (2016). Species nomenclature and the status of endemic taxa recorded for Sifnos is based on Dimopoulos & al. (2018). The life-form and chorological categories follow Raunkiaer (1934) and Dimopoulos & al. (2018). The term "endemic" is used to denote taxa with a distribution area confined to Greece. Place names mentioned in the text follow the map of Sifnos produced by Terrain Cartography Group (2018).

Abbreviations used in the text: IOI = Ionian Islands; NPi = Northern Pindos; SPi = Southern Pindos; StE = Sterea Ellas; EC = East Central; NC = North Central; NE = North East; NAe = North Aegean Islands; WAe = West Aegean Islands; Kik = Kiklades; KK = Kriti and Karpathos; EAe = East Aegean Islands.

Results

Floristic analysis

The total flora of Sifnos Island consists of 776 specific and subspecific taxa, including alien species, referred to95 families and 381 genera. *Erigeron karvinskianus* DC. was not included in the floristic analysis as not well established in Greece. The families with the

largest number of genera are represented by *Asteraceae* (51), *Poaceae* (42), *Fabaceae* (27) and *Brassicaceae* (25). The richest families are *Fabaceae* (101 taxa), *Asteraceae* (92 taxa) and *Poaceae* (76 taxa). The alien taxa are represented by 20 species belonging to 10 families and 14 genera. None seem to have an invasive character (except for *Oxalis pes-caprae* L.) and all are restricted to near settlements. This is the case of species such as *Amaranthus albus* L., *A. blitodes* S. Watson, *A. deflexus* L., *A. retroflexus* L., *Erigeron bonariensis* L., *E. sumatrensis* Retz., *Euphorbia chamaesyce* L., *E. serpens* Kunth, *Nicotiana glauca* R.C. Graham, *Solanum elaeagnifolium* Cav., *Malephora purpureocrocea* (Haw.) Schwantes, *Carpobrotus edulis* (L.) N.E. Br. and *Opuntia ficus-indica* (L.) Mill. Among the alien taxa occurring on Sifnos, three taxa (*O. pes-caprae*, *N. glauca* and *Solanum nigrum* L.) were already present on Sifnos in the early 1900s as mentioned by Malakates. Malakates did not provide information regarding the spread of *N. glauca* and *E. chamaesyce* on the island, but he underlines the diffusion of *O. pes-caprae*, defining it as a weed in vineyards and cultivated fields that is dangerous for domestic animals. Currently this species has an invasive character especially in the central and southern part of the island. *Nicotiana glauca* is fairly common especially along the roadsides and *E. chamaesyce* has been observed by the authors only in Aghia Marina and Kamari.

The island flora is mostly constituted by therophytes (55.67%), followed by hemicryptophytes (19.07%) and geophytes (11.72%) (Table 1). The high proportion of therophytes highlights the strong Mediterranean character, which is further emphasized by the chorological spectrum of the island flora. The Mediterranean group predominates constituting 69.84% of Sifnos' flora. More specifically, species with a circum-Mediterranean distribution constitute about 38.55% of the flora (298 taxa), followed by species restricted to E Mediterranean with 11.46% (89 taxa) and by species confined to Mediterranean SW-Asian 9.57% (74 taxa) (Table 2). Among the widely distributed taxa, a good percentage is represented by species with a European SW-Asian distribution with 8.92% (69 taxa). The latter value is quite high, especially considering Sifnos' position, which is closer to the Greek mainland than to the southwestern Mediterranean area. From a phytogeographical point of view, Sifnos falls in the phytogeographic region of the Kiklades (Kik) sharing the highest number of taxa with the phytogeographic region of the East Aegean Islands (EAe) with 739 taxa, followed by the phytogeographic region of the Peloponnisos (Pe) with 737 taxa, and by the phytogeographic region of Kriti and Karpathos (KK) with 728 taxa (Table 3).

Table 1. Life-form spectrum of Sifnos' flora (life-forms are as defined by Dimopoulos & al. 2018).

Life-forms	**Number of taxa**	**%**
Therophytes	432	55.67
Phanerophytes	50	6.44
Hemicryptophytes	148	19.07
Geophytes	91	11.72
Chamaephytes	51	6.57
Aquatic (Hydrophyte)	4	0.51
Total	776	100.00

Table 2. Chorological spectrum of the native flora of Sifnos Island (chorological groups are as defined by Dimopoulos & al. 2018).

Chorological group	**Number of taxa**	**%**	**Total number of taxa**	**%**
Widely distributed taxa			163	21.00
European	4	0.51		
European-SW Asian	69	8.92		
Euro-Siberian	6	0.77		
South West European	1	0.12		
Paleotemperate	31	4.01		
Circumtemperate	4	0.51		
Subtropical	11	1.42		
Cosmopolitan	37	4.78		
Mediterranean Taxa			542	69.84
E Mediterranean	89	11.46		
Mediterranean	298	38.55		
Mediterranean-Atlantic	20	2.58		
Mediterranean-European	60	7.76		
Mediterranean-SW Asian	74	9.57		
W-Mediterranean	1	0.12		
Balkan Taxa			11	1.41
Balkan-Italian	3	0.38		
Balkan-Anatolian	8	1.03		
Endemic Taxa			40	5.15
Endemic	40	5.15		
Alien taxa			20	2.57
Am.	1	0.12		
N-Am.	5	0.64		
S-Am.	4	0.51		
S-Afr.	4	0.51		
Neotrop.	4	0.51		
SW-Asian	2	0.25		
Total	776	100.00	776	100.00

Endemism on Sifnos

Sifnos hosts 40 endemics (5.15%), 9 Kikladic endemics (including one single-island endemic), 10 Aegean endemics and 21 Greek endemics (Table 4). Sifnos endemics belong to 14 families and 24 genera. *Asteraceae* is the richest family (12 taxa) followed

Table. 3. Number of taxa belonging to the flora of Sifnos that also occur in each of the 13 floristic regions of Greece.

Ionian Islands	637
Northern Pindos	438
Southern Pindos	576
Peloponnisos	737
Sterea Ellas	709
East Central	583
North Central	520
North East	622
North Aegean Islands	645
West Aegean Islands	706
Kiklades	776
Kriti and Karpathos	728
East Aegean Islands	739

by *Plumbaginaceae*, *Amaryllidaceae* and *Campanulaceae*. The lifeform spectrum of Sifnos endemics shows a predominance of hemicryptophytes (30%), followed by therophytes (27.5%) and geophytes (25%). The high percentage of hemicryptophytes is linked to natural disturbances, such as the strong winds, which are typical of the island and to the phryganic nature of Sifnos characterized by poor soils that are affected by human impact. The high rate of therophytes is due to extended drought periods. The good rate of geophytes indicates rather dry, poor soil resulting in a decrease in grazing (Snogerup & Snogerup 1987; Bergmeier & Dimopoulos 2003; Panitsa & al. 2008).

Sifnos equally shares most endemic taxa with the phytogeographic region of Peloponnisos (Pe) (20 taxa) and with the phytogeographic region of Kriti and Karpathos (KK) (20 taxa), followed by the phytogeographic regions of the East Aegean Islands (EAe) and the West Aegean Islands (Wae) with 16 taxa. According to Georghiou & Delipetrou (2010), the phytogeographical area of Kiklades is chorologically closer to the Eastern Aegean Islands. However, the presence of six biregional endemics unique to Kik and KK - *Hymenonema graecum* (L.) DC., *Campanula laciniata* L., *Nepeta melissifolia* (Fig. 2a) Lam., *Ophrys sphegodes* subsp. *gortynia* H. Baumann & Künkele, *Limonium oligotrichum* Erben & Brullo and *Limonium sitiacum* Rech. f. - and only one taxon, *Erysimum hayekii* (Jáv. & Rech. f.) Polatschek exclusive to Kik and EAe, suggests that Sifnos is phytogeographically closer to KK, than to EAe. The close palaeogeographical distance between the Southern Kiklades and Kriti during the Messinian salinity crisis favoured the spread of many endemic taxa from south to north (Strid & Tan 1997; Kougioumoutzis & al. 2014). This aspect had already been highlighted by Kougioumoutzis & al. (2014) for some Cycladic islands such as Anafi, Kimolos and Folegandros which host several endemics that occur exclusively in Kik and KK, which constitute the “Cardaegean” (Greuter 1971, 1972; Kougioumoutzis & al. 2012, 2014, 2015).

However, evaluating the overall distribution of the endemics occurring on Sifnos, it seems phytogeographically closer to the Peloponnese and in a broader sense to central

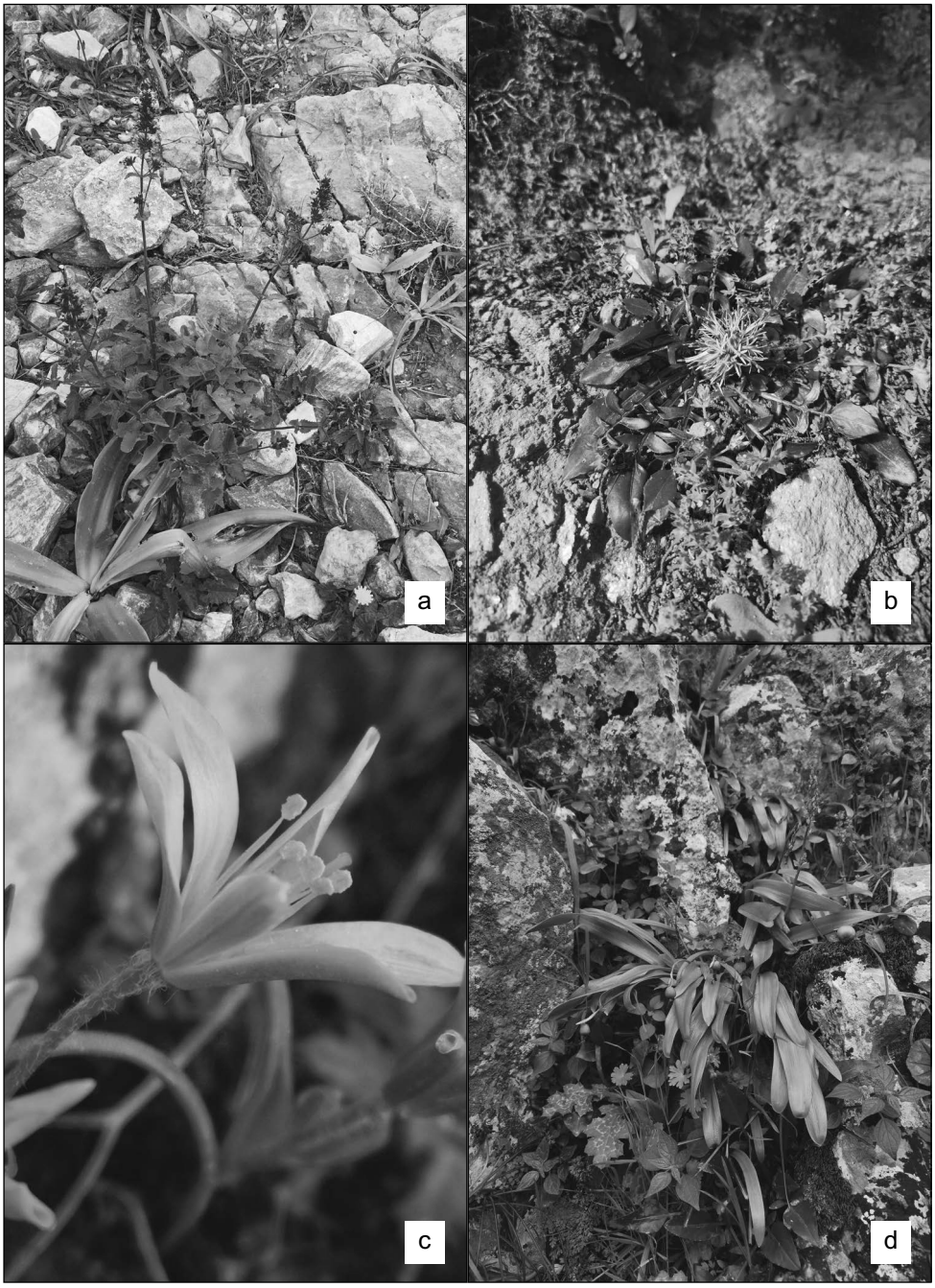


Fig. 2. a) *Nepeta melissifolia*, Herronisos (Sifnos); b) *Centaurea raphanina* subsp. *mixta*, Ilias Mt. (Sifnos); c) *Gagea pseudopeduncularis*, Xsero Ksylo (Sifnos); d) *Galanthus ikariae*, Xsero Ksylo (Sifnos).



Fig. 3. a) *Campanula heterophylla*, Xsero Ksylo (Sifnos); b) *Allium tzanoudakisianum*, Kapsalos (Sifnos); c) *Symphytum creticum*, Profitis Ilias Mt. (Sifnos); d) *Gagea rigida*, Kapsalos (Sifnos).

Table 4. Greek endemic taxa occurring on Sifnos Island (data extrapolated from Dimopoulos & al. 2018).

Family	Taxon	IoI	NPi	SPi	Pe	StE	EC	NC	NE	NAe	WAe	Kik	KK	EAe
Amaryllidaceae	*Allium apolloniensis* Biel & al.											*		
	Allium tzanoudakisianum Brullo, Pavone & Salmeri				*						*	*		*
	Galanthus ikariae Baker										*	*		*
Asteraceae	*Anthemis scopulorum* Rech. f.				*							*	*	*
	Anthemis werneri Stoj. & Acht.				*		*			*	*	*		
	Carthamus leucocaulos Sm.				*						*	*	*	*
	Centaurea laconica subsp. *linearriloba* (Halácsy & Dörfl.) E. Gamal-Eldin & Wagenitz											*		
	Centaurea raphanina subsp. *mixta* (DC.) Runemark				*	*					*	*		*
	Crepis neglecta subsp. *graeca* (Vierh.) Rech. f.			*	*	*	*	*		*	*	*		
	Echinops graecus Mill.				*	*	*				*	*		
	Filago cretensis Gand. subsp. *cretensis*				*					*	*	*	*	*
	Filago cretensis subsp. *cycladum* Wagenitz											*	*	*
	Hymenonema graecum (L.) DC.											*	*	
	Scorzonera araneosa Sm.											*		
	Scorzonera cretica Willd.				*							*	*	*
Boraginaceae	*Anchusella variegata* (L.) Bigazzi & al.	*			*	*	*				*	*	*	*
	Symphytum creticum (Willd.) Greuter & Rech. f.				*						*	*	*	
Brassicaceae	*Erysimum hayekii* (Jáv. & Rech. f.) Polatschek											*		*
	Erysimum senoneri (Reut.) Wettst. subsp. *senoneri*										*	*		
Campanulaceae	*Campanula celsii* A. DC.				*	*	*				*	*		
	Campanula heterophylla L.											*		
	Campanula laciniata L.											*	*	
Caryophyllaceae	*Dianthus fruticosus* L. subsp. *fruticosus*											*		
	Silene sartorii Boiss. & Heldr.				*	*						*	*	
Fabaceae	*Trigonella corniculata* subsp. *rechingeri* (Širj.) Lassen				*	*					*	*	*	*
Hyacinthaceae	*Muscari cycladicum* Guss.											*		
	Muscari pulchellum subsp. *clepsydroides* Karlén											*		
Iridaceae	*Crocus laevigatus* Bory & Chaub.				*	*				*	*	*	*	*
	Crocus tournefortii J. Gay				*							*	*	*
Lamiaceae	*Nepeta melissifolia* Lam.											*	*	
Liliaceae	*Gagea pseudopeduncularis* J.-M. Tison				*	*						*		
Orchidaceae	*Ophrys holoserica* subsp. *andria* (P. Delforge) Faurh.											*		
	Ophrys sphegodes subsp. *gortynia* H. Baumann & Künkele											*	*	
Plumbaginaceae	*Limonium aegaeum* Erben & Brullo				*	*					*	*	*	*
	Limonium ocymifolium (Poir.) Kuntze				*							*		*
	Limonium oligotrichum Erben & Brullo											*	*	
	Limonium proliferum (d'Urv.) Erben & Brullo					*					*	*	*	*
	Limonium sitiacum Rech. f.											*	*	
Ranunculaceae	*Nigella degenii* Vierh. subsp. *degenii*											*		
	Nigella doerfleri Vierh.				*					*		*	*	

Greece and the Western Aegean Islands. Indeed, most endemic taxa occurring on Sifnos, such as *Anthemis werneri* Stoj. & Acht., *Centaurea raphanina* subsp. *mixta* (DC.) Runemark (Fig. 2b), *Crepis neglecta* subsp. *graeca* (Vierh.) Rech. f., *Echinops graecus* Mill., *Erysimum senoneri* (Reut.) Wettst. subsp. *senoneri*, *Campanula celsii* A. DC., *Gagea pseudopeduncularis* J.-M. Tison, have a more western distribution, including the Peloponnese, Sterea Ellas and Western Aegean Islands. This may be due to the paleogeographic connection between the Cycladic unit and the Peloponnese which occurred during the Messinian salinity crisis, and the LGM when the distance between the Kiklades and the Peloponnese was shorter than today (ca. 85 km) (Kapsimalis & al. 2009). The presence of *Erysimum senoneri* subsp. *senoneri* on Sifnos underpins the paleogeographic connection between the Kiklades and the Western Aegean Islands that lasted until the Pliocene (Sfenthourakis & Triantis 2017). Interestingly, the discovery of *Gagea pseudopeduncularis* (Fig. 2c) on Sifnos widens its distribution area to the phytogeographical region of the Kiklades, whereas it had only been found previously in Sterea Ellas (Mt. Parnitha) (Tison & al. 2013) and the Peloponnese (Aegina Island) (Tan & Issigoni 2015). As for other endemics, it is worth mentioning: *Galanthus ikariae* Baker (Fig. 2d), whose range was previously restricted to Ikaria (Eastern Aegean Island), Skyros (Sporades), Andros and Naxos (Kiklades). Also, *Campanula heterophylla* L. (Fig. 3a), which belongs to a small group of late-flowering chasmophytes, a local endemic of Kriti and Kiklades, has a restricted range in the central Aegean islands, occurring on Keros, Donoussa, Amorgos, Sikinos, Folegandros and other small islands. *Allium apolloniensis* Biel & al., an autumn-flowering *Allium* species, is the only autumn-flowering member of *A*. sect. *Codonoprasum* discovered in the Kiklades and this supports the hypothesis that species with this life-cycle are Tertiary relicts of an old Mediterranean flora which were present before the fragmentation of the Aegean landmass (Biel & al. 2006). Autumn-flowering *Allium* species belonging to Sect. *Codonoprasum* as *A*. *archeotrichon* Brullo & al. (Brullo & al. 1999), *A*. *platakisii* Tzanoud. & Kypriot., *A*. *symiacum* Galanos & Tzanoud. and *A*. *tardans* Greuter & Zahar., are characterized by a very long vegetative phase and a very short dormancy phase. This vegetative feature could be an indication that these are relict species of the Tertiary period, since the relatively undifferentiated species life cycle could be indicative of more consistent climatological conditions that prevailed during the late tertiary (Messinian) period in the Mediterranean area (Greuter 1972, 1979; Tzanoudakis & Kypriotakis 1993).

Finally, also worth mentioning among the endemic species with a wider distribution that also includes the Eastern Aegean Islands are: *Allium tzanoudakisianum* Brullo, Pavone & Salmeri, *Anthemis scopulorum* Rech. f., *Filago cretensis* subsp. *cycladum* Wagenitz and *Erysimum hayekii* (Jáv. & Rech. f.) Polatschek.

Allium tzanoudakisianum (Fig. 3b), belongs to the *A*. *cupani* group, a species complex of the subgenus *Allium* which is quite critical taxonomically. *A*. *tzanoudakisianum* occurs in the Aegean area and more precisely on Naxos, Donoussa, Syros, Sifnos, Amorgos, Paros and Serifos (central Kiklades), Lesbo (Eastern Aegean Island) and in E Peloponnese (Brullo & al. 2015). It could be argued that the reduction of geographical distance during the Messinian salinity crisis and the eustatic sea-level changes during the Pleistocene enabled a linkage between the Cycladic Unit and the Eastern Aegean Islands.

Conclusions

In this work, 19 new taxa have been added to the flora of Sifnos: five endemic taxa (*Galanthus ikariae*, *Campanula heterophylla*, *Gagea pseudopeduncularis*, *Limonium oligotrichum* and *Limonium sitiacum*); four species with a mediterranean distribution (*Hellenocarum multiflorum* (Sm.) H. Wolff, *Diplotaxis viminea* (L.) DC., *Rhamnus alaternus* L. and *Kickxia elatine* subsp. *crinita* (Mabille) Greuter); one eastern mediterranean species (*Lamium moschatum* Mill.); and several alien taxa. Five of these new records, along with many other Sifnos endemics, have been found at a single site (Ksero Ksylo) characterized by north facing limestone inland cliffs at a fairly high altitude (648 m a.s.l.). Sifnos, with is predominately hilly terrain, lacks extensive limestone cliffs, but the presence of very localized, restricted and undisturbed areas characterized by cliffs and rocky slopes, has allowed many endemic plants to be preserved (Georghiou & Delipetrou 2010). Regarding the flora of Kitriani Islet, seven new records have been added following the collections by Runemark & Snogerup in 1958 and Runemark, Bentzer & Hansen in 1967: two endemic taxa (*Allium tzanoudakisianum* and *Limonium proliferum* (d'Urv.) Erben & Brullo); three taxa with a mediterranean distribution (*Erica manipuliflora* Salisb., *Teucrium capitatum* L. and *Rhamnus lycioides* subsp. *oleoides* (L.) Jahand. & Maire); two eastern mediterranean species (*Allium staticiforme* Sm. and *Paronychia macrosepala* Boiss.). All these species were already known on the main island with the exception of *A. staticiforme*, which was reported only for several central Cycladic islands.

The low number of taxa in Malakates' checklist is mirrored in the Serifos florula, also drawn up by Malakates (1928). For Serifos, the author listed only 286 taxa, a number which after in-depth research rose to 680 (Livaniou-Tiniakou 2003). According to Livaniou-Tiniakou (2003) the lower number of taxa included in Malakates' flora of Serifos is probably not due to observation gaps but to more intensive human activities during that period. Moreover, 26 of the 286 taxa recorded by Malakates on Serifos have no longer confirmed, perhaps overlooked due to their seasonality or their unsuccessful establishment on the island. It seems unlikely that islands of ca. 75 km^2, such as Serifos and Sifnos, would have such a low number of flora species at the beginning of the 1900s, even considering significant human impact during that time. The data may more accurately reflect a lack of research. The objective environmental and climatic changes that have occurred on the island over the years, have led to a loss of species linked to wetter environments while at the same time the reduction of agriculture due to water scarcity has led to the expansion of *Juniperus turbinata* maquis vegetation. Sifnos is rich in many elements with a Mediterranean-SW Asian and East Mediterranean distribution, likely introduced through colonization by long-distance dispersal and human translocation. However, thanks to the presence of undisturbed sites on the island, part of the native flora has been preserved.

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Chorispora tenella (*Brassicaceae*), alien naturalized in Morocco: comparison with similar-looking species

Abstract

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Chorispora tenella (*Brassicaceae*) is reported here as an alien species with an invasive potential in mountain pastoral habitats in Morocco. Illustrations of this and of similar species present in the country are provided, as well as its geographical distribution.

Key words: *Chorispora*, Identification, Chorology, Alien species, North Africa.

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Introduction

Botanical exploration of the Moroccan territory is in continuing development to enhance the knowledge of its flora. Thus, since the publication of the last volume of the "Flore Pratique du Maroc" (Fennane & al. 2014), these efforts resulted in the description of more than 30 new species (Homrani & Chatelain 2023).

Surveys undertaken by a group of botanists, from the National Institute of Agronomic Research – INRA Morocco, the Geneva Conservatory and Botanical Garden – CJBG and Reneco International Wildlife Consultants, led to the identification of an alien *Brassicaceae* species in High-Atlas and Anti-Atlas of Morocco (Oukaimeden, Khouzama). *Chorispora tenella* (Pall.) DC. (≡ *Raphanus tenellus* Pall.) that is reported by the red book of vascular flora of Morocco as a casual alien "Adventice" with 'Not Applicable' status, for this reason (Fennane 2021). This species has been sometimes confused with *Strigosella africana* (L.) Botsch. (≡ *Malcolmia africana* (L.) R. Br.) or *Hesperis laciniata* All., both native to Morocco (Dobignard & Chatelain 2010-2013; POWO, 2023). This last is characterized by purple, yellowish petals not maculated, 12–15 mm long, while the petals of *Chorispora tenella* are pale magenta to lavender (White 2013) maculated with purple at their base, 10-13 mm long (Fig.1). *Brassicaceae*, including 212 native species and about 280 taxa in Morocco, is among the top five families in terms of species richness and

endemism in this country (Fennane *& al.* 2023; Dobignard 2016). *Chorispora tenella* is incomprehensibly not included in the APD, POWO, and Med-Checklist databases until the writing of this paper despite it was cited before by Dobignard (2016:157) as a "new alien species" in Morocco. Given the high number of alien plants that have recently been discovered in Morocco, it appears that the alien flora is still not well known in the country (Homrani & Peltier 2020; Giardi & Homrani 2023; Sukhorukov & al. 2023; Tanji 2023). *Chorispora tenella* is one of these species that has become naturalized in Morocco.

This note is intended to discuss and illustrate the presence of *Chorispora tenella* in Morocco, as well as to provide criteria for distinguishing it from similar species present in the country.

Materials and methods

Floristic field investigations were carried out in the Anti-Atlas and High-Atlas of Morocco, from May 15 to 25, 2022, to collect plants for herbarium enrichment and study some problematic genera. The specimens collected were deposited in the herbaria of Scientific Institute of Rabat (RAB), ECWP and G (codes according to the Index Herbariorum, https://sweetgum.nybg.org/science/ih/). The revision of herbarium specimens and an in-depth webographic review revealed an alien plant, *Chorispora tenella,* that is more naturalized than what is supposed and sometimes confused with two other species. The list of examined specimens is presented below. Several sources and references were used to identify this taxon, including the "Flore Pratique du Maroc" (Fennane & al. 2007), "Flore de l'Afrique du Nord" (Maire 1977) "efloramaghreb" (www.efloramaghreb.org), discussion on https://www.inaturalist.org/ and "Flora Europaea" (Tutin & al. 1964). The comparison of *Chorispora tenella* with similar species provided here is based on our herbarium vouchers and bibliographic sources. An identification key including similar-looking species is presented and discussed. Numerous references and websites were consulted for the nomenclature, mainly the "African Plant Database" (http://africanplantdatabase.ch) and "Plants of the World Online" (https://powo.science.kew.org). The illustrations were either photographed or drawn from herbarium specimens. The distribution of the taxon in Morocco is given based on the available data.

Studied material

Morocco, Draâ-Tafilalet: Taznakht, Khouzama, 2000–2500 m, coord. WGS84 30.776240, -7.617648. 17 May 2022, Obs. C. Chatelain & F. Mombrial [herb. G, CM1724 G], A Homrani Bakali [herb. INRA-Errachidia, s.n.] and in the same municipality, 2350 m, coord. WGS84 30.75394, -7.67653. 19 May 2022, Obs J.-F. Léger [herb. ECWP, s.n.].

Morocco, Marrakesh-Safi, Oukaimeden, 2400-2700 m, 31.195767, -7.831288. 11 June 2021: Obs. A. Homrani Bakali [herb. G, RAB1145605].

Results and discussion

Distribution and habitat in Morocco

Chorispora tenella (Pall.) DC. has been observed for the first time in Morocco in the High Atlas, in Oukaimeden (or Oukaïmedene, in Marrakesh-Safi region), in the surroundings of the Barrage Oukaimeden and Azib Tiferguine (NB: Azib = sheep enclosure):

- Only one individual located in a small depression, on East side of Oukaimeden dam, on 5 May 2014, by J.C. Thiaudière sub "*Hesperis laciniata*" (com. pers. and Teline: https://www.teline.fr/fr/photos/brassicaceae/hesperis-laciniata; coordinates: 31.207742, -7.851092; elevation: 2590 m a.s.l.).
- Azib Tiferguine, 3 km ESE of Oukaimeden, on 9 June 2014, by Dobignard, who published it as a "new species for Morocco" (2016) and also on 11 June 2021, by one of us (AHB; coordinates: 31.19577, -7.83129; elevation: ±2680 m a.s.l.).
- In the manure around the azibs of Oukaimeden area, from May to June 2018, for example in the small valley behind the dam which joins the Assif (torrent) Tiferguine, by Marie Coste sub "*Hesperis laciniata*" (com. pers. and Atlasbota: https://www.atlasbota.com/wp-content/uploads/2018/06/hesperislaciniata.pdf − coordinates: 31.21027, -7.84301; elevation: ±2550 m a.s.l.).
- Downstream of the Oukaimeden dam, on 29 May 2022 by Aat Schaftenaar (Observation.org: https://observation.org/observation/259513528/; coordinates: 31.2102, -7.8511; elevation: ±2590 m a.s.l.).

We also found the plant on Siroua mountain range in two stations located in Khouzama municipality:

- Near the park Tadrart Amassine, SW of a village called Amassine (Draa-Tafilalet region), on 17 May 2022 (coordinates: 30.776240, -7.617648; elevation: 2500 m a.s.l.) in grazed meadows (Fig. 1 & 2).
- Near the Assif Tadmant, south of the place called Ikouchchal, on 19 May 2022 (coordinates: 30.75394, -7.67653; elevation 2350 m a.s.l.), in a livestock resting place under a small cliff.



Fig. 1. *Chorispora tenella:* A. plants, B. leaves, C. flowers, D. fruits, from Tadrart Amassine-Siroua (17.05.2022, A. Homrani Bakali and F. Mombrial).

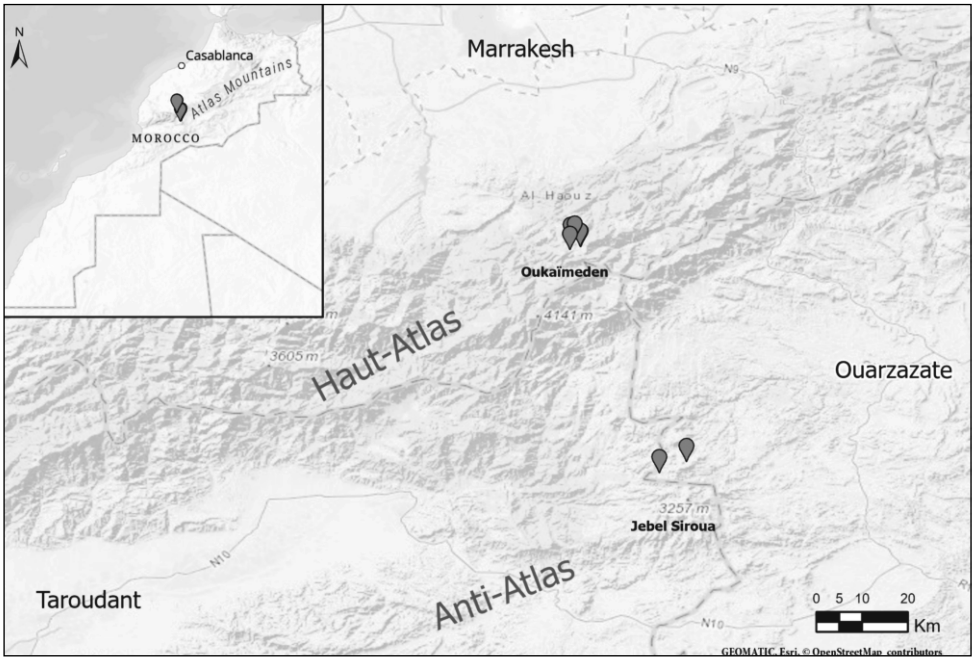


Fig. 2. Distribution map of *Chorispora tenella* in Morocco.

It is difficult to know how *Chorispora tenella* arrived in Morocco and at such high elevations. Dobignard (2016) assumes that this species, which have gone unnoticed until recently, is of "very old introduction", given the natural environments where it has been spotted. Nevertheless, it is astonishing that no botanist has observed this species until recently in the upper Oukaimeden valley, a site that has historically been extensively prospected. M. Coste (com. pers.) has been visiting the location for decades, but she has never observed this species before recent years, then it became increasingly abundant in the manure around the azibs.

We are therefore led to propose that *Chorispora tenella* was introduced in Morocco recently, either by tourists (both locations above are visited by many tourists) or, more probably from our standpoint, through the importation of cereals to feed livestock or to be sowed around azibs to produce forage. However, we do not know if the plant has been transported from one site to another (from High Atlas to Anti-Atlas), if that is the case.

In all its Moroccan sites, *C. tenella* behaves as a ruderal, nitrophilous species, which thrives in areas over-fertilized by livestock or near manure heaps, at high elevation. A ruderal and nitrophilous ecology is fairly common among alien plant species, which take advantage of habitats disturbed by man, but the high elevation of the locations *C. tenella* colonizes in Morocco is remarkable. According to the information gathered here, and in particular its Oukaimeden population, which has spread over an area around 3 km long in just around 10 years, this is definitely an invasive species in Morocco, according to Richardson & al. (2000).

General distribution

Chorispora tenella is a plant of temperate Asia including the Irano-Turanian region" and introduced in many countries including Morocco (cf. POWO 2023).

Similar-looking species

In Morocco, *Chorispora tenella* can be confused with *Hesperis laciniata* and *Strigosella africana*. The three species are phylogenetically related genera (Beilstein & al. 2006; Mandáková & al. 2017). Hereafter, a figure (Fig. 3) and a key to differentiate *Chorispora tenella* from *Hesperis laciniata* and *Strigosella africana*.

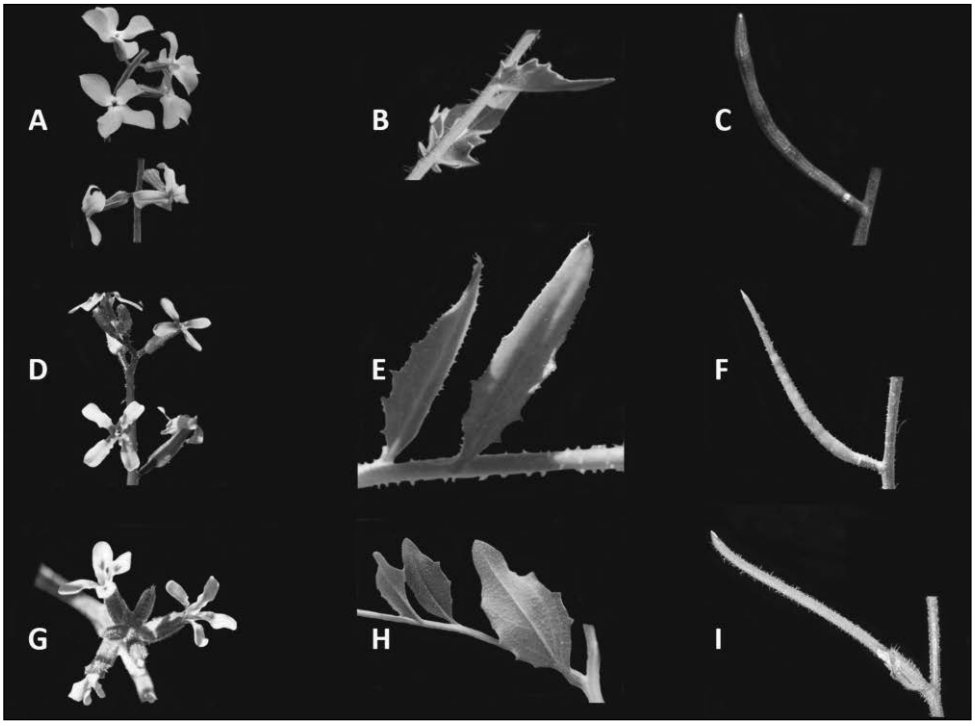


Fig. 3. Flower, cauline leaves and silique of *Hesperis laciniata* (A, B, C*), Chorispora tenella* (D, E, F) and *Strigosella africana* (H, I, J) (Photos of *Hesperis laciniata* are modified from pictures taken from flora-on.pt and atlasflore04.org).

1. Simple or stellate trichomes; Cauline leaves petiolate; Flowers lilac, violet, or pinkish, rarely whitish, maculated or not with purple, sepals <5 mm, the laterals ones not saccate; Silique, 4–7 cm long, quadrangular, not torulose, often straight, rarely curved ……
…….....……**1. *Strigosella africana***

2. Sparsely glandular sometimes with simple multiseriate trichomes; Leaves with decurrent limb, upper cauline leaves from short petiolate to sessile; Flowers pale magenta to lavender maculated with dark purple at their base, sepals 6–8 mm long, the inner ones saccate at base; Silique 2–4 cm long, often curved upwards, slightly torulose, long-beaked, breaking into corky units ……**2. *Chorispora tenella***

3. Simple or branched, uniseriate rough hairs; Cauline leaves sessile; Flowers yellowish or purple not maculated, sepals >8 mm, the laterals ones saccate at base; Silique 4–14 cm long, torulose, glandular, not breaking into corky units ……**3. *Hesperis laciniata***

Conclusion

Thanks to these records, *Chorispora tenella* can now be considered as naturalized in Morocco, after having been mentioned as an adventive by Fennane (2021). In Africa, this species was previously known only from Algeria, where it was mentioned probably for the first time by Ducellier & Maire (1923), at Oran, as a weed, but it did not persist there (Maire 1977). Then, it was identified in Oukaimeden in 2014 by Dobignard (2016) as new for Morocco. Further field investigations especially in the Moroccan mountains would be useful to gain a better understanding of its distribution and invasiveness.

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Article

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P. P. Ferrer-Gallego, R. Barrero-Sánchez, J. Crespo, I. Ferrando-Pardo & J. Fabado

Verbascum lydium (*Plantaginaceae*), a new alien species in Spain

Abstract

Ferrer-Gallego, P. P., Barrero-Sánchez, R., Crespo, J., Ferrando-Pardo, I. & Fabado, J.: *Verbascum lydium* (*Plantaginaceae*), a new alien species in Spain. — Fl. Medit. 34: 121-126. 2024. — ISSN: 1120-4052 printed, 2240-4538 online.

Verbascum lydium (*Plantaginaceae*) has recently been found in the Valencian Community, and this population represents a new exotic species for the Spanish flora. *Verbascum lydium* is native to Turkey and East Aegean Islands. In 2023 the species has been located in the port of Castellón, where has successfully reproduced and is forming a stable population in a new urban ecosystem, which opens the possibility to expand in the coming years as other exotic species with invasive potential.

Key words: alien flora, Castellón port, Valencian Community, xenophyte.

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Introduction

Verbascum L. (including *Celsia* L.) is a highly diverse genus of *Scrophulariaceae* (vel *Plantaginaceae* sensu APG 2016). According to Hasslle r (2022) and Khamar (2022) it is composed by 497 taxa (465 species and 32 subspecies) broadly distributed throughout the Old World, particularly in the temperate northern hemisphere (Murbeck 1925, 1933; Huber-Morath 1978a, 1978b).

Verbascum (excluding *Celsia* L.) includes approximately 360 species (Khamar 2022) and its greatest diversity is located in the Mediterranean region (Murbeck 1939; Heywood 1993; Mabberley 2008; Yılmaz & Dane 2012; Remal 2014; Sotoodeh 2015; Khamar 2022). Further progress on the taxonomy of *Verbascum* has recently been made thanks to molecular studies in the north of the Mediterranean basin and in the Irano-Turanian biogeographic region (Al-Hadeethy & al. 2014; Ghahremaninejad & al. 2014; Remal 2014; Sotoodeh 2015).

In Turkey, 256 *Verbascum* species and 131 additional hybrids occur (Duman 2021). Among them, 201 are Turkish endemic and the endemism ratio is about 80% (Huber-Morath 1978a, 1978b; Özhatay 2006; Karavelioğulları 2012; Yılmaz & Dane 2012; Duman 2021). In 2023 a

population of the Eastern Mediterranean species *V. lydium* Boiss. has been located in the Port of Castellón (Valencian Community, Spain). The native range of this species is East Aegean Islands and West Turkey (Huber-Morath1978b; Dimopoulos & al. 2013; POWO 2024).

Verbascum lydium was unknown until now in the Valencian and Spanish flora. Its presence is due to the activity of transporting materials (feldspar mineral) from Turkey (via port of Güllük) to Spain for the ceramics industry in the province of Castellón (Port Authority of Castellón, pers. comm.). This communication reports for the first time of the presence of this plant species in Spain.

Materials and methods

The area where the *Verbascum lydium* was found was visited repeatedly during 2023. Herbarium vouchers were collected in May 2023 and deposited in the herbarium of the Jardí Botànic de la Universitat de València (VAL). Plant nomenclature follows Euro+Med PlantBase (Euro+Med 2006).

Results and discussion

Verbascum lydium Boiss., Diagn. Pl. Orient. 1(4): 62. 1844.

Spain: Valencian Community, Castellón Province, Castellón de la Plana, port of Castellón, 39°58'24''N, 0°01'20''E, 4 m, 25 May 2023, *P. Pablo Ferrer-Gallego, Rafael Barrero & Jorge Crespo s.n.* (VAL 253503). – New to Spain.

In May 2023 we found a population of several plants in the port of Castellón, in flower and seeded fruit (Fig. 1). The population grows on the feldspar mineral transported from southwestern Turkey (via port of Güllük) for the manufacture of ceramics in Castellón (Port Authority of Castellón, pers. comm.). The species is accompanied by others such as *Erigeron bonariensis* L., *E. sumatrensis* Retz., *Dysphania botrys* (L.) Mosyakin & Clemants, *Polypogon monspeliensis* (L.) Desf., *Sinapis arvensis* L., *Sonchus tenerrimus* L., *Stellaria media* (L.) Vill., etc.

The plants found in Castellón are biennial, up to 150 cm, densely covered with long branched floccose hairs and shorter persistent glandular hairs; with a robust stem, terete and branched. Basal leaves oblong to obovate-oblong and lanceolate, 10–45 × 4–16 cm, coarsely crenate, sessile or with winged petiole to 5 cm; upper cauline leaves rounded or auriculate at base, crenate-dentate, acute or acuminate. Inflorescence lax, branched, floccose, with cluster of 2(–7) flowers. Lower bracts lanceolate, acuminate, denticulate, upper linear-setaceous. Pedicels 2–7 mm; bracteoles lanceolate. Calyx 5–8 mm, lobes lanceolate, acute. Corolla yellow, 25–40 mm diameter, sparsely tomentose outside. Stamens 5, anthers reniform with 2 anterior decurrent, filaments with purple-violet wool, 2 anterior glabrous near apex. Capsule broadly elliptic to subglobose, 5–6 × 4–5 mm, glabrescent.

Specifically, and according to the intraspecific treatment adopted by Huber-Morath (1978b) we believe that the plants found in Castellón can be identified as belonging to *V. lydium* var. *heterandrum* Murb., showing anthers of 2 lower stamens decurrent and cauline



Fig 1. *Verbascum lydium* in the Port of Castellón (Valencian Community, Spain), May 2023.

leaves shortly decurrent. However, this name is treated as a heterotypic synonym according to POWO (2024).

The port of Castellón has a typical Mediterranean climate. The average temperature is 18°C. The absolute maximum temperatures have reached 30.7°C, while the absolute minimum temperatures have reached 6.4°C. In Castellón, an average of 470 mm of rain falls per year (see https://www.aemet.es/es/portada).

The flowering period of this population in the port of Castellón is from the end of March to the beginning of July. In May 2023 the population of Castellón included c. 25 flowering individuals and c. 10 vegetative plants.

Our results confirm that this species reproduces successfully in Castellón and could be a potentially invasive species in this area. In the coming years we will continue to monitor this population and nearby areas to check its possible expansion in the territory. In this sense, outside its native distribution area, several species of the genus *Verbascum* are naturalized in other regions around the world, i.e. the United States of America, Canada, South Africa, Hawaii, Mexico, Chile, Hispaniola, Argentina, Australia, New Zealand, the Indian Ocean island of La Reunion, and Japan (Gross & Werner 1978; Gross 1980; Mito & Uesugi 2004; Baret & al. 2006; Williams 2010; Alba 2011; Jaca 2017; Scaramuzzino & al. 2018; Nesom 2019). These biological invasions constitute a risk not only to ecosystems but also to the genetic integrity of some local species due to hybridization between species of this genus, a frequent and well-studied biological process in *Verbascum* (see Kölreuter 1784; Franchet 1868; Halácsy 1898; Kotov 1960; Alba 2011; Stace & Easy 2015). There are many cases in which hybridization between native and alien species has led to the creation of new taxa with colonization and dispersal capacities much greater than those of the parental species, and can therefore cause a serious risk to ecosystems (Ellstrand & Schierenbeck 2006; Blair & Hufbauer 2010; Staude & Ebersbach 2023).

In addition to the transport of feldspars from Turkey, the presence and *in situ* germination of *V. lydium* in Castellón can be explained by the presence of a threatened bird, the Audouin's gull (*Ichthyaetus audouinii* (Payraudeau, 1826)), in the same area. In this sense, this species began nesting in the port of Castellón in 2011, although it was in 2020 when the first nests -around 250- were detected for the first time in the accumulated feldspar deposits. In 2023, the total number of Audouin's gull breeding pairs in the port was 2.661, of which 126 were located in the stockpiles area. This seabird is listed as 'Vulnerable' in the Spanish Catalogue of Endangered Species (Real Decreto 139/2011, BOE-A-2011-3582) and the Valencian Catalogue of Endangered Fauna Species (Decreto 32/2004, DOGV 4705; Orden 2/2022, de la Conselleria de Agricultura, Desarrollo Rural, Emergencia Climática y Transición Ecológica), so during the breeding season (from early April to mid-July), industrial activity and movement of people in the nesting areas are restricted. The non-use of these deposits for a certain period of time favors the germination of the seeds that carry as stowaways the feldspars coming from Turkey. Without the presence of this bird, the feldspars are usually used almost immediately without being detained for long periods of time, which does not allow time for the seeds to germinate or, at least, for the plants to complete their biological cycle.

Another question that remains to be resolved is, if wherever the migratory birds that pass through Castellón go, they carry with them seeds of this species that come from Turkey, that is, is the port of Castellón a springboard (or stepping stone) for the alien species such as *V. lydium* to reach Africa through the Audouin's gull?

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Article

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Epipactis palustris in the Eastern Mediterranean (Lebanon), a surprising peripheral micropopulation challenges us with its conservation

Abstract

Maalouf, R., Maalouf, M. & Véla, E.: *Epipactis palustris* in the Eastern Mediterranean (Lebanon), a surprising peripheral micropopulation challenges us with its conservation. — Fl. Medit. 34: 127-136. 2024. — ISSN: 1120-4052 printed, 2240-4538 online.

While *Epipactis palustris* has been documented for the first time in Lebanon (at Mount Lebanon Governorate), this presence in the Middle East outside its classical range questions us. The species is widely distributed through Europe until Central Asia, but this southernmost location is isolated from the Turkish nearest ones from at least 500 km. Its ecology is classical but very restricted to a punctiform habitat hosting other regional rarities. The orchids family is known to be the best wind dispersed of the vascular plants because of its vestigial seeds kept to a minimum. The sink-source metapopulation characteristic model of this species is debated and the issue for its regional conservation evocated.

Key words: distribution range limit, Marsh Helleborine, Plant Micro-Reserve, sink-source metapopulation, threatened species.

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Introduction

Epipactis palustris (L.) Crantz, commonly known as the marsh helleborine or swamp helleborine, is an orchid species belonging to the subfamily *Epidendroideae*. It is widespread across northern and central Europe, the Middle East, and Central Asia (Delforge 2006; POWO 2023). This species occurs in a variety of habitats including fens, damp meadows, swamp and stream margins, wet woodlands, and ditches (Summerhayes 1951).

E. palustris is characterized by robust stems reaching 30–80 cm tall, spirally arranged pleated leaves, and a one-sided inflorescence bearing several flowers with greenish-white tepals marked with purple veins (Delforge 2006). The flowers rely on insect pollinators, with wasps and bees being the primary visitors (Claessens & Kleynen 2011). After successful pollination, egg-shaped seed capsules are formed. The small, dust-like seeds lack endosperm and rely on fungal symbionts to germinate and develop (Rasmussen 1995).

Across its distribution, *E. palustris* has experienced declining populations primarily due to habitat loss from drainage of wetlands for agriculture, peat extraction, eutrophication, and groundwater depletion (Kull & Hutchings 2006). It is considered as "least concern" at European (Rankou 2011) and at global level (Matchutadze 2014) but near threatened or extinct in several parts of its range (Cheffings & Farrell 2005; Kull & Hutchings 2006). Conservation of existing populations and their sensitive wetland habitats is a high priority.

In Lebanon, 46 native orchid species have been recorded so far (Vela & Viglione 2015), but *E. palustris* had never been documented in the country before this report. The closest known populations are found in Turkey (Kreutz 2009). This substantial geographic separation makes this new record in Lebanon particularly noteworthy. The discovery contributes valuable data to the ongoing exploration of Lebanon's native orchid flora.

Materials and Methods

Floral surveys were conducted from July 25th to August 5th 2023, evolving the collection of both photos and samples of *Epipactis palustris*, along with a comprehensive survey of the associated vegetation. The photography of plant specimens was done using a Sony SLT-A55V camera with a Sony 50mm f/2.8 MACRO lens. The geographic coordinates of the specimens were acquired from the inbuilt GPS in the camera itself. Identification of the plants was achieved using relevant identification keys from applicable floras (Delforge 2006). Although floristic surveys extended to neighbouring areas, no other specimens of this orchid species were found. The vegetation survey has been done identifying the flora with "Nouvelle flore du Liban et de la Syrie" (Mouterde 1966-1984) and nomenctalure updated according to Plants of the World Online (POWO 2023).

Results

Epipactis palustris (L.) Crantz

Specimen examined

Baskinta, Mount Lebanon, from a moist area around a stream in a woodland, 1,210 m elevation; location coordinates: 33° 57' 4.03" N, 35° 46' 7.19" E on the 25th July 2023 by one of us MM. The specimens were found thriving in a shaded environment with moist substrates, situated within a *Pinus* and *Quercus* woodland area characterized by sandstone terrain (Table 1). While a total of five plants were located at the same location, only three were in a blooming state. It is noteworthy that no pollinators were observed during this observation. Nevertheless, during the last visit on August 18, 2023, it was observed that the three flowering plants had also produced fruit.

Description

The present study reveals the discovery of plant specimens characterized by a robust stem, attaining a height of around 46 cm. The leaves, arranged in a spiral phyllotaxy, exhibit dimensions ranging from 5 to 15 cm in length and 2 to 4 cm in width, presenting an oblong-ovate to oblong-lanceolate morphology with an acute apex and a concave adaxial surface (Fig. 1).

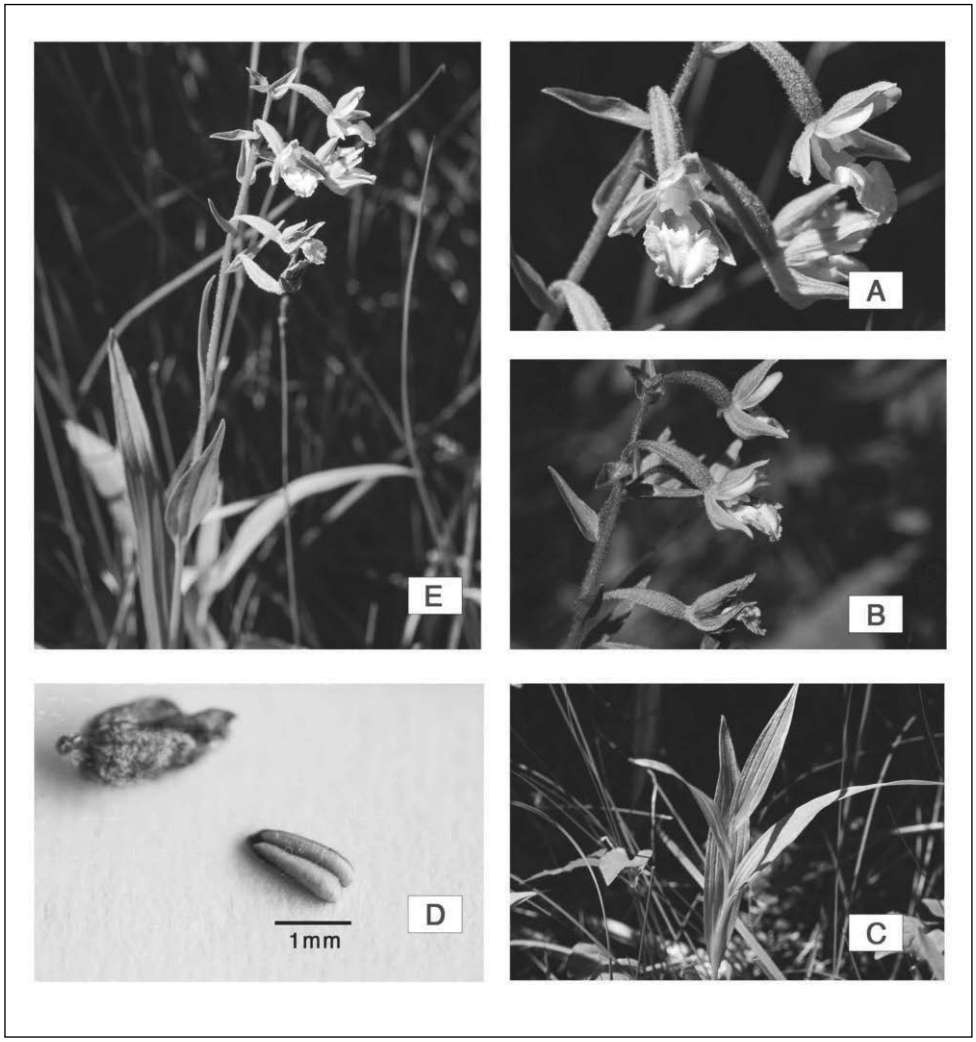


Fig. 1. *Epipactis palustris*, Baskinta, Lebanon 26th of July 2023 (photos by Mounir Maalouf). A. Close-up of the flower; B. Inflorescence; C. Distribution of the leaves on the stem; D. Pollinia; E. Habit.

The inflorescence of the specimens is a one-sided raceme, with 3 to 5 flowers gracefully oriented in one direction. The flowers measuring 2–2.5 cm in diameter, initially campanulate but gradually expanding. Coloration varies from creamy white to pure white, frequently adorned with violet-red or brown streaks.

The flowers are devoid of scent. The labellum, akin in size to the outer perianth segments, showcases a cup-shaped basal half with two erect triangular lobes on each side. The distal half is broadly elliptical, rounded, or truncate at the apex.

Table 1. List of plants and trees inventoried in the station of *Epipactis palustris*.

In the stream near the *E. palustris*	**In the surrounding woody area**
Dactylorhiza phoenissa (B.Baumann & H.Baumann) P.Delforge	*Achnatherum bromoides* (L.) P.Beauv.
Drosera rotundifolia L.	*Anacamptis morio* subsp. *syriaca* (E.G.Camus) H.Kretzschmar, Eccarius & H.Dietr.
Campanula peregrina L.	*Atocion reuterianum* (Boiss. & C.I.Blanche) Frajman
Osmunda regalis L.	*Cistus salviifolius* L.
Rhododendron ponticum var. *brachycarpum* Boiss.	*Cistus umbellatus* subsp. *libani* Demoly
Asplenium onopteris L.	*Dactylorhiza romana* subsp. *romana* (Sebast.) Soó
Juncus effusus L.	*Dianthus strictus* subsp. *multipunctatus* (Ser.) Mouterde ex Greuter & Burdet
Blechnum spicant (L.) Roth	*Epipactis helleborine* (L.) Crantz, sensu lato
Clinopodium vulgare subsp. *orientale* Bothmer	*Juniperus deltoides* R.P.Adams
Teucrium scordium subsp. *scordioides* (Schreb.) Arcang.	*Laurus nobilis* L.
	Linum trigynum L.
	Neotinea maculata (Desf.) Stearn
	Origanum ehrenbergii Boiss.
	Pilosella bauhini (Schult.) Arv.-Touv.
	Pinus halepensis Mill.
	Quercus cerris L.
	Romulea phoenicia Mouterde
	Romulea ramiflora Ten.
	Rubia tenuifolia var. *elliptica* (Boiss.) Ehrend.
	Rubus creticus Tourn. ex L.
	Styrax officinalis L.
	Teucrium divaricatum subsp. *divaricatum* Sieber ex Heldr.

Discussion

Distribution and dispersion

The recent discovery of *Epipactis palustris* in Lebanon is puzzling given the species' rarity in the southern Mediterranean region (Jacquemyn & al. 2014) the nearest known populations being over approximately 500 km away in the Malatya and Konya provinces, Turkey (Kreutz 2009; Bozkurt 2018).

- B6 / Malatya: Sürgü, W. Lüders, 5.6.1989 [≈500 km]
- B4 / Konya: Sultanhanı-Eşmekaya, 25 vi 1998, M. Vural 7840 (GAZI 32569!) [≈510 km]

Other meridional locations from southern Turkey and their areal distance from Baskinta (Fig. 2) (Davis, P. H. 1984).

- B7 / Tunceli: above Pülümür, 1900 m, D. 31595! [≈710 km]
- B9 / Bitlis: S. shore of Van G. nr Garzit, 1650 m, Renz 64591 [≈810 km]
- C9 / Hakkari: 2 km N.W. of Hakkari, 2000 m, Sorger 81-27-26! [≈820 km]

While *E. palustris*, like all orchids, is known to produce wind-dispersed seeds capable of covering long distances (Tackenberg & al. 2003; Vanden Broeck & al. 2014), this range falls toward the far end of documented dispersal distances for such a species (Cozzolino & al. 2003). Establishment of a population depends on finding scarce suitable habitat and mycorrhizal fungi that *E. palustris* relies on for germination (Rasmussen 1992). In lab experiments, only 30-89% of *E. palustris* seeds germinated even in suitable conditions (McKendrick & al. 2000). This suggests the probability of a seed dispersing from Turkey

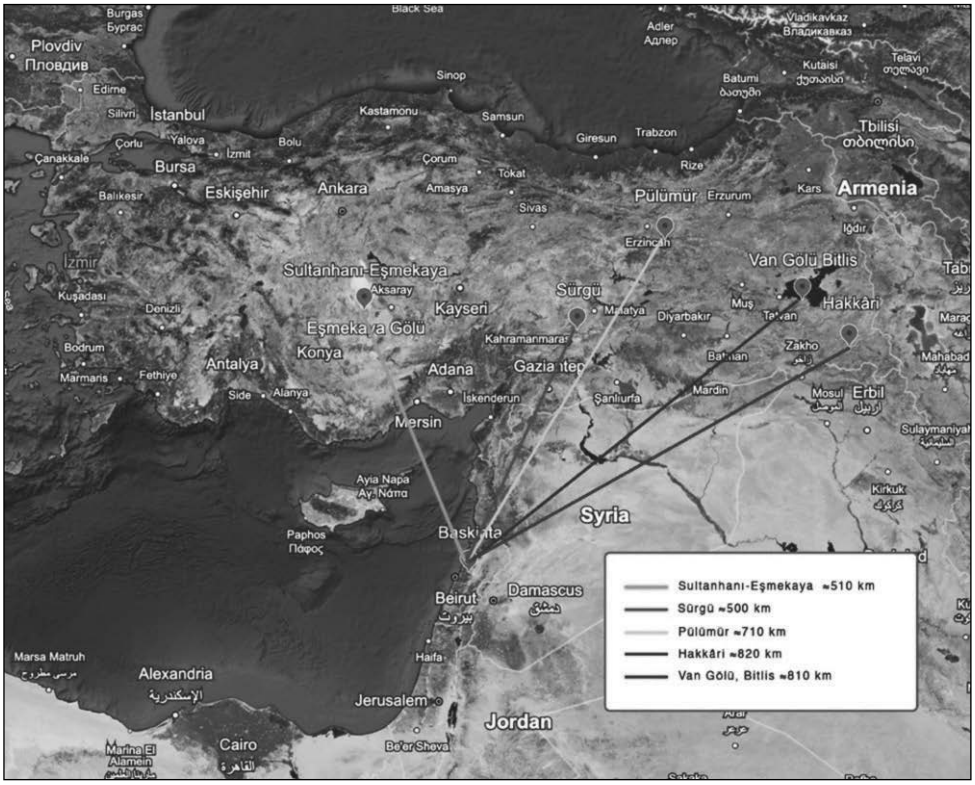


Fig. 2. The spatial separation between the nearest records in Turkey (Sürgü, Sultanhanı-Eşmekaya, Pülümür, Bitlis, Hakkâri), and Baskinta, Lebanon.

and producing a mature plant in Lebanon is extremely slim even if not impossible. Akin to *Liparis loeselii* (L.) Rich., which Waud & al. (2017) found to be a mycorrhizal generalist capable of opportunistically associating with various fungal partners to induce seed germination, if *E. palustris* exhibits similar flexibility in its mycorrhizal associations, the availability of compatible mycorrhizal fungi may not necessarily be a limiting factor for its establishment and persistence in Lebanon.

Nevertheless, the small population size of just 5 individuals observed for *E. palustris* in Lebanon is concerning. Oostermeijer & Hartman (2014) found that populations of *L. loeselii* frequently went locally extinct after just 1-5 years, suggesting high turnover rates driven by environmental stochasticity. This finding highlights the potential vulnerability of small orchid populations like *E. palustris* to environmental changes and stochastic events, underscoring the implications for the population's long-term viability and the need for concerted conservation efforts.

Under natural conditions, *E. palustris* likely requires winter chilling for dormancy break and spring germination (Rasmussen 1992), with seedlings needing 3–6 undisturbed years before flowering (Summerhayes 1951). The suitable nutrient-poor, moist to wet substrates

(Jacquemyn & al. 2014) indicate this Lebanese population could be relictual and not necessarily recently colonized. Nevertheless, the small population size of just 5 individuals, in stark contrast to the thousands found in established populations (Esfeld & al. 2008; Vanden Broeck & al. 2014), points toward a recent founding event. Additionally, *E. palustris* lacks dormancy mechanisms and cannot persist solely as a soil seed bank for extended periods (Rasmussen & al. 2015), making long-term persistence without above-ground individuals less likely. However, habitat loss and degradation over time may have caused a previously established population to dwindle to such a small size (Lienert & al. 2002). Additionally, if this area has not been thoroughly surveyed in the past, a relictual population may have been present but overlooked until now (Fischer & Stöcklin 1997). Relictual populations often exhibit genetic divergence from other populations (Hollingsworth & Dickson 1997), thus genetic analysis comparing this population to others could yield evidence about its origin.

Several remarkably similar discoveries have been recently reported in Northwestern Africa, marking another southern limit for Eurasian forest orchids: *Neottia nidus-avis* (L.) Rich. in Tunisia (El Mokni & al. 2010), *Cypripedium calceolus* L. and *Epipactis microphylla* (Ehrh.) Sw. in Algeria (Nemer & al. 2019; Bougaham & al. 2020). Unfortunately, at this time, no field survey has been conducted to argue in favor of either the relictual population or the recent founding event. On the contrary, the long-term persistences of the very reduced and/or unique subpopulation of *Neottia nidus-avis* (Madoui 2019) and of *Cephalanthera rubra* (L.) Rich. (Rebbas & al. 2023) in Algeria have been documented. Finally, a third kind of contrasted situation can be reported for the forest orchid *C. damasonium* (Mill.) Druce and the wetland orchid Spiranthes aestivalis (Poir.) Rich. in Algeria. Both have not been seen again from their unique historical locality (Quézel & Santa 1962) despite extensive research in their respective localities (De Bélair & al. 2005; Hamel & Meddad-Hamza 2016; Beghami & al. 2015; Ait Medjber & al. 2023).

Pollination ecology

We still know very little about the pollination ecology in Lebanon, except that flowers were pollinated during summer in 2023. In Sweden "Ants, bumble bees and hover flies were the most frequent visitors, but they generally played a minor role as pollinators. Solitary wasps (*Eumenidae*) were the most important pollen vectors although only present at low frequencies." (Nillsson 1978). In the Netherlands, "*Epipactis palustris* (L.) Crantz was visited by honeybees, sawflies, parasitic hymenopterans, ants, hoverflies and other flies" (Brantjes 1981), the most of them being pollinators as well. In Poland, Jakubska-Busse & Kadej (2008) observed "the behaviour of visiting and pollinating insects (mainly *Apidae* and *Syrphidae*) consisting of moving mostly within one inflorescence (or neighbouring inflorescences)". They also reminded that the construction of the flower of *E. palustris* fosters self-pollination and that in the population they examined vegetative reproduction dominates.

Threats and conservation

In sum, while long-distance dispersal cannot be ruled out, the specific habitat requirements suggest this Lebanese population could be relictual. Further demographic and genetic analysis to compare it to Turkish populations are needed to determine its origins and viability. Regardless, this population of *Epipactis palustris* in Lebanon is threatened by urbanistic

spread. In the *Guiding design and general detailed System for the area of Baskinta* (2002) the area where *E. palustris* population was found is classified as D1 (mixed-used development that includes residential and commercial uses). At around 175 m to the west and of the site there are some human constructions. Another construction is situated 200 m above the site, adjacent to the stream leading to *E. palustris*. Protecting *E. palustris*'s habitat and searching for other occurrences in Lebanon should be a priority for the preservation of this orchid.

Eriksson (1996) was the first one to claim "Short-lived or highly habitat specialized plants with good dispersal tend to build up metapopulations, i.e. systems of local populations and non-occupied but potentially suitable sites, interconnected with dispersal, and in a continuous flux of local colonization and extinction.". At this stage of our knowledge, the species is not globally threatened and was assessed as LC / Least Concern (Matchutadze 2014) but a regional assessment for Lebanon should obviously result to an opposite category like, probably, CR / Critically Endangered. But regional assessments have to consider, at a second step, the existence of conspecific populations outside the region that may affect the risk of extinction within the region should be investigated : "In most cases, this will mean downgrading the category met by the global criteria, because populations within the region may experience a rescue effect from populations outside the region". Actually, it clearly depends on the following factors: 1) Whether the regional population is the target of significant immigration of propagules capable of surviving in the region; 2) Whether the immigration is expected to decrease; and 3) Whether the regional population is a sink (Gärdenfors & al. 2001). This is particularly true for plant species like orchids that share very abundant and very flying propagules (here seeds) comparably with the bryophytes spores: "In bryophytes, information on the effects of isolation of subpopulations is lacking. However, in general, those taxa with a large production of small diaspores are considered probably more easily spread […] and hence not so vulnerable to isolation through fragmentation of their habitats" (Hallingbäck & al. 2000). Additionally, for practical reasons, they recommend that, in most circumstances, a minimum distance between 100km and 1,000km for species with spores can indicate severe fragmentation. We believe that Eurasiatic terrestrial orchids with high production of wind dispersed small seeds share this problematics. In Lebanon, where western winds are dominant (cf. https://world-weather.info/archive/lebanon/beyrouth/#t0 consulted at 19/3/2024), it concerns preferably the South-Eastern European or Southern Anatolian sources of propagules. The minimum we can say is that both in Greece and Turkey (Kreutz 2009; Tsiftsis & Antonopoulos 2017) *Epipactis palustris* is mainly limited in the norther mountains because already at their southern limit of distribution. Thus, most probably, the immigration of propagules is naturally extremely low., even if not impossible as already concluded before.

Next challenges

In any case, in such a peculiar sink-source metapopulation context, a pluriannual monitoring from the field is needed for knowing the population trend and for understanding the medium-term dynamics of the *E. palustris* population and even of its habitat.

As already argued by Tremblay & al. (2006): "A major difficulty applying the metapopulation approach to orchid conservation is identifying empty sites suitable for colonization". In this context, we would need to know at least a bit more about the local guild of potential pollinator insects.

In conclusion, contacting the owner of the concerned field and its upstream basin could help to better anticipate the species conservation against the urbanistic problematics. A classification as a "plant micro-reserve" (Lumbreras 2001) already tested at Lebanese level in the same area near Baskinta (cf. https://www.cepf.net/resources/documents/involuntary-resettlement-safeguard-baskinta, consulted at 19/3/2024) would be a very optimistic outcome.

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A. Hirche, R. Ait Ikhlef, A. Drissi, S. Lochon-Menseau, L. Dixon & H. Michaud

Eclipta prostrata (*Asteraceae*), a new alien species in the Algerian flora

Abstract

Hirche, A., Ait Ikhlef, R., Drissi, A., Lochon-Menseau, S., Laura. Dixon, L. & Michaud, H.: *Eclipta prostrata* (*Asteraceae*), a new alien species in the Algerian flora. — Fl. Medit. 34: 137-142. 2024. — ISSN: 1120-4052 printed, 2240-4538 online.

Different floristic surveys in Algeria led to the discovery of xenophytes. *Eclipta prostrata* (*Asteraceae*) is a new one and was recently discovered in Algiers beach, Zemmouri El Bahri. A brief description of its location and ecology are provided. This information completes the recent records in Tunisia and Morocco and confirms that E. prostrata is widespread throughout most of North Africa.

Key words: xenophytes, alien flora, floristic survey, North Africa.

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Introduction

Human impact on biodiversity, direct or indirect, involves four basic factors: 1) overexploitation of natural resources; 2) habitat modification, conversion, and fragmentation; 3) the introduction of exotic (Non-native) species; and (4) pollution. Among these threats, the exotic species are considered here. Non-native species were formerly defined as species outside of their bioregion which can possibly threaten native ones (De Candolle 1855). In the 1950s, scientists considered that biological invasions can have a deleterious effect on habitats and ecosystems (Macdonald & Jarman 1984; Davis 2009; Gentili & al. 2021). The increasing world trade led to increasing various transport ways and organism disseminations, especially propagules and plant seeds. Alien invasive species cause changes in the ecosystems to which they are introduced, but their impacts on ecosystems and biodiversity are not clearly understood (Larson & al. 2013; Simberloff & al. 2013). Alien species are not always invasives, but they could anyway threaten ecosystems (Ricciardi & al. 2007; Jeschke & al. 2013). In the Mediterranean countries, several records of naturalization and introduced species were observed, favored by intense maritime activity in the Mediterranean Sea (Campos & al. 2004; Bresch & al. 2013; El Mokni & Iamonico 2018;

Fortic & al. 2023; Galasso & al. 2024). The same applies to Algeria where several exotic plants have been reported in the last decade along the coasts (Meddour & El Mokni 2016; Sakhraoui & al. 2019). A new alien species, *Eclipta prostrata* (L.) L., was recently discovered in the North coast of Algeria (Zemmouri Beach). It has been recently observed by El Mokni and Iamonico in Tunisia (2018) as part of ongoing research on invasive plants in the region (El Mokni & al. 2013, 2018).

Eclipta L. is a small genus of 11 species native to Asia and North America (WFO 2022).

Materials and methods

Eclipta prostrata (Fig. 1) was discovered during a botanical field trip organized on September 13, 2023 by the "Jardin d'essai" most important botanical garden in Algeria with its own researchers and those from the National Mediterranean Botanical Conservatory of Porquerolles and from the University of Sciences and Technology Houari



Fig. 1. *Eclipta prostrata*. 1) habitus, 2) peduncles hairiness 3) Leaves 4) different stages of flowers with black and glabrous mature achenes in the older flower 5) peduncles (photos by A. Hirche, Driss A, Ait Ikhlef R). Zemmouri Beach, Algiers, 17 September 2023.

Boumediene (USTHB) about harvesting the seeds of littoral plants. The plant was found in a partially stagnant water. Consultations were conducted on the main flora of Algeria (Maire 1958; Quézel & Santa 1962; Dobignard & Chatelain 2011) and the key Algerian herbaria (Herbarium of INA, URZA) and LEVE, and by remote examination of Herbarium specimens of the Royal Botanic Gardens, Kew (K), (K000895510), the Open Herbarium (Open Vascular Plant Herbarium Network), and of the Muséum National d'Histoire Naturelle – MNHN (P). Herbaria acronyms are according to Thiers (2018). The species is not still reported for the Algerian flora. Recent discovery introductions in neighboring countries (El Mokni & Iamonico, 2018) confirmed and facilitated its identification.

Results and discussion

Habitat and ecological notes

Eclipta prostrata was found in a pond inside a branch of the Zemmouri wadi, a few hundred meters away from the beach of Zemmouri El Bahri located at the east of Algiers. The location is at 36.810408° Northern Latitude, 3.5981733 East Longitude. The elevation is about 5 m above sea level. Zemmouri wadi is one of the rare unpolluted wadis in the Algiers region. The population of *E. prostrata* found below a raised dune, along the beach and consisted of approximately 4 to 8 tufts of plants with 60 cm to 1 m in diameter.

Phenology

Flowering and fruiting times in Algeria, are between June and November.

Notes on vegetation

Eclipta prostrata was found in a wadi (river) in September with aquatic and herbaceous communities (see Table 1).

Table 1. Floristic composition of the relevé (sample) whith *Eclipta prostrata*. The alien status (3rd column) follows the Greuter (2006+) and Le Floc'h & al. (2010). The nomenclature follows Dobignard & Chatelain (2011).
Abbreviations. 2st column: Ch = chamaephyte, G = geophyte, H = hemicryptophyte, Hyd= Hydrophyte, Hel: Helophyte, P = phanaerophyte, T = therophyte; 3rd column: NTV =Native; NAT = Naturalized; 4rd column: (+): Levels of Frequency.

Plant names	Life forms	Status	Levels of Frequency
Ephedra fragilis Desf.	P	NTV	+
Cakile maritima Scop.	T	NTV	++
Euphorbia peplis L.	T	NTV	+
Eryngium ilicifolium Lam.	T	NTV	+
Ammophila arenaria (L.) Link	G	NTV	++
Pancratium maritimum L.	G	NTV	++

Table 1. continued.

Tamarix gallica L.	P	NTV	
Pistacia lentiscus L.	P	NTV	
Lotus creticus L.	Ch	NTV	
Xanthium strumarium L.	T	NTV	+++
Salsola kali L.	T	NTV	++++
Crucianella hirta Pomel	Ch	NTV	++
Rumex palustris Sm.	T	NTV	
Persicaria lapathifolia (L.) Delarbre	T, Hyd	NTV	
Arundo donax L.	G	NAT	
Typha elephantina Roxb.	G	NTV	
Solanum nigrum L.	T	NTV	
Tamarix gallica L.	P	NTV	
Dysphania ambrosioides (L.) Mosyakin & Clemants	T	NAT	
Lythrum salicaria L.	H, Hel	NTV	
Eclipta prostrata(L.) L.	T	NAT	

Discussion and Conclusion

According to Caillon (2020) this hygrophilous and heliophilous species is found in a wide variety of habitats. It favors wetlands, sometimes strongly ruderalized, such as irrigated crops (weeds of rice fields), temporarily exposed banks of lakes, canals and rivers, however, the only observation at the moment in Algeria is in its typical biotope, a humid area (pound) but close to an agricultural area. This could explain why El Mokni & Iamonico (2018) had discovered this species generally on ruderal sites, assuming they are more or less humid.

Eclipta prostrata has been discovered in major part of the World and in Africa (POWO 2024). There was a gap in North Africa, particularly in Algeria, Tunisia and Libya. It has been found in Tunisia in 2011, now in Algeria (2023) and it probably would be found soon in Libya.

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Article

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K. Labrighli, C. Moujahdi, L. Rhazi & J. El Oualidi

Raising awareness of toxic spontaneous plants in Morocco: a comprehensive checklists

Abstract

Labrighli, K., Moujahdi, C., Rhazi, L. & El Oualidi, J.: Raising awareness of toxic spontaneous plants in Morocco: a comprehensive checklists. — Fl. Medit. 34: 143-158. 2024. — ISSN: 1120-4052 printed, 2240-4538 online.

The Morocco's geographical position makes it an ecologically and climatically diverse country, home to various plant species of ecological, cultural and medicinal importance. Some of these plants are widely used in traditional Moroccan medicine, although their toxicity has been reported in previous studies. This could pose a threat to human health. This investigation seeks to catalog the spontaneous poisonous plants found in Morocco. Although these plants have an important heritage in traditional medicine, unintentional poisoning, particularly in the case of poor and financially sensitive populations, remains a major obstacle. In this work, we have compiled a comprehensive database of toxic plants found in Morocco, describing in detail the equipment and methods used on the one hand, and enriching our study with a detailed discussion on the other.
As part of this study, we have identified 189 toxic species in Morocco. However, we will focus on the 138 spontaneous Moroccan species that are toxic to humans. These species are belonging to 99 genera and 46 botanical families, of which five are the most representative and total 66 species (47.82%), namely: *Fabaceae*, *Ranunculaceae*, *Solanaceae*, *Asteraceae*, and *Euphorbiaceae*. Among the cataloged taxa, 21 are strictly endemic to Morocco and 20 occur also in other sourrounding countries. In addition, the classification by life forms showed that the Therophytes (34 species) and Hemicryptophytes (27 species) are the most represented.
Our data collection not only enriches current scientific knowledge, but also reinforces effective mitigation policies. This research strives to promote awareness, avoid incidents of inadvertent poisoning and take early action, while preserving the country's botanical heritage. Research prospects in this field are also considered in the concluding section.

Key words: toxic plants; native species; traditional knowledge; North Africa.

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Introduction

Morocco boasts impressive ecological diversity, encompassing different ecosystems from coastal areas to the Atlas Mountains and the immense Sahara Desert. Morocco’s geo-

graphic and climatic diversity favors rich biodiversity, which in turn favors a very high floristic diversity estimated at 5211 species and subspecies (Fennane & Ibn Tattou 2012). The country's diverse landscapes and rich biodiversity are home to an exceptional range of plant species, which have played an important role in the daily lives of the indigenous population for many generations. As part of our research project, we have developed a comprehensive database containing information on all the toxic plant species found in the regions of Morocco. However, this article focuses solely on spontaneous toxic species and our discussion and conclusions are limited to this part of the flora.

Poisonous plants hold significant importance in the social context of Morocco, particularly concerning traditional medicine and folk practices. Indigenous communities in the country have historically utilized the healing potential of specific toxic plants, administering them in precisely measured quantities to treat specific ailments. Nevertheless, the boundary between medicinal usage and inadvertent poisoning is often unclear, resulting in unintended outcomes for those searching for relief. Moreover, accidental ingestions do occur, particularly among vulnerable populations, posing a major public health problem (Najem & al. 2019).

The article's primary goal is to compile a comprehensive list and categorization of spontaneous toxic species in Morocco. By identifying and categorizing the most dangerous species based on their level of toxicity, we hope to offer crucial insights into the distribution and properties of these toxic plants. This information will make a valuable contribution to the current academic literature and assist in designing efficient strategies to reduce the dangers related to contact with harmful plants.

Through careful examination of Morocco's toxic flora, this article aims to increase awareness among the public on the subject. Its focus is on prevention and early intervention to reduce the risk of accidental poisoning. Furthermore, it establishes the groundwork for future research and enables the development of targeted management strategies that will secure the continued preservation of the country's botanical heritage.

The following sections detail the materials and methods and present a comprehensive database of the spontaneous toxic plants of Morocco, together with detailed results and discussion. The paper concludes with a perspective and points of view.

Materials and Methods

Study Area

Our study is dealing with the whole area of Morocco. The country encompasses a wide range of ecosystems, including coastal areas, fertile plains, the Atlas Mountains and vast desert areas of the Sahara. These diversified geographical conditions provide a favorable habitat for growing and reproducing various plant species, some of which are poisonous to humans.

Data Collection on Toxic Plants in Morocco

Data on poisonous plants in Morocco were collected from several credible scientific sources. The main sources used were the following:

Reference Books: Charnot (1945); Bellakhdar (1997); Fennane (1997); Hmamouchi (1999).

Reports from the Anti Poison and Pharmacovigilance Centre of Morocco: we thoroughly reviewed the annual reports of the Anti-Poison and Pharmacovigilance Centre of Morocco to identify plants involved in reported poisoning cases in Morocco between 2008 and 2021.

Scientific research: extensive searches were conducted in reputable scientific databases, including Scopus, ScienceDirect, PubMed, Web of Science, and Google Scholar, to access various types of literature. Articles such as: Traibi & al. (2013), Rachid & al. (2013), Mouaffak & al. (2013), Romo & al. (2017), Oulmaati & al. (2017), Nchinech & al. (2019), Najem & al. (2019), Hoummani & al. (2019), Hosni & al. (2019), Farzaei & al. (2020), Achour & al. (2021), Ghizlane & al. (2021), Elouardi & al. (2022) were reviewed. Monographs such as Benzeid & al. (2018) provided additional context, and ethnobotanical studies including:Yassir & al. (2012), El Alami & al. (2016), Najem & al. (2019), Kharchoufa & al. (2021), Belhaj & al. (2021), Chaachouay & al. (2021) offered insights into local knowledge. Surveys conducted by other researchers on toxic plants in Morocco, such as Loutfia & al. (2013), Fennane & Rejdali (2016), Eddouks & al. (2017), Saadi & al. (2017), Kharchoufa & al. (2018), Najem & Ibijbijen (2018) and Imane & al. (2018), further enriched our database.

These bibliographic sources allowed us to compile comprehensive, updated, and reliable data on toxic plants in Morocco, thus contributing to the robustness and validity of our study.

List of Toxic Plants

Using the data collected, a preliminary list of toxic plants was compiled by identifying plant species reported to be potentially hazardous to human health. To further validate this list, we adopted an approach based on using *ProTox 3.0 server*. This software predicts the potential toxicity of molecules using an algorithm based on their chemical structure.

To catalog the active principles and known chemical compounds present in each toxic plant, the information obtained from bibliographic sources was thoroughly analyzed. The toxicity of these molecules was then predicted using the *ProTox 3.0 server* (https://tox.charite.de/protox3/#). The final list included plants with molecules identified as toxic by the software.

Database construction

A total of 189 toxic plants were identified, including invasive species, cultivated plants, and some species toxic exclusively to animals, for which no evidence was found in the literature to confirm their toxicity to humans. However, in this paper, we have chosen to present only spontaneous toxic plants, totaling 138 species out of the 189 identified, while excluding those not relevant to human toxicity. A comprehensive database was created for these 189 plants, containing the following fields:

Scientific name:

We consulted the African Plant Database (version 4.0.0) (http://www.ville- ge.ch/musinfo/bd/cjb/africa) to check the accepted scientific name and synonym(s) for each plant. The three volumes of the “Flore pratique du Maroc” (Fennane & al. 1999, 2007, 2014) were used as sources of information for the botanical family, life form and flowering season.

Common and vernacular names

Common names (in French and English) and vernacular ones (in arabic or amazigh) come from Fennane & al. (1999, 2007, 2014), Skalli et al. (2006): Najem & al. (2020).

Red List conservation status

Assessment of the conservation status of each species according to the Red List criteria. We used the "Livre Rouge de la flore vasculaire du Maroc" (Fennane & al. 2021) as a reference. Additionally, we consulted the IUCN Red List online to verify the global conservation status of our species.

Endemism status

Indicates whether the plant is endemic to Morocco or whether it is also found in other regions of the world. We used the Checklist of Endemics and Type Specimens of the Vascular Flora of North Africa (El Oualidi & al. 2012) and "Livre Rouge de la flore vasculaire du Maroc" (Fennane & al. 2021) as references.

Geographical and regional distribution

Specific distribution according to the geographical regions of the country, following the information and the map presented in the "Flore pratique du Maroc" (Fennane &al. 1999, 2007, 2014). See the Electronic Supplementary File 1 (ESF1, Fig. S1).

Bioclimatic zone distribution

Classification of toxic plants according to their distribution in Morocco's bioclimatic zones, following the classification in Fennane & al. (1999).

Ecology and habitat

Description of the environment and preferred habitat of each poisonous plant (arid environments, forests, mountainous areas, etc.) following the information presented in the "Flore pratique du Maroc " (Fennane & al. 1999, 2007, 2014).

Uses of the plants

Indicate some primary uses of the recorded plants (Food, Medicinal…)

Toxic parts

Indicate the specific plant parts (roots, leaves, flowers, etc.) responsible for its toxicity.

Lethality

Specifies whether the plant is potentially lethal if ingested or contacted.

Toxic Dose

Provide information on the toxic dose for humans, if available.

Intoxication symptoms

Detailed description of the symptoms caused by ingesting or exposing to each toxic plant, allowing quick identification of signs of intoxication.

Toxicity producing molecules

If identified, list the active ingredients/molecules responsible for each plant's toxicity.

LD50 of molecules

Indication of the median lethal dose of the molecules responsible, if available, which provides information on the toxic potency of these compounds.

Molecules categorization

To evaluate the toxic potential of the molecules collected from the studied species, we used the *ProTox* 3.0 web server. *ProTox* 3.0 is a widely recognized web-based tool for predicting the toxicity of chemical compounds. The server integrates molecular similarity models and machine learning algorithms to make predictions based on a database of

molecular structures and their known biological activities.(Banerjee & al. 2024) We submitted the molecular structures of our samples to Protox 3.0 to estimate their toxicity levels. The results obtained were classified into three categories: highly toxic, moderately toxic, and low toxic, based on the toxicity scores generated by the server. This method enabled us to establish detailed toxicity profiles for each sample, thus facilitating the comparison and analysis of toxic substances present in the collected species.

Toxicity-inducing uses:

Information on specific circumstances or uses that may cause poisoning.

Information validation

The data collected from the various bibliographic sources were rigorously validated by comparing them with recent scientific articles and specific studies on certain toxic plants. This cross-validation approach has enabled us to guarantee the accuracy and reliability of the information gathered, as well as the quality of our database.

Results and Discussion

As part of this study, we have identified 189 toxic species in Morocco. However, we will focus on the 138 spontaneous Moroccan species that are toxic to humans. It is worth noting that some of the remaining species are toxic exclusively to animals (37 species), while others (14 species) are introduced and cultivated species (ESF1, Table S1).

This section aims to enhance our comprehension of the toxicity of spontaneous plants in the Moroccan ecosystem. The presented results will provide a detailed analysis of the toxicity of these plants, highlighting significant trends and characteristics.

Plants that are both toxic and strictly endemic to Morocco are marked with a * in the table in ESF1.

Classification by degree of toxicity

The plants were classified according to their toxicity levels (highly toxic, moderately toxic, slightly toxic) using the Protox 3.0 server to forecast the toxicity levels of the poisonous molecules in the plants collected. Among the 138 species examined, 7 species have unidentified toxic molecules. Fig. 1a shows that a significant percentage of the plants were classified as 'highly toxic' and 'moderately toxic' highlighting the need for increased vigilance, especially in regions where these plants are prevalent. These results make it possible to rank toxic plants according to their potential danger, which is essential for risk management.

Life form and family

Life form

Another aspect of the analysis was the life forms and botanical family affiliation of spontaneous toxic species.

Examining the distribution of toxic plants based on their biology reveals the range of "tactics" used by these species to adapt to different environments.

Fig. 1b displays the variety of life forms categories, which demonstrates how spontaneous toxic plants can thrive in diverse environments and adapt to shifting environmental

conditions. The distribution is mainly dominated by the therophytes, which comprise 34 species. They exhibit exceptional adaptability to harsh environmental conditions such as arid soil and bush fires. This suggests that many toxic plants are well-suited to seasonal or periodically stressed environments. Furthermore, there are high numbers of taxa of hemicryptophytes (27), chamaephytes (21), and nanophanerophytes (24), which may be attributed to the prevalent dry conditions in many areas of Morocco.

This analysis highlights the importance of understanding the biological distribution of poisonous plants endemic to Morocco, which provides important insights into their ecology and special adaptations.

Family

An examination of the distribution of poisonous plants by the botanical family unveils compelling patterns. As depicted in Fig. 1c, the family with the highest representation is *Fabaceae*, which exhibits 17 toxic species, followed by *Ranunculaceae* and *Solanaceae* each with 13 species. Additionally, *Asteraceae* and *Euphorbiaceae* have substantial representation, each with more than 10 toxic species. Diversity in habitats and ecological conditions to which the toxic plants are adapted is shown by several other families, each represented by either one or two plants.

Distribution of spontaneous toxic species in Morocco

Our study examined the geographical repartition of toxic plants in Morocco, specifically regarding geography and bioclimatic zones. It is worth mentioning that some of the taxa recorded in our listcan be found in multiple bioclimatic zones and geographical areas.

Geographical divisions

According to our analysis (Fig. 1d), the top regions with the highest occurrence of toxic species are the coastal and mountainous areas, notably the Rif, followed by the High and Middle Atlas Mountains, which possess a significant concentration of these plants. The North and Middle Atlantic coastal regions, as well as the Mediterranean coast, exhibit a substantial number of toxic plants, while the diversity is comparatively lower in Saharan Morocco and the Saharan Atlas.

This geographic distribution can be affected by several environmental and climatic factors that are region-specific.

One significant factor is altitude, which affects temperature, precipitation patterns, and soil types, all of which can create microenvironments conducive to the growth of some toxic species (Elouardi & al. 2022). For example, higher altitudes in the Rif and Atlas Mountains experience cooler temperatures and increased rainfall compared to the arid regions of Saharan Morocco, promoting the proliferation of diverse plant species, including toxic ones (Maimouni & al. 2021)

Water availability is another critical factor. Coastal regions and areas with higher rainfall tend to support a richer biodiversity, including toxic plants. The North Atlantic and Mediterranean coastal areas receive more consistent precipitation, contributing to a higher prevalence of these species (Zerkani & al. 2022). In contrast, the arid conditions of the

Saharan regions limit the diversity and abundance of plant species in general, including toxic ones (Souahi & al. 2022); (Kawada & al. 2020).

The distance from human habitats is also a significant factor. Remote mountainous regions, with minimal human interference, can serve as refuges for plants biodiversity, including toxic species. In contrast, these plants may be eradicated or diminished in more populated areas due to agricultural activities, urbanization, and land use changes (Muller & al. 2015).

These factors do not exclusively affect toxic plants but influence plant biodiversity as a whole. However, plant species have adaptations that allow them to thrive in specific environmental conditions, making their presence more pronounced in particular regions. Therefore, the observed distribution pattern is a result of these complex interactions between the plants' ecological preferences and the regional environmental conditions.

Bioclimatic zones distribution

The analysis of poisonous plant distribution by bioclimatic zones indicates that the sub-humid bioclimate has the highest representation, followed closely by the warm semi-arid and humid ones. These findings are illustrated in Fig. 1e and reflect the ecological preferences of poisonous plants and their adaptation to specific environmental conditions.

Toxic plants in the sub-humid zone likely adapt to the more humid environment of this area due to their ecological preferences for higher moisture levels. This adaptation may involve physiological mechanisms such as enhanced water uptake and storage capacities, as well as morphological traits like larger leaf surface areas that facilitate transpiration and cooling (Lambers & al. 2008; Chaves & al. 2003).

Conversely, plants in the warm semi-arid zone likely exhibit specific adaptations to survive high temperatures and drought conditions. These adaptations may include the development of deep root systems to access groundwater, reduced leaf surface area to minimize water loss, and the production of secondary metabolites that deter herbivory and contribute to their toxicity (Chaves & al. 2003; Larcher 2003). These survival mechanisms enable these plants to thrive in harsh environments where other species may not persist.

Overall, the observed distribution patterns of toxic plants reflect their ability to adapt to distinct bioclimatic zones, highlighting the importance of specific ecological and physiological traits that enable their survival under varying environmental conditions (Lambers & al. 2008).

Endemism and conservation status of spontaneous toxic plants in Morocco

Endemism

Regarding endemism, 39 out of the 138 spontaneous toxic plants are specific to Morocco. This is a vital component of Moroccan biodiversity (Rankou & al. 2013).

According to Fig. 2a, 21 out of the 39 species are exclusive to Morocco, representing 54% of all endemic species in our database and 15% of all spontaneous species collected in our database. The remaining endemic species are distributed across other regions, including Algeria, the Iberian Peninsula, Mauritania, the Canary Islands, and the Macaronesian islands.

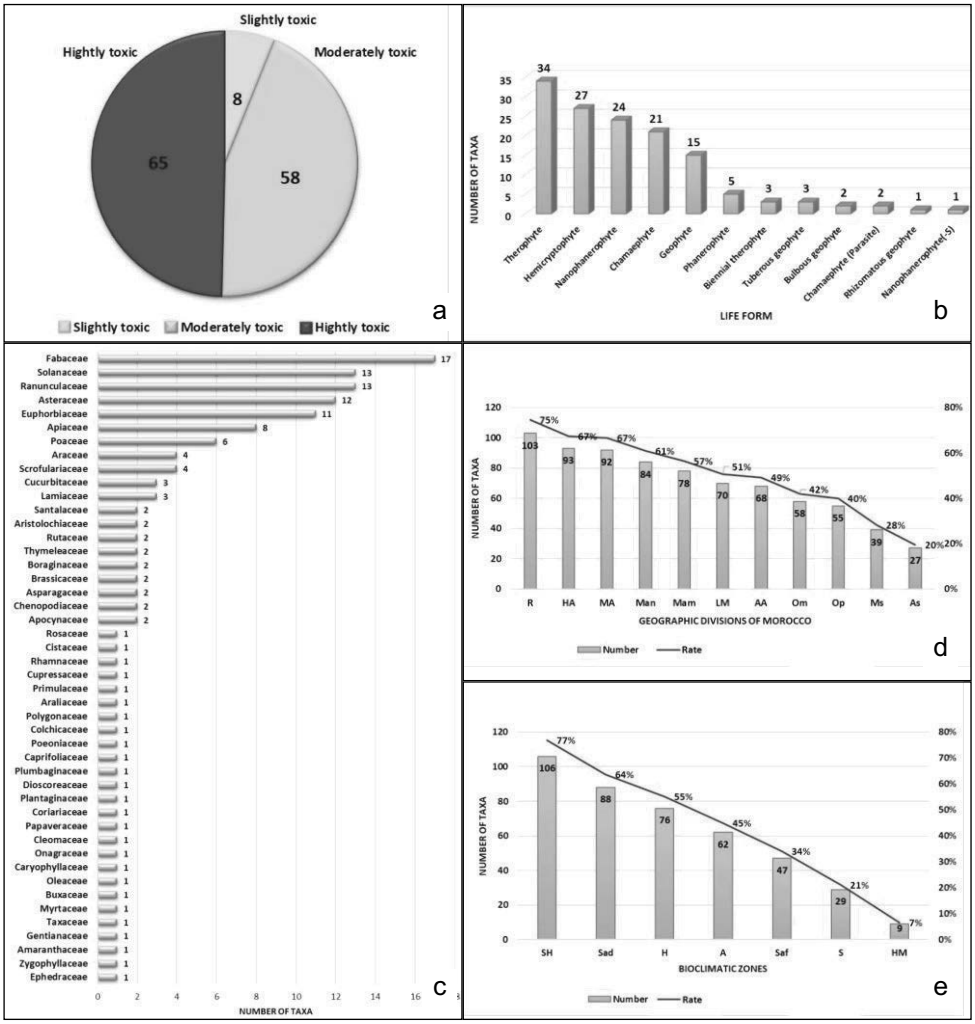


Fig. 1. Spontaneous toxic plants in Morocco: a) toxicity level; b) life forms; c) families; d) geographical divisions (R: Rif, MA: Middle Atlas, HA: High Atlas, Man: North Atlantic Morocco, Mam: Middle Atlantic Morocco, LM: Mediterranean coast, AA: Anti Atlas, Om: Eastern Moroccan mountains, Op: Eastern Moroccan plains and plateaus, Ms: Saharan Morocco, As: Saharan Atlas); e) bioclimatic zones (SH: Subhumid, Sad: Semi-arid warm, H: Humid, A: Arid; Saf: Semi-arid cold, S: Saharan, HM: High Mountain);

This report presents valuable data on the endemism status of toxic plants in Morocco. The presence of 21 species exclusively found in Morocco highlights the country's rich biodiversity and emphasizes the need for preservation. The fact that 18 other species are also found in Morocco and other neighboring countries underscores the importance of international collaboration in their conservation efforts.

These findings have important implications for biodiversity management and conservation in Morocco. Endemic species are often vulnerable to environmental disturbances, climate change and other threats. Therefore, targeted conservation efforts are needed to preserve these unique species.

Conservation status

An assessment of the conservation status of poisonous plants in Morocco using Red List valuations, According to Fennane & al. (2021), highlights the vulnerability of certain species. As shown in Fig. 2b, most species are currently considered to be at low risk of extinction (LC), while 24 species are classified as threatened (Critically Endangered, Vulnerable and Endangered). This underlines the importance of continued monitoring of these species and the implementation of appropriate conservation strategies.

It is also important to note that the presence of species classified as "Data Deficient" highlights the uncertainty surrounding their status. This uncertainty requires further research to properly assess their status and importance. In addition, the fact that several species are classified as "Near Threatened: close to the threshold of the threatened categories" suggests that precautionary conservation measures may be needed to prevent them from falling into the higher threat categories.

In comparison with the global IUCN Red List assessment, for which the status of only 28 species was available, the majority (26 species) are also categorized as "Least Concern" (LC), indicating a low risk of extinction on a global scale. However, one species is classified as "Vulnerable" and another as "Near Threatened," aligning with the findings at the national level where several species are also approaching a threatened status. While these global assessments corroborate the local evaluation for many species, the presence of globally vulnerable species highlights the necessity for specific conservation actions beyond the national context. Additionally, the identification of species as "Near Threatened" at both levels stresses the need for precautionary conservation measures to prevent further deterioration of their status.

These results underscore the importance of preserving Moroccan flora, especially endemic threatened species. Targeted conservation efforts, ongoing research and biodiversity awareness are key to ensuring the long-term survival of these "unique" toxic plants.

Symptoms of poisoning, lethality, toxic parts and uses

Symptoms of poisoning

Exposure to toxic plants can lead to a variety of symptoms. An analysis of the 138 spontaneous toxic plants indicates several common symptom combinations. The symptoms may vary depending on the specific toxic plant involved, highlighting the necessity for prompt and accurate identification of intoxication indicators. Moreover, some plants can induce multiple types of symptoms, complicating the assessment and management of intoxication

Fig. 2c provides an overview of the main symptom categories observed.

Digestive and nervous disorders: The results of our study reveal that 38% of the toxic plants identified in our list i.e. 54 plants cause digestive and nervous system disturbances, with symptoms such as nausea, vomiting, diarrhea, and alterations to the nerv-

ous system, including convulsions and dizziness. These observations are consistent with the data from the Anti-Poison and Pharmacovigilance Centre of Morocco (CAPM), which, in its report covering the period from 2009 to 2019, identified the digestive and nervous systems as the most frequently affected by plant poisonings in Morocco (Rhalem & al. 2022).

Digestive and cardiac disorders: symptoms combining digestive and cardiac disorders highlight the diversity of possible reactions to toxic plant poisoning, including cardiac problems such as palpitations and arrhythmias in addition to gastrointestinal symptoms. They are linked with 44 plants representing 32% of toxic plants in our list.

Digestive and respiratory disorders: gastrointestinal symptoms coupled with respiratory problems such as dyspnea or coughing are associated with 22 plants representing 16% of toxic plants in our list.

Skin irritation and photosensitization: skin irritation and photosensitization indicate that some toxic plants can cause skin damage and increase skin sensitivity to sunlight, leading to skin problems. They are associated with 17 plants representing 12% of toxic plants in our list.

Digestive and renal disorders: gastrointestinal symptoms accompanied by kidney problems, such as kidney damage, are associated with 11 plants representing 8% of toxic plants in our list.

Blood disorders: a small percentage of toxic plants (6%), corresponding to 8 plants, can cause blood disorders, which can include abnormal blood coagulation, anemia, etc.

Reproductive disorders: finally, a plant can cause reproductive disorders, affecting fertility or development in exposed individuals.

Identifying symptoms of toxicity associated with each toxic plant is crucial for timely and accurate diagnosis of intoxication cases, as well as provision of the appropriate treatment to prevent serious complications.

The various symptom combinations observed suggest that toxic plants in Morocco can have diverse effects on human health. This underscores the significance of continual awareness-raising for local populations, emphasizing the potential hazards linked with exposure to these plants.

Lethality of toxic plants

It is crucial to evaluate the lethality of the 138 spontaneous toxic plants in Morocco, indicating their ability to cause fatality when ingested or exposed to.

Fig. 2d illustrates that most recorded toxic plants, specifically 69%, are classified as lethal, thus posing a significant health and life hazard.

Meanwhile, the remaining 31% exhibit toxicity of less severity, causing adverse effects but not lethal.

The significant percentage of poisonous plants that can cause death in the above list underscores the importance of taking precautions when encountering this flora. Acquiring knowledge on the poisonous potency of these plants is crucial in mitigating the hazards of intoxication, primarily in areas where these plants are prevalent.

The presence of non-lethal toxic plants is noteworthy given their potential to cause health issues despite not being deadly. However, the effect of these plants can vary based on dosage, exposure time, and individual susceptibility.

Toxic parts

Regarding toxic plant parts, our results reveal a diversity of parts involved. Fig. 2e shows an overview of the different toxic plant parts.

Seeds are the primary toxic components of 43 plants. This prevalence can be attributed to their reproductive function, which has inspired the development of defensive mechanisms to safeguard their progeny.

Completely toxic plants: 34 plants are toxic as a whole, meaning that all their parts present a toxic risk. This is an important feature to consider, as it indicates that these plants can be particularly dangerous.

Roots: Toxic roots are present in 29 plants. Roots can store toxic compounds in large quantities.

Aerial Parts: Leaves, stems, and flowers found in the aerial parts of 27 plants are significantly toxic, suggesting that these parts may be more accessible to humans.

Fruits: Toxic fruits are present in 26 plants.

The complexity of plant toxicity and the need to consider all parts when assessing potential risks is emphasized by the existence of multiple toxic components in a single plant.

Plants uses

An analysis of the toxic plants listed reveals that 71.01% are utilized for medicinal purposes, highlighting their significance in traditional pharmacology. Additionally, 10.87% of the plants are used as food sources, while 9.42% are known for their aromatic properties. Ornamental use and food additives are less common, representing 2.90% and 2.17% of the plants, respectively. These findings emphasize that toxic plants, despite their potential hazards, play an important role across various fields of use

Poisonous plants and method of use

Poisonous plant intoxication can occur through various methods of use, each resulting in specific toxicity consequences. Examining the data shows the most frequent modes of use linked to toxic plant poisoning. Fig. 2f provides a summary of the primary modes of use that lead to toxicity.

Fresh consumption: Direct consumption of toxic plants in their fresh state is the main source of intoxication, with 77% of plants being toxic when consumed without prior treatment.

Decoction: The preparation of toxic plants in decoction form, where the plant parts are boiled in water, is also a frequent source of intoxication, with 52% of toxic plants concerned.

Infusion: where plant parts are soaked in hot water, is another common method, with 39% of plants becoming toxic when used in this way.

Powdered use: 28% of toxic plants become harmful when ground into powder and used in this way.

Essential oils: Essential oils extracted from certain plants can be toxic, accounts for 12% of toxic plants.

Poultice: Applying toxic plants to the skin in the form of a poultice can also cause intoxication, accounting for 11% of plants.

Maceration: Maceration, where plant parts are immersed in a liquid (usually oil or alcohol) to extract the active compounds, is associated with 9% plants.

Many plants have the potential to become toxic when used in various ways, emphasizing the intricate interactions between plants and their usage patterns.

These results highlight the significance of implementing preventative measures, educational campaigns and increasing public awareness of best practices in handling and using plants, with a focus on the specific usage patterns that can lead to toxicity.

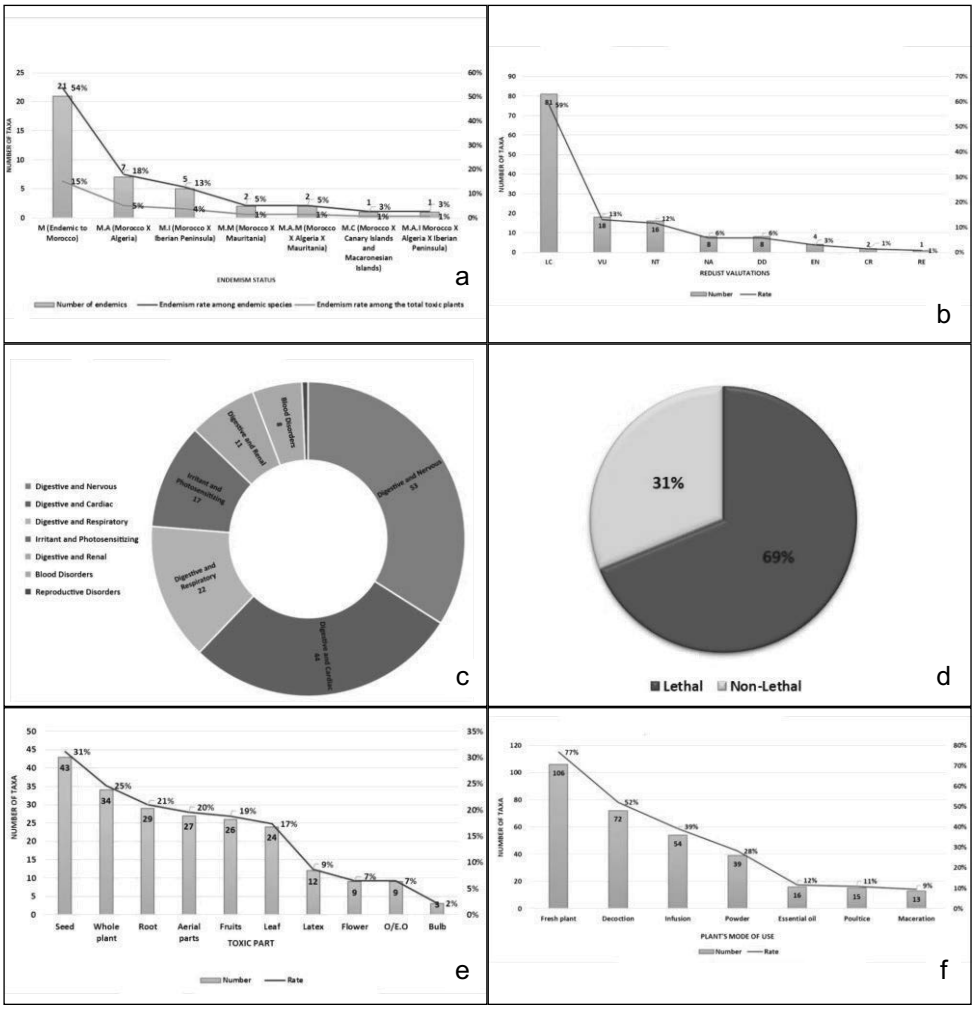


Fig. 2. Spontaneous toxic plants in Morocco: a) endemism; b) Red List criteria (LC: Least Concern, NA: Not Applicable, VU: Vulnerable, NT: Near Threatened, DD: Data Deficient, CR: Critically Endangered, EN: Endangered, RE: Regionally Extinct); c) intoxication symptoms; d) lethality; e) toxic part; f) method of use.

Conclusion

This study presents an extensive examination of toxic endemic plants in Morocco, emphasizing their geographic distribution, toxicity, and conservation status.

The broad range of toxic plant and their adaptation to various environments illustrates a crucial element of Moroccan biodiversity. The plants' presence is influenced by local conditions, as shown by the geographical distribution.

Targeted preservation measures are necessary due to the presence of endemic toxic species and their conservation status. Plant toxicity is a complex issue, evident by the various symptoms of intoxication and parties involved.

Preventing accidental poisoning is fundamentally reliant on increasing awareness about toxic plants. Informing the public, health professionals, and ecosystem managers about the risks linked with toxic plants is crucial to minimize harmful exposure.

Research perspectives

This study establishes a solid foundation for future research on toxic plants in Morocco. The research perspectives include exploring ecological interactions, analyzing toxic compounds for potential medical applications, conserving endangered endemic species, raising awareness among the public and healthcare professionals, and conducting epidemiological surveys on poisoning in human and animal populations (Domina & al. 2024). Expanding our database to include plants toxic to animals, along with developing an automatic identification system based on deep learning (Labrighli & al. 2022), aims to enhance the understanding and management of toxic plants in Morocco, thereby contributing to biodiversity conservation and public health.

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Article

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C. Salmeri, G. Bacchetta, C. Blandino, M. E. Boi, A. Cristaudo, G. Crocenzi, V. Di Cecco, L. Di Martino, A. I. Di Paola, M. C. Escribá, E. Estrelles, G. Fabrini, J. Güemes, A. Nebot, I. Panero, M. Porceddu, J. Prieto-Mossi, F. Tantalo & S. Magrini

Mediterranean plant germination reports – 6

Abstract

Salmeri, C., Bacchetta, G., Blandino, C., Boi, M. E., Cristaudo, A., Crocenzi, G., Di Cecco, V., Di Martino, L., Di Paola, A. I., Escribá, M. C., Estrelles, E., Fabrini, G., Güemes, J., Nebot, A., Panero, I., Porceddu, M., Prieto-Mossi, J., Tantalo, F. & Magrini, S.: Mediterranean plant germination reports – 6. — Fl. Medit. 34: 159-194. 2024. — ISSN: 1120-4052 printed, 2240-4538 online.

This is the sixth issue of the series of germination reports from Mediterranean areas (sensu Med-Checklist). It comprises germination protocols for 29 taxa, 19 of which are endemic, preserved in six seedbanks from the Ribes and/or GENMEDA networks. The investigated taxa and populations are *Leucanthemum tridactylites*, *Achillea barrelieri* subsp. *barrelieri*, *Erysimum majellense*, *Digitalis micrantha* and *Saxifraga porophylla* subsp. *porophylla* from Abruzzo (Italy) by Di Cecco & al. (Nos. 121-125), *Armeria sulcitana* and *Iberis integerrima* from Sardinia (Italy) by Boi & al. (Nos. 126-127), *Eokochia saxicola* and *Primula palinuri* from Campania and *Lythrum tribracteatum* from Latium (Italy) by Crocenzi & al. (Nos. 128-130), *Hyoseris lucida* subsp. *taurina*, *Lotus cytisoides*, *Senecio leucanthemifolius*, *Silene neglecta* from Lipari (Aeolian Islands) and *Linaria pseudolaxiflora* from Gozo (Maltese archipelago) by Di Paola & al. (Nos. 131-135), *Gadoria falukei* from Almería (Spain) by Nebot & Güemes (No. 136), *Coris monspeliensis*, *Limonium dufourii*, *L. furfuraceum*, *L. lobatum*, *L. perplexum*, *L. supinum*, *Nigella nigellastrum*, *Parentucellia viscosa*, *Silene mellifera* and *S. tridentata* from Valencian Community (Spain) by Escribá & al. (Nos. 137-146), *Erysimum metlesicsii*, *Jacobaea lycopifolia* and *Matthiola incana* subsp. *rupestris* from Sicily (Italy) by Scafidi & al. (Nos. 147-149).

Key words: endemic species, *ex-situ* conservation, protocols, Italy, Sardinia, seeds, Sicily, Spain.

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Introduction

This sixth issue of the series of germination reports from Mediterranean areas (sensu Med-Checklist) examines the germination protocols of 29 taxa belonging to twelve dicot

plant families, namely *Plumbaginaceae* (6), *Asteraceae* (5), *Brassicaceae* (4), *Caryophyllaceae* (3), *Plantaginaceae* (3), *Primulaceae* (2), *Amaranthaceae* (1), *Fabaceae* (1), *Lythraceae* (1), *Orobanchaceae* (1), *Ranunculaceae* (1) and *Saxifragaceae* (1).

Twelve of the 29 taxa are endemic to Italy, of which 2 are strictly endemic to Sardinia and 1 to Sicily, other 6 taxa are endemic to Spain, of which 3 are strictly endemic to the Valencian flora, 1 species is restricted to the Maltese archipelago (Malta) and the island of Linosa (Sicily), while the remaining 10 taxa have a wider distribution in the Mediterranean. 62% of the taxa studied are considered threatened to varying degrees and are included in an IUCN Red List category at the national or global (3 species) level.

As is known, seed germination is a key event in the plant life cycle which influences the survival of most plant species. Knowing the germination behaviour, especially of endemic and rare taxa, is pivotal to both *in situ* and *ex situ* conservation actions, providing useful information about the ecological requirements for seedling establishment and plant growth in the current and future environmental conditions. These reports contribute to the improvement of the knowledge of the best germination protocols for Mediterranean plants and implement to 149 records the checklist of Mediterranean germination reports available in the MPGR folder, a valid tool for researchers and technicians involved in plant conservation and propagation.

121. *Leucanthemum tridactylites* (A.Kern. & Huter ex Porta & Rigo) Huter, Porta & Rigo (*Asteraceae*)

Accession data:

It: Abruzzo. Pennapiedimonte (Chieti), loc. Fontanino Acquaviva (WGS84: 42.120981° N, 14.115225° E), pseudo-alpine meadows, rocky slopes, 2,170 m a.s.l., 12 Aug 2023, *V. Di Cecco & F. Tantalo* (MSB_N_20230812_111_VDC).

Germination data

Pre-treatments: Soaking in water for 2h, sterilization with a solution of 1% sodium hypochlorite plus Tween 20 for 4 minutes, followed by 3 rinses in sterile distilled water.
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]
92.5%	constant 20°C	12/12h	2.0	5.1	15.5	5.8

Observations

Leucanthemum tridactylites is endemic to Italy and is found only in Abruzzo, Molise, Lazio, and Calabria. This species is a scapose hemicryptophyte and lives in pseudo-alpine meadows, rocky slopes, and cracks in rocks at an elevation ranging from 1500 to 2200 m a.s.l., where it blooms from July to August.

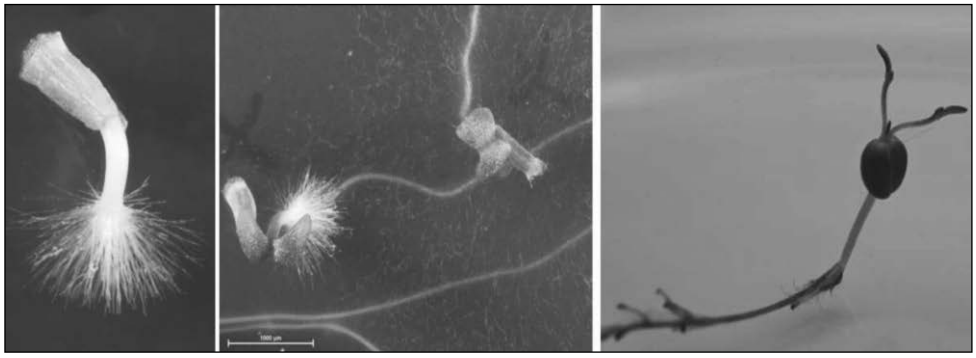


Fig. 1. Germinated seeds of *Leucanthemum tridactylites.*

It is a species included in the Italian Red List of Threatened Plants under the IUCN "Least Concern" (LC) category (Orsenigo & al. 2018; Rossi & al. 2020).

Germination tests were carried out 7 months after seed harvesting, using constant temperatures of 15°C and 20°C with a light-dark photoperiod of 12/12 hours, and constant temperatures of 20°C and 5°C in continuous darkness. The seeds of *L. tridactylites* showed no dormancy and had the highest germination rate (92.5%) at a temperature of 20°C with a light-dark photoperiod of 12/12 hours.

The Petri dishes incubated in the dark at a temperature of 20°C were opened after 50 days and the germination percentage was 55%. In contrast, the Petri dishes incubated in the dark at 5°C and opened after 50 days revealed no germinated seeds. Eighty seeds were incubated in the dark at 5°C for 3 months (vernalization); they were subsequently subjected to a constant temperature of 15°C with a light-dark photoperiod of 12/12 hours, reaching 52.5% of germination. The viability of the non-germinated seeds at the end of the tests was estimated through the cutting test.

These results suggest that *L. tridactylites* seeds prefer constant high or medium temperatures for germination. We report the first germination data for this taxon here.

V. Di Cecco, F. Tantalo & L. Di Martino

122. ***Achillea barrelieri*** (Ten.) Sch.Bip. subsp. ***barrelieri*** (*Asteraceae*)

Accession data:

It: Abruzzo. Pennapiedimonte (Chieti), loc. Fontanino Acquaviva (WGS84: 42.120536° N, 14.115330° E), consolidated gravels and pioneer sod, 2,184 m a.s.l., 12 Aug 2023, *V. Di Cecco & F. Tantalo* (MSB_N_20230812_112_VDC).

Germination data

Pre-treatments: Soaking in water for 2h, sterilization with a solution of 1% sodium hypochlorite plus Tween 20 for 4 minutes, followed by 3 rinses in sterile distilled water. 80 seeds were incubated in the dark at 5°C for 3 months (vernalization); they were subsequently subjected to a constant temperature of 15°C with a light-dark photoperiod of 12/12h[(1)].

Germination medium: 1% agar, pH 5.75.
Sample size: 80 seeds (20 × 4 replicates) for each condition.

Germination	Thermoperiod	Photoperiod [light/dark]	T_1 [d]	T_{50} [d]	T_{max}[d]	MTG [d]
100%	constant 20°C	12/12h	2.0	2.5	6.0	3.5
97.5%[(1)]	constant 15°C	12/12h	1.0	1.6	10.5	6.4
97.5%	constant 20°C	0/24h	-	-	-	-
90.0%	constant 15°C	12/12h	2.5	4.0	7.3	4.5

Observations

Achillea barrelieri subsp. *barrelieri* is endemic to Italy and is found only in Abruzzo, Molise, Lazio, Marche, and Umbria. This species is a cespitose hemicryptophyte and lives on consolidated gravels and pioneer sod at altitudes from 2000 to 2600 m a.s.l., where it blooms in July and August. The species is included in the Italian Red List of Threatened Plants under the IUCN "Least Concern" (LC) category (Orsenigo & al. 2018; Rossi & al. 2020).

Germination tests were carried out 6 months after seed harvesting, using constant temperatures of 15°C and 20°C with a light-dark photoperiod of 12/12 hours, and constant temperatures of 20°C and 5°C in continuous darkness. Seeds showed no dormancy and had the highest germination rate (100%) at a temperature of 20°C with a 12/12 h light-dark photoperiod. The Petri dishes incubated in the dark at a temperature of 5°C were opened after 50 days revealing any germinated seeds. The seeds subjected to vernalization for 3 months reached 97.5% of germination. The viability of the non-germinated seeds at the end of the tests was estimated through the cutting test.

These results suggest that *Achillea barrelieri* subsp. *barrelieri* seeds prefer constant high or medium temperatures for germination. Vernalization slightly improved the germination rate. We report here the first germination data for this taxon.

V. Di Cecco, F. Tantalo & L. Di Martino

123. *Erysimum majellense* Polatschek (*Brassicaceae*)

Accession data:

It: Abruzzo. Fara San Martino (Chieti), loc. Val Cannella (WGS84: 42.083469 N, 14.115810 E), steppe and rock slopes, and arid calcareous meadows, 2,154 m a.s.l., 06 Oct 2023, *V. Di Cecco* (MSB_N_20231006_114_VDC).

Germination data

Pre-treatments: Soaking in water for 2h, sterilization with a solution of 1% sodium hypochlorite plus Tween 20 for 3 minutes followed by 3 rinses in sterile distilled water.
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]
81.2%	constant 15°C	12/12h	3.2	4.5	7.0	5.0

Observations

Erysimum majellense is endemic to Italy, circumscribed to Abruzzo, Molise, and Lazio. This species is a scapose hemicryptophyte and lives on steppe and rock slopes, and arid calcareous meadows from 1100 to 2400 m above sea level, where it blooms from June to August. The species is included in the Italian Red List of Threatened Plants in the IUCN "Least Concern" (LC) category (Orsenigo & al. 2018; Rossi & al. 2020).

Germination tests were carried out 1 month after seed harvesting, using constant temperatures of 10°C, 15°C, 20°C, 25°C, and the alternating temperature of 10/20°C, with a light-dark photoperiod of 12/12 hours, and constant temperatures of 20°C and 5°C in continuous darkness. The seeds of *E. majellense* showed no dormancy and had the highest germination rate (81.25%) at a temperature of 15°C with a light-dark photoperiod of 12/12 hours. Seeds germinated at a rate of 75% at the constant temperatures of 10°C and 20°C with a light-dark photoperiod of 12/12 hours. The germination percentage was slightly lower (70%) for seeds incubated at the 20/10°C alternating thermoperiod, with 12/12h light-dark condition, while it dropped to 32.5% at 25°C and 12/12 h light-dark photoperiod. The Petri dishes incubated in the dark were opened after 34 days, revealing a germination percentage of 43.75% at 20°C and of only 7.5% at 5°C. Eighty seeds were incubated in the dark at 5°C for 3 months (vernalization); then they were maintained under a constant temperature of 20°C with a 12/12h light-dark photoperiod, reaching 67.5% of germination.

The viability of the non-germinated seeds at the end of the tests was estimated through the cutting test.

These results suggest that seeds of *Erysimum majellense* mostly germinate between 10° and 20°C and show a positive photoblastic response. Vernalization does not improve seed germination in this species.

V. Di Cecco, F. Tantalo & L. Di Martino

124. *Digitalis micrantha* Roth ex Schweigg. (*Plantaginaceae*)

Accession data:

It: Abruzzo. Taranta Peligna (Chieti), loc. Valle di Taranta (WGS84: 42.038494 N, 14.152415 E), forest clearings, 1,370 m a.s.l., 13 Sept 2023, *A. Di Renzo* & *F. Tantalo* (MSB_N_20230913_113_ADR).

Germination data

Pre-treatments: Priming with 500 ppm gibberellic acid (GA_3) aqueous solution for 24 hours. Afterwards, sterilization with a solution of 1% sodium hypochlorite plus Tween 20 for 3 minutes, followed by 3 rinses in sterile distilled water.

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%	constant 20°C	12/12h	4.3	6.3	16.0	7.3

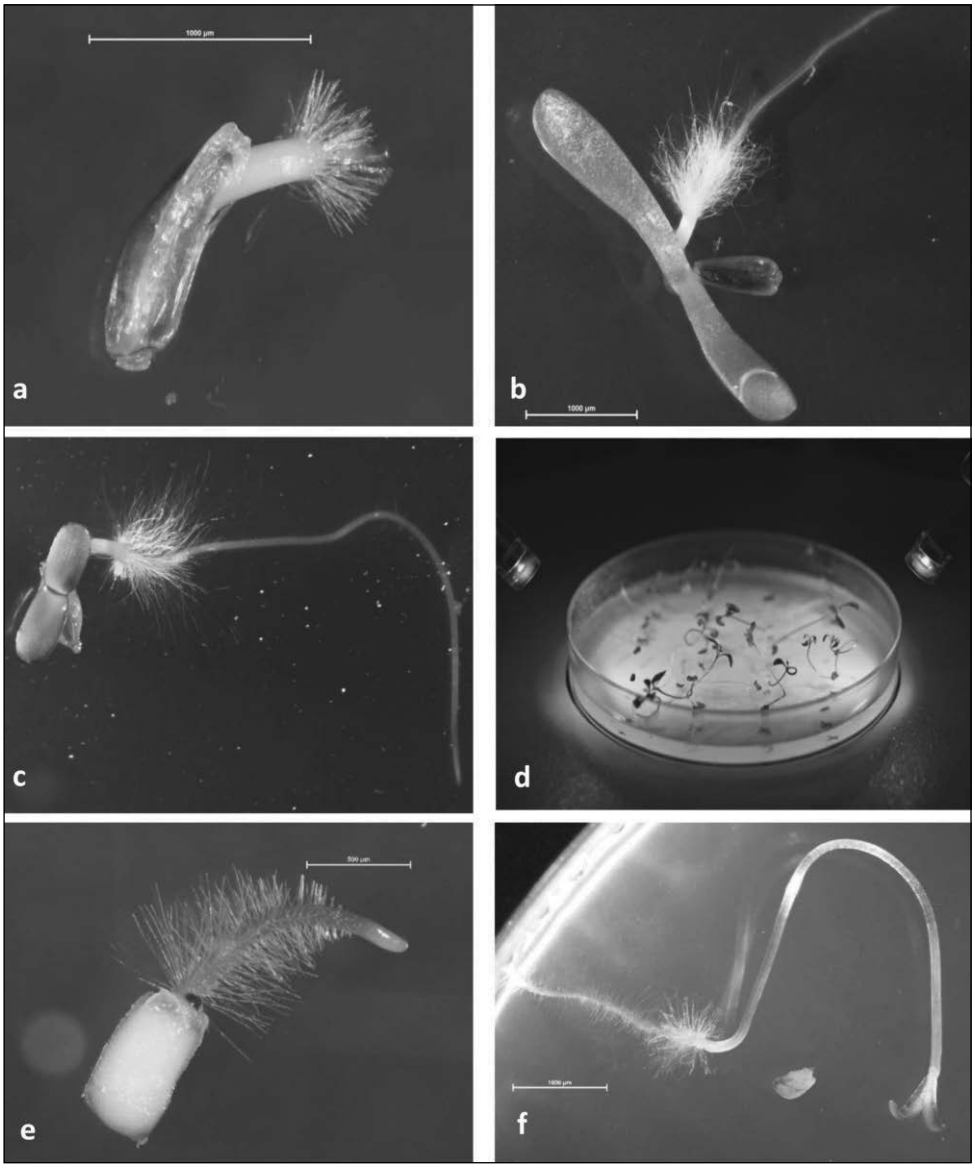


Fig. 2. Germinated seeds of *Achillea barrelieri* subsp. *barrelieri* (a, b), *Erysimum majellense* (c, d), *Digitalis micrantha* (e, f),

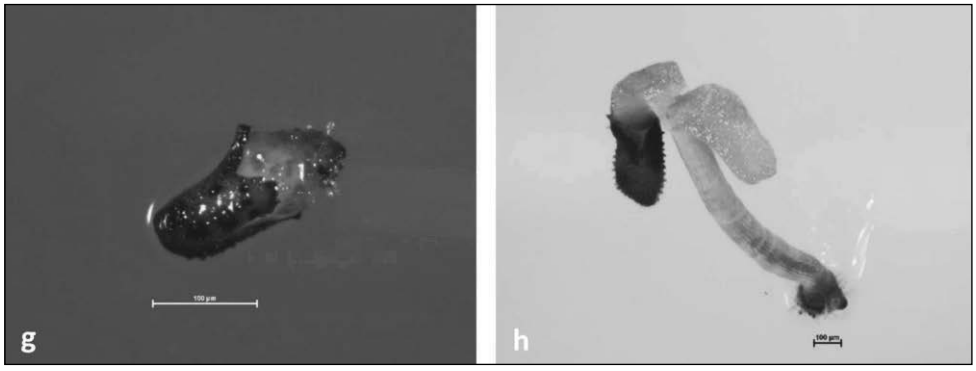


Fig. 2. Germinated seeds of *Saxifraga porophylla* subsp. *porophylla* (g, h),

Observations

Digitalis micrantha is endemic to Italy and is found only in the Apennines. This species is a scapose hemicryptophyte that lives in forest clearings starting from 300 m above sea level; flowering occurs from May to July. The species is included in the Italian Red List of Threatened Plants in the IUCN "Least Concern" (LC) category (Orsenigo & al. 2018; Rossi & al. 2020).

Germination tests were carried out 7 months after seed collection at different temperatures (5°C, 10°C, 15°C, 20°C, 25°C, 10°/20°C) and different photoperiods (12/12 hours light-dark and continuous darkness). A significant germination percentage (71.25%) was recorded only at a constant temperature of 10°C with a 12/12h light-dark photoperiod, after over 100 days of incubation. Seed germination was significantly improved by hormonal priming pre-treatment (24 h in 500 ppm GA_3), which provided 100% of germination at the constant temperature of 20°C and a 12/12h light-dark photoperiod. These results suggest that *D. micrantha* seeds have some physiological dormancy and the treatment with gibberellins accelerates their cell development.

V. Di Cecco, F. Tantalo & L. Di Martino

125. *Saxifraga porophylla* Bertol. subsp. ***porophylla*** (*Saxifragaceae*)

Accession data:

It: Abruzzo. Fara San Martino (Chieti), loc. Cima Murelle (WGS84: 42.111121 N, 14.132902 E), compact or crumbling limestone cliffs, 2,571 m a.s.l., 12 Aug 2023, *V. Di Cecco* & *F. Tantalo* (MSB_N_20230812_115_VDC).

Germination data

Pre-treatments: Priming with 10^{-3} M gibberellic acid (GA_3) aqueous solution for 24 hours. Afterwards sterilization with a solution of 1% sodium hypochlorite plus Tween 20 for 2 minutes followed by 3 rinses in sterile distilled water.

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]
81.4%	constant 20°C	12/12h	8.0	6.2	36.8	9.9

Observations

Saxifraga porophylla subsp. *porophylla* is endemic to Italy, only occurring in the central-southern Apennines (Abruzzo, Molise, Lazio, Marche, Umbria, Campania, Basilicata, and Calabria). This species is a pulvinate chamaephyte and lives on compact and crumbling limestone cliffs from 1200 m a.s.l. upwards; flowering occurs in June. It is a species included in the Italian Red List of Threatened Plants under the IUCN "Least Concern" (LC) category (Orsenigo & al. 2018; Rossi & al. 2020).

Germination tests were carried out 8 months after seed collection, using a constant temperature of 20°C with a light-dark photoperiod of 12/12 hours, which provided a germination percentage of 81.39%. Further germination tests at different temperatures (5°C, 15°C, 20°C) and different photoperiods (12/12 hours light-dark and continuous darkness) were carried out on seeds not treated with gibberellins without any germination, thus suggesting the presence of a physiological seed dormancy in this taxon.

The viability of the non-germinated seeds at the end of the tests was estimated through the cutting test.

V. Di Cecco, F. Tantalo & L. Di Martino

126. *Armeria sulcitana* Arrigoni (*Plumbaginaceae*)

Accession data:

Sa: Gonnosfanadiga (South - West Sardinia), Genn'e Spina (WGS84: 39.4454360°N, 8.6571890°E), granitic cliffs and rocky walls, 840 m a.s.l., 5 Jul 2021*, M. Porceddu & M. Sarigu* (BG-SAR PRIN 01/21, Sardinian Germplasm Bank).

Germination data

Pre-treatments: No treatment.
Germination medium: 1% agar.
Sample size: 60 seeds for each test (20 × 3 replicates).

Germination	Thermoperiod	Photoperiod [light/dark]	T_1 [d]	T_{50} [d]	T_{max} [d]	MTG [d]
86.1%	constant 10°C	12/12h	5.0	12.0	40.0	11.9
85.8%	constant 15°C	12/12h	5.0	8.0	26.0	9.7

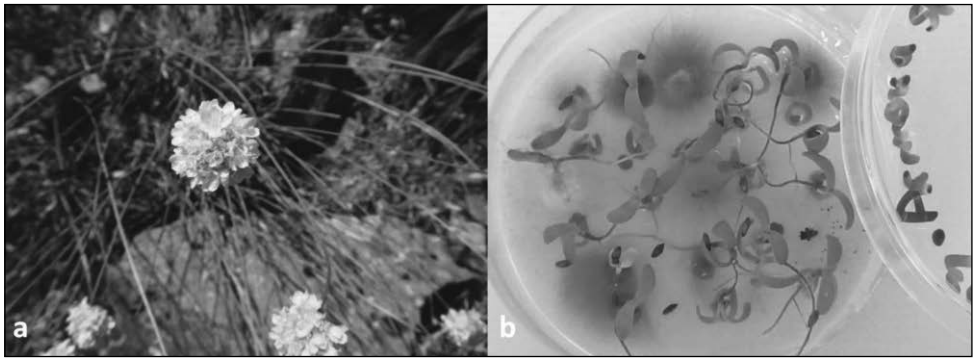


Fig. 3. a) Flowering specimen of *Armeria sulcitana*; b) Germinated seeds and seedlings of *A. sulcitana.*

Observations

Armeria sulcitana is endemic to Sardinia, and its distribution range is restricted to the Sulcis-Iglesiente biogeographic sector (Bacchetta & Pontecorvo, 2005). It is considered Least Concern (LC) both in Sardinia and in the Italian flora's red list (Rossi & al. 2020). This is the first complete germination report for this taxon. Seeds of *A. sulcitana* germinated with high percentages (>85%) at 10°C and 15°C, and reached 76.8% of germination at 20°C. The germination tests were carried out at the Sardinian Germplasm Bank (BG-SAR; Porceddu & al. 2017). The result reported in the SER's Seed Information Database indicates high germination capability at 20°C obtained in 33 days by testing 52 seeds with no replicates (SER, INSR, RBGK, Seed Information Database -SID-, 2023).

M. E. Boi, M. Porceddu & G. Bacchetta

127. *Iberis integerrima* Moris (*Brassicaceae*)

Accession data:

Sa: Iglesias (South - West Sardinia), Bacino San Giorgio (WGS84: 39.289583°N, 8.520027°E), garrigue, 134 m a.s.l., 5 Jul 2023, *M.E. Boi, L. Dessì & A. Lallai* (BG-SAR 11/23, Sardinian Germplasm Bank).

Germination data

Pre-treatments: No treatment.
Germination medium: 1% agar.
Sample size: 100 seeds for each test (25 × 4 replicates).

Germination	Thermoperiod	Photoperiod [light/dark]	T_1 [d]	T_{50} [d]	T_{max} [d]	MTG [d]
100%	constant 20°C	12/12h	3.0	3.1	7.0	4.4
99.0%	constant 15°C	12/12h	3.0	3.1	7.0	4.3

97.0%	alternating 20/10°C	12/12h	3.5	4.0	7.8	5.0
95.0%	constant 25°C	12/12h	3.0	6.3	26.5	10.0
93.0%	constant 10°C	12/12h	5.0	5.5	11.5	7.2

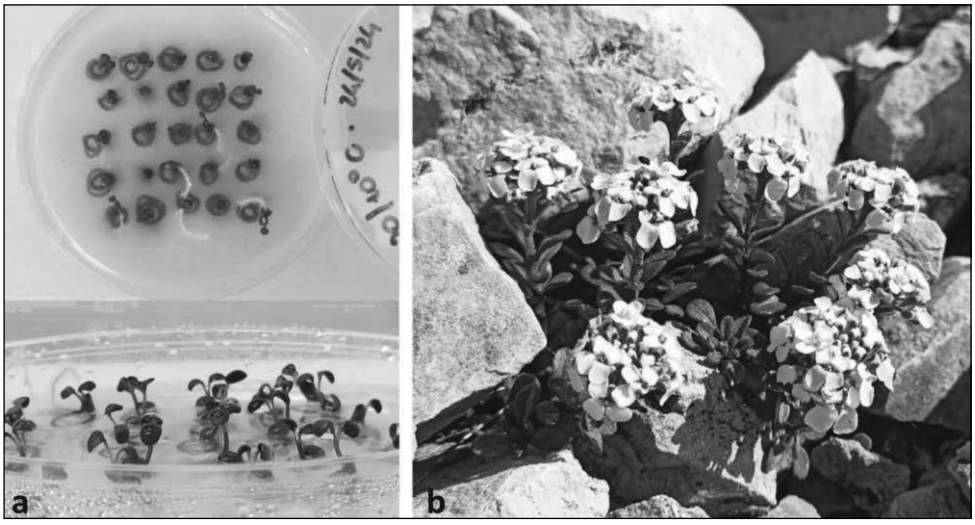


Fig. 4. a) Details of germination tests of *Iberis integerrima*; b) Flowering specimen of *I. integerrima.*

Observations

Iberis integerrima is an endemic calcicolous chamaephyte of Sardinia that occurs on carbonatic substrates also naturally enriched by metal(loid)s and on polluted mine wastes of abandoned mine sites (Angiolini & al. 2005; Fig. 1b). It is considered Near Threatened (NT) in the Italian flora's red list (Rossi & al. 2020) and of medium/high conservation priority at the regional scale (Bacchetta & al. 2012).

Results from germination tests showed that seeds of *I. integerrima* germinated with a high percentage close to 100% at all tested temperatures (10, 15, 20, 25 and 20/10°C). However, the germination capacity is reduced at 5°C and 30°C (17% and 71%, respectively). Radicle emergence started in the first three days from sowing, reaching the T_{50} in less than a week and finished approximately within 26 days. The germination tests were carried out at the Sardinian Germplasm Bank (BG-SAR; Porceddu & al. 2017). Previous studies carried out at 20°C on different seed lots stored under seed banks at - 25°C and 5°C for 12, 11, 9, 8 and 3 years showed germination percentages ranging from 64% to 92 % (Porceddu & al. 2022), results which are comparable to those obtained with fresh seeds tested for this report. Although germination data about other *Iberis* species are scarcely available, *I. violacea* W.T.Aiton (Carruggio & al. 2020) and *I. linifolia* L. (Pérez-García & al. 2006) show similar germination percentages.

M. E. Boi, M. Porceddu & G. Bacchetta

128. *Eokochia saxicola* (Guss.) Freitag & G. Kadereit (*Amaranthaceae*)

Accession data

It: Campania. Anacapri (NA) (WGS84: 40.56083° N, 14.21722° E), vertical sea cliffs, mainly on shady sites, within approx. 8-10 m a.s.l., 20 Oct 2022, *G. Fabrini* (2227 063s 1022 1222, Germplasm Bank, Sapienza University of Rome).

It: Campania. Anacapri (NA) (WGS84: 40.56083° N, 14.21722° E), vertical sea cliffs, mainly on shady sites, within approx. 8-10 m a.s.l., 14 Nov 2023, *G. Fabrini* (2260 063s 1022 0123, Germplasm Bank, Sapienza University of Rome).

Germination data

Pre-treatments: no treatments.
Germination medium: 3 sheets of sterilized filter paper (Whatmann No. 1), imbibed with 6 ml of sterilized distilled water.
Sample size: 80 seeds for each test (20 × 4 replicates).

Germination	Thermoperiod	Photoperiod [light/dark]	T_1 [d]	T_{50} [d]	T_{max} [d]	MTG [d]	N. accession
96.7%	alternating 20/10°C	12/12h	4.2	11.6	23.7	13.2	2260 063s 1022 0123
83.0%	alternating 15/6°C	12/12h	14.0	14.0	36.2	20.2	2227 063s 1022 1222

Observations

Eokochia saxicola is a perennial, suffruticose chamaephyte endemic to southern Italy, where it only grows on calcareous or volcanic sea cliffs between 5 to 90 m a.s.l. The species has an extremely fragmented range with stations in Campania (two on Capri and two in Cilento) and one in Sicily, on the rock of Strombolicchio in the Aeolian archipelago (Santangelo & al. 2012; Strumia & al. 2015). It blooms in the summer months between July and September and fruits in autumn. The species is reported as Endangered (EN) in the IUCN Red List of Threatened Species (Domina & Santangelo 2023). It is also listed as a priority species in the Annexes II and IV of the Habitat Directive 92/43 CEE, and in Annex I of the Bern Convention. It is protected under regional laws and partially included in Natura 2000 sites and is one of the target species of the LIFE SEEDFORCE project. The highest and fastest germination rate was observed at an alternating temperature of 20/10°C, with 96.7% of the seeds germinating under 12/12h photoperiod conditions. These results are based on germination tests conducted with seeds collected in November 2023. When a lower alternating temperature of 15/6°C was applied to seeds sampled in 2022, the germination rate decreased but remained relatively high, reaching 83%. Additionally, other tests were conducted with seeds collected in 2022 under various conditions: temperatures of 20/10°C, 15/6°C and 25/15°C in complete darkness (0/24h). However, none of these tests

achieved an 80% germination rate. The same was true for seeds tested at 20/10°C and 25/15°C with a 12/12h light/dark photoperiod.

G. Crocenzi, I. Panero & G. Fabrini

129. *Primula palinuri* Petagna (*Primulaceae*)

Accession data:

It: Campania. Centola (SA), Palinuro (WGS84: 40.0320833N, 15.2726389E), Jurassic limestones and dolostones, 20 m a.s.l., 15 July 2023, *Ilaria Panero* (2224 061s 0522 0722, Germplasm Bank, Sapienza University of Rome).

Germination data

Pre/treatments: No treatment.

Germination medium: Petri dishes with 3 sheets of sterilized filter paper (Whatmann No. 1), imbibed with 6 ml of sterilized distilled water.

Sample size: 100 seeds for each test (25 × 4 replicates).

Germination	Thermoperiod	Photoperiod [light/dark]	T_1 [d]	T_{50} [d]	T_{max} [d]	MTG [d]
99%	alternating 15/6°C	12/12h	10	12.24	16	12.8
94%	alternating 20/10°C	12/12h	9.75	15.09	30.5	16.48
93%	constant 10°C	12/12h	12	15.21	18	15.9
81%	constant 15°C	12/12h	9	9.98	13.25	11.0

Observations

Primula palinuri Petagna is an endemic plant species that is listed as Endangered (EN) in the IUCN Red List of Threatened Species (Gangale & al. 2011). It is a suffruticose, perennial, summer deciduous, hexaploid plant, endowed with a sturdy rhizome topped by a dense rosette of fleshy, leathery but not rigid leaves, with a cartilaginous toothed margin, closely adhering to the rocks (Barbi 2008). It is unique for its Mediterranean ecology, only found on north-facing sea cliffs along the southern Tyrrhenian coasts of Italy (Aronne & al. 2018). *P. palinuri* matures its capsules from the end of June to the end of July. By August, some of these capsules show initial cracks at the apex and begin to dehisce and disperse seeds in October (Silvestro & al. 2020). Germination tests were carried out 1 month after seed harvesting, using constant temperatures of 10°C and 15°C, and alternate temperatures of 15/6°C and 20/10°C with a 12/12 h light/dark photoperiod.

The results obtained indicate that *P. palinuri* seeds germinate more effectively at lower temperatures, with reduced germination rates (>80%) observed at higher temperatures

(25°C and 25/15°C). The optimal temperature for germination was found to be 15/6°C, achieving a germination rate of 99%.

I. Panero, G. Crocenzi & G. Fabrini

130. *Lythrum tribracteatum* Salzm. ex Spreng (*Lythraceae*)

Accession data

It: Lazio. Ladispoli (RM), Palo Laziale (WGS84: 41.93755N, 12.09591E), small Mediterranean temporary ponds which are present only in winter or late spring, 3 m a.s.l, Jul 2021, *D. La Montagna* (2212 062s 0721 010 21, Germplasm Bank, Sapienza University of Rome).

Germination data

Pre-treatments: no treatments.
Germination medium: 3 sheets of sterilized filter paper (Whatmann No. 1), imbibed with 6 ml of sterilized distilled water.
Sample size: 100 seeds for each test (25 × 4 replicates).

Germination	Thermoperiod	Photoperiod [light/dark]	T_1 [d]	T_{50} [d]	T_{max} [d]	MTG [d]
81%	alternating 25/15°C	12/12h	4.0	5.7	12.5	7.2

Observations

Lythrum tribracteatum is an erect, branching, annual herb, which habitually prefers mudlees, ditches or temporary ephemeral ponds. It grows 6–30 cm high and it has an erect or prostrate, branched, opposite, quadrangular stem, usually reddish and papillose. The leaves are alternate and range from linear to oblong-elliptical. The flowers are homostylous, solitary, and axillary while the fruits are cylindrical capsules and usually match the length of the floral tube when mature. The seeds are about 0.5-1.0 mm long, obovoid to rhomboid (Tavilla & al. 2023). According to Valdés (2012), *L. tribracteatum* occurs in the Mediterranean basin and east to central Asia. It is one of the species characterizing the *Lythrion tribracteati* alliance which belongs to the plant communities of the *Isoëto–Nanojuncetea* class in the western Mediterranean regions (Brullo & al. 2022). The *Lythrion tribracteati* is included in the priority habitat of Mediterranean temporary ponds (3170*) as per the Annex I of the Habitat Directive 92/43 CEE. The species is also listed in the Italian Red List of threatened plants (Rossi & al. 2020) under the Least Concern (LC) IUCN category.

Seeds tested at a temperature of 25/15 °C with a 12/12h light/dark photoperiod showed the highest germination percentage (81%), while the number of germinated seeds decreased below 80% with temperatures of 20/10 °C and 15/6 °C under 12/12h light/dark photoperiod. At the same temperatures under continuous darkness no germination was recorded, thus revealing a positive photoblastic response of *L. tribracteatum* seeds.

G. Crocenzi, G. Fabrini, D. La Montagna & I. Panero

131. *Hyoseris lucida* L. subsp. ***taurina*** (Pamp.) Peruzzi & Vangelisti (*Asteraceae*)

Accession data

Si: Lipari (Messina), Lisca Bianca – Panarea (WGS84: 38.639058° N, 15.114147° E), coastal scrub on sandy soil and rocky outcrops, 7 m a.s.l., 12 May 2023, *A. Cristaudo & A.I. Di Paola* (SiMaSeedPLUS/CT/23/05, BGS-CT).

Germination data

Pre-treatments: five months of dry after-ripening at 22 ± 2°C and 50% RH.
Germination medium: 1% agar on 9 cm Petri dishes.
Sample size: 100 seeds (25 × 4 replicates) for "intermediate" cypselas, 60 seeds (15 × 4 replicates) for both the "central" and "peripheral" cypselas.

CENTRAL CYPSELAS:

Germination	Thermoperiod	Photoperiod [light/dark]	T_1 [d]	T_{50} [d]	T_{max} [d]	MTG [d]
100%	constant 25°C	12/12 h	2.0	1.6	7.0	2.2
100%	alternating 20/10°C	12/12 h	3.0	3.4	5.0	3.9
100%	alternating 25/15°C	12/12 h	2.0	1.9	7.0	2.4
100%	alternating 35/25°C	12/12 h	2.0	1.7	7.0	2.4
100%	alternating 35/25°C	0/24 h	-	-	-	-
98%	constant 30°C	12/12 h	2.0	1.6	7.0	2.2
98%	constant 35°C	12/12 h	2.0	3.8	10.0	4.8
98%	alternating 15/5°C	12/12 h	7.0	6.5	7.0	7.0
98%	alternating 30/20°C	12/12 h	2.0	1.5	7.0	2.1
98%	alternating 20/10°C	0/24 h	-	-	-	-
98%	alternating 25/15°C	0/24 h	-	-	-	-
98%	alternating 30/20°C	0/24 h	-	-	-	-
97%	constant 5°C	12/12 h	10.0	13.3	18.0	13.2
97%	constant 15°C	12/12 h	3.0	4.3	5.0	4.6
96%	constant 20°C	12/12 h	2.0	1.9	5.0	2.5
96%	constant 15°C	0/24 h	-	-	-	-
96%	constant 20°C	0/24 h	-	-	-	-
95%	constant 10°C	12/12 h	5.0	4.7	6.0	5.2

95%	constant 25°C	0/24 h	-	-	-	-
95%	alternating 15/5°C	0/24 h	-	-	-	-
93%	constant 10°C	0/24 h	-	-	-	-
93%	constant 30°C	0/24 h	-	-	-	-

INTERMEDIATE CYPSELAS:

Germination	Thermoperiod	Photoperiod [light/dark]	T_1 [d]	T_{50} [d]	T_{max} [d]	MTG [d]
100%	alternating 30/20°C	0/24 h	-	-	-	-
98%	alternating 30/20°C	12/12 h	1.0	1.7	5.0	2.5
98%	constant 20°C	0/24 h	-	-	-	-
98%	constant 25°C	0/24 h	-	-	-	-
97%	alternating 15/5°C	12/12 h	5.0	5.5	15.0	6.2
96%	constant 25°C	12/12 h	1.0	1.6	5.0	2.3
96%	constant 30°C	12/12 h	1.0	1.7	7.0	2.5
96%	alternating 20/10°C	12/12 h	3.0	3.9	5.0	4.4
96%	alternating 20/10°C	0/24 h	-	-	-	-
95%	alternating 25/15°C	12/12 h	2.0	3.2	14.0	3.6
95%	alternating 35/25°C	12/12 h	2.0	2.0	4.0	2.6
95%	constant 15°C	0/24 h	-	-	-	-
94%	constant 10°C	12/12 h	5.0	5.0	12.0	5.6
94%	constant 35°C	12/12 h	3.0	5.7	16.0	6.2
94%	constant 10°C	0/24 h	-	-	-	-
94%	alternating 15/5°C	0/24 h	-	-	-	-
94%	alternating 25/15°C	0/24 h	-	-	-	-
93%	constant 20°C	12/12 h	2.0	2.4	5.0	3.0
91%	constant 15°C	12/12 h	4.0	4.4	7.0	4.8
89%	constant 30°C	0/24 h	-	-	-	-
88%	constant 5°C	12/12 h	12.0	12.0	26.0	12.8
86%	alternating 35/25°C	0/24 h	--	-	-	-

PERIPHERAL CYPSELAS:

Germination	Thermoperiod	Photoperiod [light/dark]	T_1 [d]	T_{50} [d]	T_{max} [d]	MTG [d]
98%	constant 15°C	12/12 h	3.0	4.3	12.0	5.2
97%	alternating 20/10°C	12/12 h	3.0	4.6	13.0	5.4
91%	constant 10°C	12/12 h	5.0	7.1	13.0	8.1
91%	alternating 25/15°C	12/12 h	2.0	3.8	6.0	4.2
90%	constant 25°C	12/12 h	2.0	2.9	10.0	4.2
83%	constant 20°C	12/12 h	3.0	3.8	9.0	4.5
82%	alternating 30/20°C	12/12 h	3.0	3.3	14.0	4.6
80%	constant 15°C	0/24 h	-	-	-	-

Observations

Hyoseris lucida subsp. *taurina* is a perennial herb characterized by a woody stock, robust roots and fleshy, glabrous, leaves. It flowers from March to November and has a W Mediterranean-S Tyrrhenian distribution. It grows on rocky, siliceous cliffs, subject to marine spray and with a prevalent northern exposure (Brullo & al. 1997).

The seed accession was collected on Lisca Bianca, an islet off the coasts of Panarea (Aeolian Islands, Italy) which is part of a regional integral nature reserve (RNI "Isola di Panarea e Scogli Viciniori") and of the ZSC ITA030025 "Isola di Panarea e scogli Viciniori".

As common among the *Asteraceae* (Fenesi & al. 2019) and already reported for this taxon by Brullo & al. (1997), *H. lucida* subsp. *taurina* brings heteromorphic diaspores which differ in their shape, position, function and germination capacity. In particular, three kinds of diaspores have been identified in the capitula: narrow, unwinged cypselas, positioned at the centre (referred to as "central cypselas"); winged cypselas in an intermediate position (referred to as "intermediate cypselas"); winged cypselas positioned at the border and equipped with a less developed pappus than the first two categories (referred to as "peripheral cypselas").

Seeds were tested at seven constant (5, 10, 15, 20, 25, 30, 35 °C) and five alternating temperature conditions (15/5, 20/10, 25/15, 30/20, and 35/25°C), both in light/dark (12/12 h photoperiod) and full darkness (0/24 h), after five months of drying after ripening.

Central and intermediate cypselas reached high germination percentages at almost all the temperatures tested, both in light and in darkness. Peripheral cypselas have a greater proportion of empty or not fully developed seeds. High germination percentages were obtained, in the presence of light, at 10, 15, 20, 25, 20/10, 25/15 and 30/20 °C but not at the lower and higher temperatures tested (5, 30, 35, 15/5 and 35/25 °C), indicating a narrower thermal range if compared with the other two categories. Peripheral cypselas in dark condition germinated only at 15°C. Here we present the first germination data for this taxon.

A.I. Di Paola, C. Blandino, G. Emma, M. Di Stefano & A. Cristaudo

132. *Lotus cytisoides* L. (*Fabaceae*)

Accession data:

Si: Lipari (Messina), Lisca Bianca – Panarea (WGS84: 38.639058° N, 15.114147° E), coastal scrub on sandy soil and rocky outcrops, 7 m a.s.l., 27 Jun 2023, *A. Cristaudo & A.I. Di Paola* (SiMaSeedPLUS/CT/23/12, BGS-CT).

Germination data

Pre-treatments: four months of drying after ripening at 22 ± 2°C and 50% RH; scarification with a scalpel.

Germination medium 1% agar in 9 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 30°C	12/12 h	1.0	2.5	10.0	3.1
100%	alternating 25/15°C	12/12 h	3.0	2.5	4.0	3.0
100%	alternating 25/15°C	0/24 h	-	-	-	-
100%	alternating 30/20°C	0/24 h	-	-	-	-
99%	constant 25°C	12/12 h	1.0	2.5	4.0	2.8
99%	alternating 15/5°C	12/12 h	3.0	2.8	8.0	3.6
99%	alternating 20/10°C	12/12 h	3.0	2.6	8.0	3.4
99%	alternating 30/20°C	12/12 h	3.0	2.5	4.0	3.0
99%	constant 20°C	0/24 h	-	-	-	-
99%	alternating 15/5°C	0/24 h	-	-	-	-
98%	constant 5°C	12/12 h	8.0	8.0	29.0	9.9
98%	constant 10°C	12/12 h	3.0	3.4	15.0	4.7
98%	constant 15°C	12/12 h	2.0	2.5	5.0	3.1
98%	constant 20°C	12/12 h	1.0	1.5	3.0	2.0
98%	constant 15°C	0/24 h	-	-	-	-
98%	constant 30°C	0/24 h	-	-	-	-
98%	alternating 20/10°C	0/24 h	-	-	-	-

Observations

Lotus cytisoides L. is an herbaceous perennial plant. The centre of its distribution area is the Mediterranean Basin, where it occurs in the Balearic Islands, Corse, Crete, France, Greece, Spain, Italy, ex-Yugoslavia, Sardinia, Sicily and Malta. It grows on coastal environments, on sandy dunes or rocky cliffs, preferring undeveloped soils, sandy or rocky and poor in nutrients, at altitudes between 0 and 100 m a.s.l. Its yellow flowers appear from April to June. The tested seed accession was collected on Lisca Bianca, an islet off the coasts of Panarea (Aeolian Islands, Italy).

The seeds have an impermeable seed coat, which imposes a physical dormancy. Therefore, it was necessary to scarify the seeds with a scalpel, making a small incision in the distal portion of the seed, away from the hilum to avoid damaging the radicle. Scarified seeds were immediately transferred to the germination substrate to prevent the drying of the exposed embryo. Seeds were tested at six constant (5, 10, 15, 20, 25, 30 °C) and four alternating temperature conditions (15/5, 20/10, 25/15 and 30/20°C), both in light/dark (12/12 h) photoperiod and continuous darkness (0/24 h), after four months of drying after ripening. High germination percentages (>95%) were obtained at all the tested conditions, without significant differences between constant and alternating temperatures and the light presence or absence.

A.I. Di Paola, C. Blandino, G. Emma, M. Di Stefano & A. Cristaudo

133. *Senecio leucanthemifolius* Poir**.** (*Asteraceae*)

Accession data:

Si: Lipari (Messina), Lisca Bianca – Panarea (WGS84: 38.639058° N, 15.114147° E), coastal scrub on sandy soil, 7 m a.s.l., 12 May 2023, *A. Cristaudo & A.I. Di Paola* (SiMaSeedPLUS/CT/23/02, BGS-CT).

Germination data

Pre-treatments: six months of drying after-ripening at 22 ± 2°C and 50% 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]
97%	constant 15°C	12/12 h	2.0	4.6	14.0	5.5
95%	alternating 25/15°C	12/12 h	4.0	4.6	19.0	5.5
88%	alternating 30/20°C	12/12 h	4.0	4.5	27.0	5.5
86%	constant 10°C	12/12 h	5.0	6.6	23.0	7.9

Observations

Senecio leucanthemifolius Poir. is an annual species of the *Asteraceae* family. It is native to the Mediterranean Basin, where it grows on poorly developed soils, flowering from December to April. The seeds were collected on Lisca Bianca, an islet off the coasts of Panarea (Aeolian Islands, Italy). Seeds were tested at six constant (5, 10, 15, 20, 25, 30 °C) and four alternating temperature conditions (15/5, 20/10, 25/15 and 30/20°C), both in light/dark (12/12 h) photoperiod and full darkness (0/24 h), after six months of drying after ripening. The highest germination rates (≥85%) were observed at constant temperatures ranging from 10 to 20 °C and at alternating temperatures ranging from 20/10 to 30/20 °C, only under light exposure. Some germination occurred also in continuous darkness, but the final percentage never reached 80%. This is the first germination protocol developed for this species.

A.I. Di Paola, C. Blandino, G. Emma, M. Di Stefano & A. Cristaudo

134. *Silene neglecta* Ten**.** (*Caryophyllaceaee*)

Accession data:

Si: Lipari (Messina), Lisca Bianca – Panarea (WGS84: 38.639058° N, 15.114147° E), coastal scrub on sandy soil, 7 m a.s.l., 12 May 2023, *A. Cristaudo & A.I. Di Paola* (SiMaSeedPLUS/CT/23/21, BGS-CT).

Germination data

Pre-treatments: five months of drying after-ripening at 22 ± 2°C and 50% RH.
Germination medium: 3 sheets of filter paper (Whatmann No. 1), imbibed with 6 ml of distilled water in 9 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%	alternating 15/5°C	12/12 h	5.0	5.5	10.0	6.2
91%	alternating 20/10°C	12/12 h	2.0	2.6	12.0	3.4
93%	alternating 25/15°C	12/12 h	2.0	2.6	14.0	3.8
86%	alternating 30/20°C	12/12 h	2.0	2.6	22.0	4.4

Observations

Silene neglecta Ten. is an herbaceous annual species. Its distribution area extends from north-eastern Spain to the Mediterranean, with records for central and southern Italy, southwestern Sardinia, Sicily, northern Algeria and Tunisia (Sáez & al. 2022). It grows on siliceous rocky substrates or coastal sands, at altitudes from 0 to 600 m a.s.l., flowering from March to May. *S. neglecta* has been often confused with *S. nocturna*, until its status as a valid species has been recently clarified by Sáez & al. (2022).

The seed accession was collected on volcanic sands and poorly developed soils on the islet of Lisca Bianca (Aeolian Islands, Italy). Seeds were tested at six constant (5, 10, 15, 20, 25, 30 °C) and four alternating temperature conditions (15/5, 20/10, 25/15 and 30/20°C), both in light/dark (12/12h) photoperiod and darkness (0/24h), after five months of drying after ripening. The highest final germination percentage was scored at the four alternating temperature regimes with 12/12h photoperiod, suggesting a response to those environmental cues indicating seed proximity to the soil surface.

A.I. Di Paola, C. Blandino, G. Emma, M. Di Stefano & A. Cristaudo

135. *Linaria pseudolaxiflora* Lojac. (*Plantaginaceae*)

Accession data:

Ma: Gozo (Malta), Ras il-Wardija promontory (WGS84: 36.0366° N; 14.186747° E), limestone lithosoil, 129 m a.s.l., 28 Apr 2023, *S. Cambria* (SEEDFORCE/CT/23/05, BGS-CT).

Germination data

Pre-treatments: five months of dry after-ripening at 22 ± 2°C and 50% RH.
Germination medium: 1% agar in 6 cm Petri dishes, with the addition of 0, 100, 250 and 500 mg/L GA_3.
Sample size: 100 seeds (25 × 4 replicates).

Germination	Thermoperiod	GA_3 [mg/L]	Photoperiod [light/dark]	T_1 [d]	T_{50} [d]	T_{max} [d]	MTG [d]
100%	alternating 20/10°C	0	12/12 h	9.0	9.5	10.0	10.0
100%	alternating 25/15°C	0	12/12 h	3.0	3.4	10.0	4.1
100%	alternating 25/15°C	500	12/12 h	6.0	6.1	17.0	7.1
99%	constant 20°C	500	12/12 h	6.0	9.2	32.0	9.2
99%	alternating 25/15°C	100	12/12 h	6.0	6.1	10.0	6.9
99%	alternating 25/15°C	250	12/12 h	6.0	6.3	12.0	7.0
97%	constant 20°C	100	12/12 h	6.0	9.5	49.0	10.7
97%	constant 20°C	250	12/12 h	6.0	8.0	32.0	8.8
90%	alternating 30/20°C	0	12/12 h	6.0	6.6	27.0	8.5

Observations

Linaria pseudolaxiflora Lojac. is an annual species, endemic to the Maltese Islands and to the island of Linosa (Italy). It grows on shallow and well-drained lithosols or

rocky outcrops, on both volcanic (Linosa) and limestone (Maltese Islands) substrates. *L. pseudolaxiflora* is a species listed in Annex II of the 92/43/CEE Directive "Habitat" and its global IUCN status is Vulnerable (Mifsud & al. 2019). It flowers from the end of February to the beginning of April, setting fruits in March-April. The seeds were tested, after five months of drying after-ripening, at three constant temperatures (15, 20 and 25 °C) and at the corresponding three alternating ones (20/10, 25/15, 30/20 °C). The effect of gibberellic acid was tested only at 20 and 25/15 °C, adding 100, 250 and 500 mg/L of GA_3 to the growing media. Each temperature was tested with a 12/12 h light/dark photoperiod. In the alternating temperature, the exposure to light coincided with the warmer phase. Without GA_3, high final germination percentages were obtained only at the alternating temperatures, reaching 100% at 20/10°C and 25/15 °C. In the gibberellic acid treatments, all the tested conditions reached a final germination percentage >80%, demonstrating that GA_3, at 20°C, equalized the requirement of alternating temperatures.

A.I. Di Paola, C. Blandino, G. Emma, M. Di Stefano & A. Cristaudo

136. *Gadoria falukei* Güemes & Mota (*Plantaginaceae*)

Accession data

Hs: Botanical Garden of the University of Valencia, environmental conditions, 20 Aug 2018, J. Pons-López (UVEG-JBVAL-BG-264B2018). *Ex-situ* collection from Almería. Dalías, Sierra de Gádor, barranco Bernal (WGS84: 36.826103ºN, 2.723992ºW), limestone walls with marine fossils (bivalves), orientation S, cattle refuge area, 580 m a.s.l., 12 Jun 2012, *J. Güemes & J. Mota* (UVEG-JBVAL-BG-141B2012, Germplasm Bank of the University of Valencia).

Germination data

Pre-treatments: no pre-treatment.

Germination medium: sterile 0.6% agar, following the protocols of the Germplasm Bank of the University of Valencia.

Sample size: 100 seeds for each test (25 × 4 replicates).

Germination	Thermoperiod	Photoperiod [light/dark]	T_1 [d]	T_{50} [d]	T_{max} [d]	MTG [d]
96%	Constant 15ºC	12/12h	12.8	13.3	30	15.0
95%	Constant 20ºC	12/12h	8.0	8.6	17	10.0
89%	Constant 10ºC	12/12h	22.5	24.4	32	25.5
88%	Constant 25ºC	12/12h	14.3	16.0	32	17.4
83%	Constant 20ºC	0/24h	14.3	15.4	32	18.6

Observations

Gadoria falukei Güemes & Mota is a Critically Endangered narrow endemic species of a monotypic genus discovered in 2012, which occurs with a single population in Sierra de Gador, Almería (Spain). It is a perennial suffrutescent species growing on south-facing almost vertical and overhanging limestone walls with marine fossils (bivalves), in a cattle refuge area at 580 m a.s.l. (Güemes & Mota 2017). The population, with less than 80 individuals, is divided into three subpopulations and most of the plants are unreachable. This study was conducted on seeds collected from the *ex-situ* collection at the Botanical Garden of the University of Valencia during summer 2018. This is the first seed germination report for the species.

Seed germination under eight different conditions (10ºC, 15ºC, 20ºC and 25ºC with 12/12h and 0/24h light/dark photoperiod) was tested, resulting in highly influenced by the photoperiod regime. All the temperatures tested provided germination percentages above 88% when seeds were incubated at 12/12h light/dark photoperiod. Those incubated at 15ºC presented the highest germination percentage (96%) and those incubated at 25ºC presented the lowest results (88%). Even if the germination percentages at 15 ºC and 20ºC under light conditions were basically the same, the germination at 15ºC was delayed by at least 5 days at all tested parameters. The photoperiod had a strong effect on seeds incubated at 10ºC and 25ºC, as when full darkness was applied seed germination significantly decreased by up to 7% and 20%, respectively. Seeds incubated at 15ºC obtained 71% of germination.

The high autogamy of the species and the high fruit and seed production, combined with the high germination percentages observed in the 12/12h photoperiod, increase the probability of plant establishment in its rupicolous habitat. These characteristics raise the chances of species survivorship, especially in crevices fairly exposed to sunlight, which represent the best sites for future reinforcements.

A. Nebot & J. Güemes

137. *Coris monspeliensis* L. (*Primulaceae*)

Accession data:

Hs: Valencia, Vilamarxant, La Pea (WGS84: 39.595964ºN, -0.682458ºW), 200 m a.s.l., 20 Sept 2007, *F. Marco* (UVEG-JBVAL-BG 189B2007, Germplasm Bank of the University of Valencia).

Germination data

Pre-treatments: 1000 ppm Gibberellic acid (GA_3) for 24h.
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]	MGT [d]
99.0%	constant 20°C	12/12h	4.0	4.8	9.8	5.6

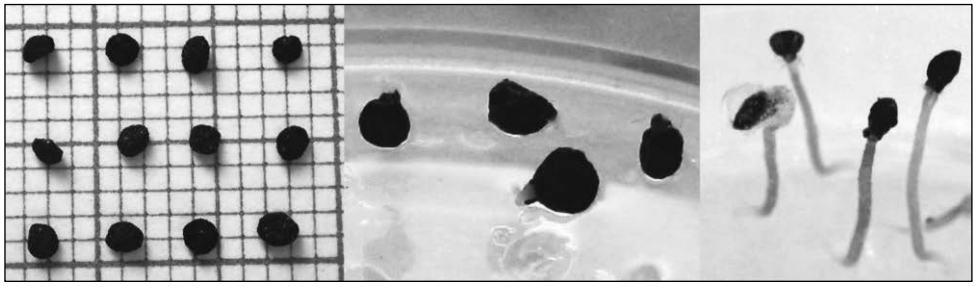


Fig. 5. Seeds and seedlings of *Coris monspeliensis*.

Observations

This perennial plant has small but attractive violet flowers all grouped in a terminal cluster. It is part of the heliophile chamaephyte communities and shrublands characteristic of the Mediterranean region and is distributed throughout South Europe, North Africa and the Balearic Islands. In the Valencian Community, it can be found dispersed throughout almost the entire territory. It is a plant with great ornamental potential.

The seeds of this species exhibit physiological dormancy; therefore, a prior imbibition in gibberellic acid (GA_3) for 24 hours is required to achieve high germination percentages. Only 11% germination has been observed in the control group.

M.C. Escribá, E. Estrelles & J. Prieto-Mossi

138. *Limonium dufourii* (Girard) Kuntze (*Plumbaginaceae*)

Accession data:

Hs: Valencia, València, el Saler, la Devesa (WGS84: 39.342777ºN, -0.318834ºW), 0.5 m a.s.l., 22 Aug 2009, *A. Navarro* (UVEG-JBVAL-BG 86B2009, Germplasm Bank of the University of Valencia).

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]	MGT [d]
98.0%	constant 20°C	12/12h	2.0	1.7	4.5	2.4

Observations

This perennial species is a narrow endemism from the Valencian Community (Castellón and Valencia provinces), with small and disjointed populations considered endangered. All

populations grow in littoral areas, mainly in salt marshes or on cliffs exposed to the sea spray. The main threat is the intensive urban growth and the over-tourism in coastal territories. Moreover, it hybridizes with other *Limonium* species cohabiting in the same plant communities. To support plant production for conservation programs, it is essential to collect seeds from individuals as pure as possible to preserve the target species. The dense pubescence and the compact arranged spikelets are its main differential characters.

The seeds of this species are non-dormant and, therefore, do not require any pre-treatment. They achieve high germination percentages and exhibit a rapid response under the single condition tested. Another study observed the germination response of this species at a temperature regime of 30/20°C and a photoperiod of 18/6 hours (González-Orenga & al. 2019). The germination percentage was also high, though the germination rate was slower (MGT = 5.3 days).

M.C. Escribá, E. Estrelles & J. Prieto-Mossi

139. *Limonium furfuraceum* (Lag.) Kuntze (*Plumbaginaceae*)

Accession data:

Hs: Alicante, Elx, Clot de Galvany (WGS84: 38.250157ºN, -0.531724ºW), 4 m a.s.l., 24 Oct 2011, *P. Soriano, M. Boscaiu & E. Estrelles* (UVEG-JBVAL-BG 95B2011, Germplasm Bank of the University of Valencia).

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]	MGT [d]
100.0%	constant 30°C	12/12h	1.3	1.6	2.7	2.0
97.6%	constant 22.5°C	12/12h	1.7	2.1	6.7	3.1
81.0%	constant 15°C	12/12h	2.0	3.5	8.3	4.6

Observations

This perennial *Limonium* is a dense hairy plant with a very characteristic and apparent inflorescence, which provides it with high ornamental potential. It is a narrow endemic species distributed only in the Alicante province (Valencian Community), that grows in thermo-Mediterranean semi-arid environments on saline or gypsum soils. Its populations have a high number of individuals and, therefore, it is not on the current list of threatened plants. However, conservation protocols are being developed due to its local nature. As in the other *Limonium* species studied, high germination percent-

ages are achieved under the investigated conditions. Seeds of this species are non-dormant, therefore, no pretreatment is required. In this study, the response across a range of temperatures was examined, revealing that both germination percentage and rate decrease at lower temperatures.

M.C. Escribá, E. Estrelles & J. Prieto-Mossi

140. *Limonium lobatum* (L. fil.) Chaz. (*Plumbaginaceae*)

Accession data:

Hs: Alicante, Santa Pola, Ermita del: 38.227325ºN, -0.510777ºW), 2 m a.s.l., 08 May 2009, *C. Obón* (UVEG-JBVAL-BG 10B2009, Germplasm Bank of the University of Valencia).

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]	MGT [d]
96.9%	constant 20°C	12/12h	1.0	0.7	7.0	2.0

Observations

This species is characterized by markedly lobed leaves, bluish-white flowers and its annual nature. It is a plant that grows on dry and stony soils, mostly in coastal communities, but there are some populations in inland areas. Its populations are distributed in the Mediterranean basin, mainly in the southern regions; from the southeast of the Iberian Peninsula and northern Africa to the Irano-Turanian region. In the Valencian Community, it is a very rare plant located in semi-arid areas, with a single nucleus in the south of the Alicante province, that shows a great interannual fluctuation in the number of individuals. It is a plant considered endangered in this region.

Its annual character implies that its survival depends on the germination capacity of its seeds. Thus, it is essential to increase the knowledge of the seed behaviour requirements, as well as the longevity of these seeds in the soil. The limiting factor is the low availability of seeds to develop such studies reliably.

As in the other *Limonium* species studied, high germination percentages were achieved under the tested conditions. The seeds of this species are non-dormant, so no pretreatment is required.

M.C. Escribá, E. Estrelles & J. Prieto-Mossi

141. *Limonium perplexum* L. Sáez & Rosselló (*Plumbaginaceae*)

Accession data:

Hs: Castellón, Peñíscola, microrreserva Torre Badum (WGS84: 40.316134ºN, 0.358344ºE), 8 m a.s.l., 9 Nov 2015, *E. Estrelles, A.M. Ibars & P. Pérez-Rovira* (UVEG-JBVAL-BG 61B2015, Germplasm Bank of the University of Valencia).

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]	MGT [d]
96.3%	constant 30°C	12/12h	1.0	0.7	4.3	1.5
94.7%	constant 22.5°C	12/12h	1.0	0.9	4.3	1.7
87.7%	constant 15°C	12/12h	1.7	1.6	3.3	2.2

Observations

This is a plant that can be annual or perennial depending on the environment where it grows. It is a small plant, with branchy inflorescences, which attract attention. It is endemic to the Valencian coast, included in the catalogue of threatened plants within the endangered category. Its populations normally grow on ledges of coastal cliffs in scarce locations of the province of Castellón, and consist of few individuals, although strong interannual fluctuations are observed in the censuses. Relevant conservation work has been carried out on its natural populations (Laguna & al. 2016).

No dormancy was observed in the seeds of this species, similarly to the other *Limonium* species studied in this work. Germination was both high and rapid, improving with increasing temperature.

M.C. Escribá, E. Estrelles & J. Prieto-Mossi

142. *Limonium supinum* (Girard) Pignatti (*Plumbaginaceae*)

Accession data:

Hs: Alicante, Villena, Microrreserva de Flora "Cabecicos de Villena" (WGS84: 38.643980ºN, -0.892783ºW), 540 m a.s.l., 16 Nov 2016, *A.M. Ibars, E. Estrelles, J. Prieto & P. Soriano* (UVEG-JBVAL-BG 147B2016, Germplasm Bank of the University of Valencia).

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]	MGT [d]
100.0%	constant 30°C	12/12h	1.0	0.5	1.3	1.0
100.0%	constant 22.5°C	12/12h	1.0	0.5	1.3	1.0
94.7%	constant 15°C	12/12h	1.0	1.5	3.0	2.0

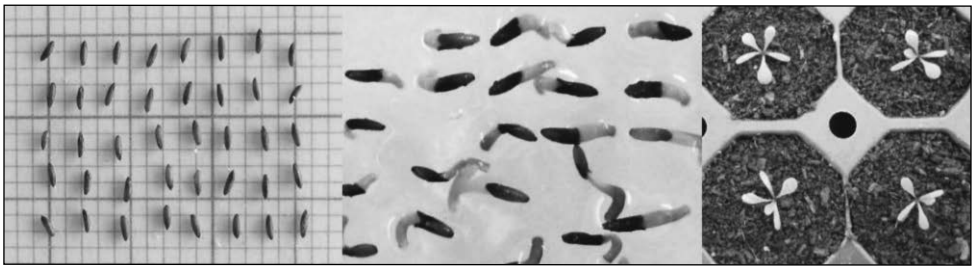


Fig. 6. Seeds and seedlings of *Limonium supinum*.

Observations

This perennial plant, practically glabrous with violaceous flowers, is endemic to the centre and southeast of the Iberian Peninsula. Principal populations are found in inland halophilic environments. In the Valencian Community, it is a very rare plant, and thus it is included in the collecting objectives for its *ex-situ* conservation in the germplasm bank.

The observed germination response is consistent with the data obtained for other species of the genus studied. The seeds are non-dormant and exhibit a similar response to that observed for the *Limonium* group, with faster germination percentages and rates as the temperature increases

M.C. Escribá, E. Estrelles & J. Prieto-Mossi

143. *Nigella nigellastrum* (L.) Willk. (*Ranunculaceae*)

Accession data:

Hs: Valencia, Pedralba, prope Barranco Seco (WGS84: 39.590953ºN, -0.736854ºW), 180 m a.s.l., 22 Jun 2009, *A. Navarro* (UVEG-JBVAL-BG 124B2009, Germplasm Bank of the University of Valencia).

Germination data
Pre-treatments: disinfection with a 10% sodium hypochlorite water solution for 10 minutes followed by 3-4 rinses in sterile distilled water and imbibition in sterile distilled water for 24 h.
Germination medium: FP. Whatman Filter Papers N.2 (Filter Lab 516/G), soaked to saturation in distilled water.
Sample size: 100 seeds (25 × 4 replicates).

Germination	Thermoperiod	Photoperiod [light/dark]	T_1 [d]	T_{50} [d]	T_{max} [d]	MGT [d]
94.0%	constant 4°C	0/24h	20	8.0	25.0	9.5

Observations

This annual herb has small bluish-white stellate flowers, with bifid petals showing a characteristic nectary structure. It grows in dryland tree crops, wastelands, dry grasslands and margins of crop-fields at low altitudes. It is distributed in the western and eastern regions of the Mediterranean basin, especially in the northern territories, as well as in the west of the Irano-Turanian region. In the Valencian Community, it is a rare plant, found only in a few localities of the Valencia province. Therefore, it is included in the regional list of protected species.

We have selected the used germination conditions based on the findings of Torra & al. (2015) on closely related species within the *Ranunculaceae* family, including *Delphinium*, *Consolida*, and *Nigella*. Their research identified darkness and low temperatures as optimal conditions for the seed germination of the studied taxa. Given the ecological similarity of *N. nigellastrum* to these species, we hypothesized that its germinative response would follow a similar pattern. The germination tests conducted under light conditions (12/12 h) yielded significantly low results (>12%), strongly suggesting that the seeds exhibit photoinhibition. However, further studies are required to definitively confirm the negative photoblastic seed behaviour of this plant, particularly under different temperature regimes.

M.C. Escribá, E. Estrelles & J. Prieto-Mossi

144. *Parentucellia viscosa* (L.) Caruel (*Orobanchaceae*)

Accession data:
Hs: Alicante, Xàbia, Els Planets (WGS84: 38.782277º N 0.138994º E), 30 m a.s.l., 11 June 2009, *A. Navarro* (UVEG-JBVAL-BG 93B2009, Germplasm Bank of the University of Valencia).

Germination data
Pre-treatments: disinfection with commercial H_2O_2 solution for 10 minutes followed by 3-4 rinses in sterile distilled water and imbibition in sterile distilled water for 24 h.
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]	MGT [d]
98.2%	20/10°C	12/12h	9.8	14.2	23.3	14.9

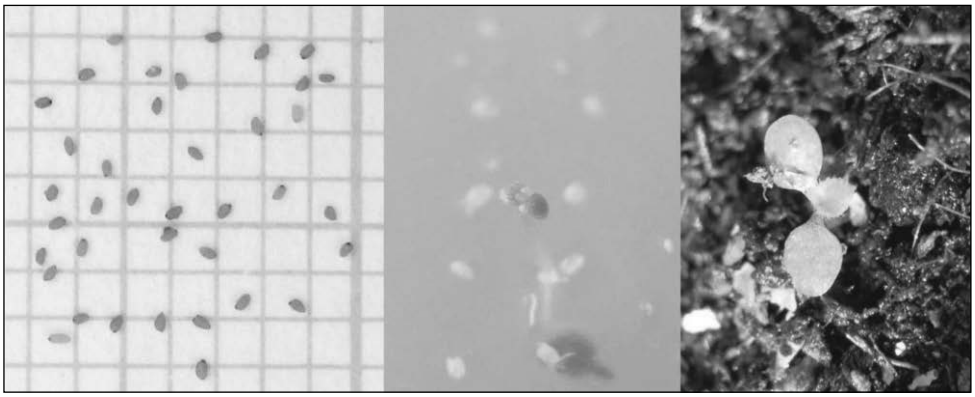


Fig. 7. Seeds and seedlings of *Parentucellia viscosa*.

Observations

This hemiparasitic annual plant, with tiny seeds, grows in grasslands and roadside ditches, preferably on nitrified and humid soils. It is distributed throughout West and South Europe, North Africa, southwest Asia and Macaronesia. In the Valencian Community it is occasionally present in the provinces of Alicante and Castellón, so it is included in the regional list of protected species.

The seeds appear to exhibit a preference for an alternating temperature regime, as results below 25% were observed under constant temperature regimes at 20ºC. Future studies are recommended to verify this requirement.

M.C. Escribá, E. Estrelles & J. Prieto-Mossi

145. *Silene mellifera* Boiss. & Reut. (*Caryophyllaceae*)

Accession data:

Hs: Alicante, Villena, Cueva del Lagrimal (WGS84: 38.5133570ºN, -1.019064ºW), 980 m a.s.l., 07 Aug 2008, *J. Prieto & F. Marco* (UVEG-JBVAL-BG 165B2008, Germplasm Bank of the University of Valencia).

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]	MGT [d]
87.5%	constant 20°C	12/12h	3.0	2.6	3.0	3.0

Observations

This perennial plant has a slimy stem, and the leaf blade of the petals is bifid, greenish or white in colour. Present in scrublands, rocky perennial and shady grasslands, always in mountainous areas with humid environments. This species is an endemism of the East and South Iberian Peninsula. In the Valencian Community, it is located in mountainous areas in the three provinces.

This seed accession does not exhibit dormancy, and its germination response is highly synchronized and relatively rapid.

M.C. Escribá, E. Estrelles & J. Prieto-Mossi

146. *Silene tridentata* Desf. (*Caryophyllaceae*)

Accession data:

Hs: Valencia, L'Olleria, Pla de la Tramussera (WGS84: 38.949273ºN, -0.532279ºW), 460 m a.s.l., 30 May 2007, *E. Estrelles, F. Marco & A.M. Ibars* (UVEG-JBVAL-BG 13B2007, Germplasm Bank of the University of Valencia).

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]	MGT [d]
100.0%	constant 20°C	12/12h	1.0	1.8	3.0	2.3

Observations

This small annual herb shows pinkish petals deeply bifid. It is present in dry therophytic crop fields and wastelands, on somewhat carbonated soils. It is distributed in the Iberian Peninsula (centre, south and east), Canary Islands, north Africa and southwest Asia. In the Valencian Community, dispersed populations have been located in the three provinces.

Similar to the previous taxon, germination is both rapid and highly synchronized. These two *Silene* species may potentially belong to the category of generalist germinators identified by Zani and Müller (2017). However, this hypothesis requires further validation through testing across a broader range of temperatures.

M.C. Escribá, E. Estrelles & J. Prieto-Mossi

147. *Erysimum metlesicsii* Polatscheki (*Brassicaceae*)

Accession data:

Si: Palermo, Belmonte Mezzagno, Monte Grifone (WGS84: 38.066667°N, 13.392778°E), 800 m a.s.l., limestone slopes, 11 Jul 2023, *F. Scafidi 085-SF* (SPGR/PA 1949/23; Sicilian Plant Germplasm Repository, University of Palermo)

Germination data

Pre-treatments: disinfection with a 1% sodium hypochlorite solution for 3 minutes followed by 2 rinses in sterile distilled water.
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]	MGT [d]
100.0%	constant 15°C	0/24h	3.0	3.5	6.0	4.0
98.7%	constant 15°C	12/12h	2.0	5.3	14.0	6.7
98.7%	constant 20°C	0/24h	3.0	2.2	5.0	3.1
96.0%	constant 20°C	12/12 h	3.0	2.7	8.0	3.5

Observations

Erysimum metlesicsii is a suffruticose chasmophyte endemic to western (Palermo Mts., Sicani Mts.) and central Sicily (Caltanissetta, Sutera, Campofranco, Agrigento and Aragona). The species is reported as Least Concern (LC) in the Red List of the Italian flora (Rossi & al. 2020). The germination tests were carried out at the Germplasm Bank of University of Palermo. This is the first germination report for the species. Seeds did not reveal any dormancy. Best germination results (100%) were achieved at the constant temperature of 15°C under full darkness, but high germination rates also occurred with 12/12h photoperiod (ca. 99%), and at higher temperature (20°C). As under 12/12h photoperiod both the germination rate and speed were a little lower at all tested temperatures, seeds seem to be somewhat negatively affected by light.

F. Scafidi, G. Pipitone & C. Salmeri

148. *Jacobea lycopifolia* (Desf. ex Poir.) Greuter & B.Nord. (*Asteraceae*)

Accession data:

Si: Messina**,** Motta d'Affermo, C.da Pattina (WGS84: 37.992778°N, 14.285833°E), 28 Sept 2023, uncultivated land, *F. Scafidi 131-SF* (SPGR/PA 1997/23; Sicilian Plant Germplasm Repository, University of Palermo).

Germination data
Pre-treatments: disinfection with a 1% sodium hypochlorite solution for 3 minutes followed by 2 rinses in sterile distilled water.
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]	MGT [d]
93.3%	constant 20°C	12/12h	2.0	2.7	17.0	3.7
90.7%	constant 15°C	0/24h	3.0	3.9	13.0	4.8
82.7%	constant 20°C	0/24h	2.0	3.0	18.0	4.4

Observations
Jacobea lycopifolia is a rare suffruticose chamaephyte endemic to South Italy (Sicilia, Puglia and Basilicata), which is reported as Least Concern (LC) in the Red List of the Italian flora (Rossi & al. 2020). The germination tests were carried out at the Germplasm Bank of University of Palermo. This is the first germination report for the species, which showed its best germination rate (93.3%) at 20 °C with 12/12h photoperiod, while under full darkness the germination rate was lower (82.7%). At 15°C, 90.7% of seeds germinated under full dark condition, but the germination dropped to 77.3% with a 12/12h light/dark photoperiod. The germination results, however, were influenced by mould contamination in all tested conditions.

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149. ***Matthiola incana*** (L.) W.T. Aiton subsp. ***rupestris*** (Raf.) Nyman (*Brassicaeae*)

Accession data:
Si: Palermo, Santa Flavia, Capo Zafferano (WGS84: 38.111389°N, 13.537778°E), 32 m a.s.l., coastal limestone cliffs, 21 Aug 2023. *F. Scafidi 121-SF* (SPGR/PA 1988/23; Sicilian Plant Germplasm Repository, University of Palermo).

Germination data
Pre-treatments: disinfection with a 1% sodium hypochlorite solution for 3 minutes followed by 2 rinses in sterile distilled water.
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]	MGT [d]
90.7%	constant 15°C	12/12h	3.0	3.1	23.0	4.2

Observations

It is a suffruticose chamaephyte native to Sicily (Ustica, Egadi and Aeolian islands included) and Calabria, where sporadically grows on coastal calcareous cliffs and old rock walls. This is the first germination report for this taxon, which is considered as Near Threatened (NT) in the Red List of the Italian flora (Rossi & al. 2020). The germination tests were carried out at the Germplasm Bank of University of Palermo. Seed germination was tested at the constant temperatures of 15°C and 20°C, with a mean germination percentage of 90.7% reached at 15°C under 12/12h photoperiod; seeds incubated in total darkness got only 49.3% of germination. At 20°C the germination percentage dropped at 74.7% under light condition (12/12h) and to 70.6% under full darkness, while the germination speed (MTG) slightly quickened to 3.7-3.9 days. These results seem to indicate that seeds are positively influenced by light but negatively affected by high temperature. Previous tests conducted at 25°C on some populations from Taormina (ME), in fact, gave only 10% of seed germination with marked mould contamination.

F. Scafidi, G. Pipitone & C. Salmeri

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Article

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Studies on the genus *Dysphania* (*Amaranthaceae*) in North Africa: *Dysphania pumilio*, a neophyte new for the Tunisian flora

Abstract

El Mokni, R.: Studies on the genus *Dysphania* (*Amaranthaceae*) in North Africa: *Dysphania pumilio*, a neophyte new for the Tunisian flora. — Fl. Medit. 34: 195-201. 2024. — ISSN: 1120-4052 printed, 2240-4538 online.

Dysphania pumilio (*Dysphanieae*, *Chenopodioideae*, *Amaranthaceae*) is here reported for the first time to North Africa in northeastern Tunisia, based on floristic surveys, analysis of literature, and examination of herbarium specimens. Morphology, distribution, current status of naturalization, and ecological features of this alien in Tunisia are presented.

Key words: Alien plants, Tunisia, *Caryophyllales*, *Chenopodium pumilio*, new records.

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Introduction

First introductions and first records in the wild of alien plant species are well documented in North Africa (see e.g., Rebbas 2018; Mahklouf 2023; Khamar & al. 2024). In Tunisia, these findings include taxa belonging mainly to *Asteraceae* (El Mokni & Iamonico 2018; El Mokni & al. 2022), *Cactaceae* (El Mokni & al. 2020; El Mokni & Verloove 2021a; El Mokni & al. 2024), *Asparagaceae* (El Mokni & Verloove 2022), *Agavaceae* (El Mokni & Verloove 2021b), *Aizoaceae* (El Mokni & Iamonico 2019; El Mokni & al. 2022), *Amaranthaceae* (El Mokni & Iamonico 2019), *Crassulaceae* (El Mokni & al. in Sukhorukov & al. 2018; El Mokni & Sáez 2019; El Mokni 2024), *Euphorbiaceae* (El Mokni 2023) and *Bignoniaceae* (El Mokni & Iamonico 2024).

As concern the subfamily *Chenopodioideae* Burnett (*Amaranthaceae*, *Caryophyllales*), a recent study by El Mokni & al. (2024) pointed out the first occurrence of *Dysphania cristata* (F.Muell.) Mosyakin & Clemants in the Mediterranean basin. Traditionally the genus *Dysphania* R. Br. comprises 7–10 aromatic plant species endemic to Australia (Aellen 1930; Scott 1978; Wilson 1983). Owing to molecular studies (Fuentes-Bazan & al. 2012a, 2012b), *Dysphania* R.Br. has been amended to include the glandular-hairy species of the formerly large genus *Chenopodium sensu*

lato and counts more than 50 species (Uotila & al. 2021). All the *Dysphania* species were earlier included in the subgenus *Ambrosia* A.J.Scott of the genus *Chenopodium* (see Fuentes-Bazan & al. 2012b and literature therein). Later, a worldwide phylogeny and systematics of *Dysphania* was elaborated (Uotila & al. 2021). Representatives of the genus are mainly ruderal and weed plants (except for Australian species growing on the sands within the natural vegetation types), more common in the tropics, subtropics, and warm-temperature zones of the world. Most of them reached Europe by the import of wool and agricultural products from Australia, South America, and Africa. Several authors (e.g., Aellen 1960; Uotila & Suominen 1976; Dostálek 1985; Kühn 1993; Uotila 2001, 2021; Sukhorukov 2012a, 2012b; Sukhorukov & Zhang 2013; Sukhorukov & al. 2015) highlighted the high great morphological variability in the genus, especially in the leaf blade, as well as in seed morphology and anatomy. Thus, the similar fruits, rarely exceeding 1 mm, and the dimensions of the generative organs very often make their distinction not easy.

In North Africa, four species of *Dysphania* are currently recorded [11 species are known in the Euro-Mediterranean area according to Uotila (2011+) and Iamonico (2011a)]: *D. ambrosioides* (L.) Mosyakin et Clemants [Sect. *Adenois* (Moq.) Mosyakin & Clemants], *D. botrys* (L.) Mosyakin & Clemants [Sect. *Botryoides* (C.A.Mey.) Mosyakin & Clemants], *D. carinata* (R. Brown) Mosyakin & Clemants [Sect. *Dysphania* Uotila, Sukhorukov, Bobon, McDonald, Krinitsina & Kadereit], *D. multifida* (L.) Mosyakin & Clemants [Sect. *Adenois* (Moq.) Mosyakin & Clemants].

In this paper the presence of *Dysphania pumilio* (R. Br.) Mosyakin & Clemants [Sect. *Dysphania* Uotila, Sukhorukov, Bobon, McDonald, Krinitsina & Kadereit] in Tunisia (Fig. 1) is reported for the first time as a new record for the non-native vascular flora also of North Africa. Distribution, status of naturalization and notes on its morphology and ecology are provided. The work is part of an ongoing study on updating the checklist of the non-native Tunisian chenopodiaceous flora (see e.g. Sukhorukov & al. 2018; El Mokni & Iamonico 2019; El Mokni & Debruille 2021; El Mokni & al. 2024), undertaken since almost two decades.

Material and Methods

The present research is based on field surveys carried out in Tunisia over the last 14 years. Collected specimens are part of the personal collection of the author (Herb. El Mokni) housed in the Herbarium of Monastir University (not yet listed in *Index Herbariorum*). Analysis of relevant literature dealing with morphological features and distributive areas of different collected material were carried out together with examination of specimens (sub *Chenopodium pumilio* R. Br.) preserved at AV, MPU, P, and STR (herbarium codes follow Thiers (2024) [continuously updated]). The morphological description of the species is mainly based on personal data, as well as on data from Iamonico (2011), Kambhar & al. (2017) and Bogosavljević & Zlatković (2017). Nomenclature follows Uotila & al. (2021).

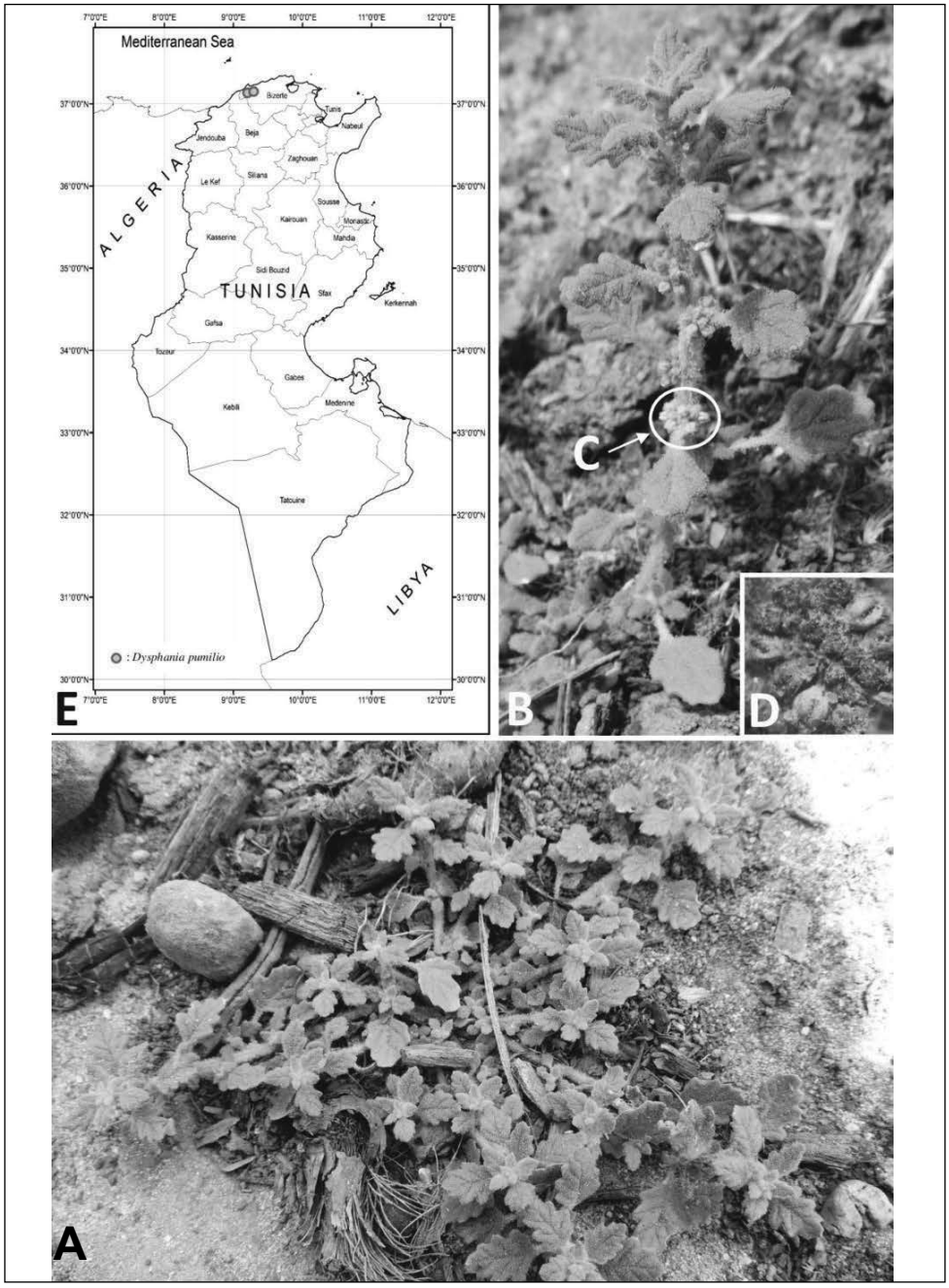


Fig 1. *Dysphania pumilio* in Tunisia: **A)** Habit with prostrate branches in its habitat; **B**) Lateral ascending branche in flowering/fruiting period; **C**) Inflorescence/infrutescence in axillary glomerule; **D**) Details of tepals with eglandular hair on the apex; **E)** Known localities of first records in North Eastern Tunisia (North Africa). Photographs R. El Mokni, Mai-June 2024.

Results and discussion

Dysphania pumilio (R. Br.) Mosyakin & Clemants, Ukrayins'k. Bot. Zhurn. (Ukr. Bot. J.) 59: 382, 2002 º *Chenopodium pumilio* R. Br., Prodr. Fl. Nov. Holl. 1: 407. 1810.

Morphology – (Fig 1). An annual prostrate or ascending plant, up to 80 cm long with malodorous leaves, densely covered with elongated non-glandular and short glandular trichomes. A detailed description is available in Grozeva (2007), Iamonico (2011b), Kambhar & al. (2017) and Bogosavljević & Zlatković (2017).

Chorology – Native to southern Australia; introduced with wool shipments and naturalized in New Zealand, central and southern Africa, Americas and Europe, Caucasus, Syria, South Korea, New Guinea, and Japan (Dostálek & al. 1990; Akeroyd 1993; Uotila & Tan 1997; Iamonico 2011b; Bogosavljević & Zlatković 2017; Sukhorukov & al. 2018; POWO 2024).

Occurrence and habitat in Tunisia – *Dysphania pumilio* grows on the peripheric of ponds in clayey-loamy soils within communities of thermophilous herbs. Its occurrence is restricted to two localities (one within the pond of 'Majen Chitana' at 170–180 m above sea level and one near the port of 'Sidi Mechrig' at 10–13 m above sea level) in Sejnane, Bizerta governorate (northeastern of Tunisia, Fig. 1.E). Historically, the taxon has never been reported in or around these two localities before 2024 (the area was under annual prospections of the author for the last ten years).

Up to now, this neophyte can be considered as casual to Tunisia and North Africa (following Pyšek & al. 2004). Further studies are needed to verify its presence in other Tunisian regions and neighboring countries for its distributive range in North Africa.

Notes on the main associated species – Reported populations of more than a hundred individuals were observed in the wild over an area of about 300 m^2 (for 'Majen Chitana') and another of about 100 m^2 (for port of 'Sidi Mechrig'), together with several species, characteristic of clayey-loamy soils merged with water during rainy seasons, thermophilous herbs and grasses, mainly: *Baldellia ranunculoides* (L.) Parl., *Corrigiola littoralis* L., *Crassula helmsii* (Kirk) Cockayne (locally invasive!), *Glinus lotoides* L., *Juncus pygmaeus* Rich. ex Thuill., *Lythrum borysthenicum* (Schrank) Litv, and *Parapholis incurva* (L.) C.E.Hubb.

Phenology – Flowering and fruiting from Mai to June (in Tunisia), elsewhere in the word from July to September (in Bulgaria, Grozeva 2007; in India, Kambhar & al. 2017), from July to October (in Croatia, Bogosavljević & Zlatković 2017).

Taxonomic notes – Macromorphologically, *Dysphania pumilio* could be confused to *D. botrys* due to almost similar leaves shape. The former could be easily distinguished by its habit (prostrate to ascending *vs*. erect) and its malodorous leaves (*vs*. aromatic leaves).

Specimens examined (new records) – Tunisia. Bizerta: Sejnane, Sidi Mechrig 09 Mai 2024, *El Mokni s.n.* (Herb. El Mokni!), ibidem, 22 Mai 2024, *El Mokni s.n.* (Herb. El Mokni!), ibidem, 13 June 2024, *El Mokni s.n.* (Herb. El Mokni!).

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Article

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Inventory and characterization of Orchids in the region of Sidi Bel Abbès (North-West Algeria)

Abstract

El Bouhissi, M., Babali, B., Dib, T., Cherifi, K., Ait Hammou, M. & Miara, M.: Inventory and characterization of Orchids in the region of Sidi Bel Abbès (North-West Algeria). — Fl. Medit. 34: 203-218. 2024. — ISSN: 1120-4052 printed, 2240-4538 online.

This study explores the rich diversity of Algeria, with a particular focus on the Sidi Bel Abbès region, which is renowned for its floristic richness, its ecological diversity and its phytodiversity. Our research aims to identify and map orchids, which face challenges due to both climate constraints and increasing anthropozoogenic activities impacting their habitats. Between 2015 and 2022, we carried out an extensive orchid inventory, resulting in the observation, identification, and geolocation of 25 species belonging to 4 genera in the study area. Among the orchids, *Ophrys* species were the most prevalent, with a total of 17 species, including one hybrid, followed by *Anacamptis* and *Orchis*, each comprising three species. *Himantoglossum* was the least represented with only two species recorded. Detailed characterizations and ecological data were established for each species to acquire comprehensive understanding of their habitats and distributions. While some taxa demonstrated widespread distribution across the Sidi Bel Abbès region, others exhibited highly localized occurrences.

Key words: Phytodiversity, inventory, anthropozoogenic action, climatic constraints, North Africa.

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Introduction

Orchids are considered the most emblematic family of species because of their beauty and the fragility of their habitats coupled with the threats that weigh on their preservation. They comprise over 25 000 species distributed across various climatic regions around the globe (Gravendeel & al. 2004). These entomophilous flowering plants represent a botanical heritage with an extraordinary diversity. Orchids are highly diversified in tropical region, while in Europe, are predominantly found in the Mediterranean region, where several genera are endemic. With the exception of the northern shore of this region, the southern one has not been subject of comprehensive and in-depth studies on the entire taxon, except some previous researches in Tunisia (Vallès & Vallès-Lombard 1988; Martin & al. 2015).

The studies devoted to the inventory of orchids in Algeria have not been reviewed since the Second World War. Some older studies have been reported by Maire (1959) and Quézel & Santa (1962). However, an exploration was conducted by Baumann in 1975, after which a publication dedicated to European species (Baumann & al. 2006) also has mentioned some rare and unknown species in Algeria. Few recent studies have been devoted to orchids of Morocco (Raynaud 1988) and Libya (Baumann & Baumann 2001), while, there are more studies regarding Tunisia (Martin 2008; El Mokni & al. 2010; Le Floc'h & al. 2010; Véla & al. 2012, 2015; El Mokni & Domina 2019). In the concern of Algeria, particularly, the northeastern part of the country, it is crucial to mention the taxonomic inventories and observations carried out by Derradji (1999), De Bélair (2000), De Bélair & Boussouak (2002), De Bélair & al. (2005), Rebbas & Véla (2008, 2013), Hadji & Rebbas (2013) and Beghami & al. (2015).

New taxon of orchids have been discovered in Algeria, or even formally described (Medjahdi & al. 2009; Rebbas & Véla 2013; Kreutz & al. 2013; Babali & al. 2013; Hadji & Rebbas 2013; Kreutz & al. 2014; Babali & al. 2018a, 2018b), while others are undoubtedly yet to be discovered. However, very few studies have been published regarding the threats weighing on the conservation status of a given species (Orsenigo & al. 2016).

The present research aims to study this family of orchids, a first work in its kind in the region of Sidi Bel Abbès, located in the West of Algeria. Some orchid species, which have been previously observed during some initial inventory works (Cherifi 2013; Ouici & al. 2015; Cherifi & al. 2017; Cherifi & al. 2021) on the flora of this region, served as the starting point for our investigation on this interesting family. The lack of works on orchids in this region, led us to undertake a research aiming to carry out the first inventory of orchids in the Sidi Bel Abbès region, to enhance our knowledge of the ecology and natural habitats hosting these taxon, to create distribution maps of the inventoried species and moreover, to identify their degradation factors for a sustainable management of natural areas hosting these taxa.

Material and methods

Study area description

Sidi Bel Abbès province is situated in a strategic position and covers approximately 15% of the territory of the Northwest region of the country. It is considered as a hub due to its privileged location, as it is crossed by the main road networks of this part of the country. Bordered from the North by the province of Oran, from the Northwest by the province of Ain témouchent, from the Northeast by the province of Mascara, from the West by the province of Tlemcen, from the East by the provinces of Mascara and Saida, from the south by the provinces of Naâma and El-Bayad, and limited from the Southeast by the province of Saida (Fig. 1). Administratively, Sidi Bel Abbès is composed of 52 municipalities among 15 districts, covering an area of 9150.63 km^2.

The relief can be divided into three distinct physical units. The mountainous areas cover a total area of approximately 2250.37 km², representing 24.59% of the province. They are located in the Northern part, including the Tessala and Beni Chougrane mountains, covering about 864.20 km², as well as the central part of the province with the Dhaya mountains,

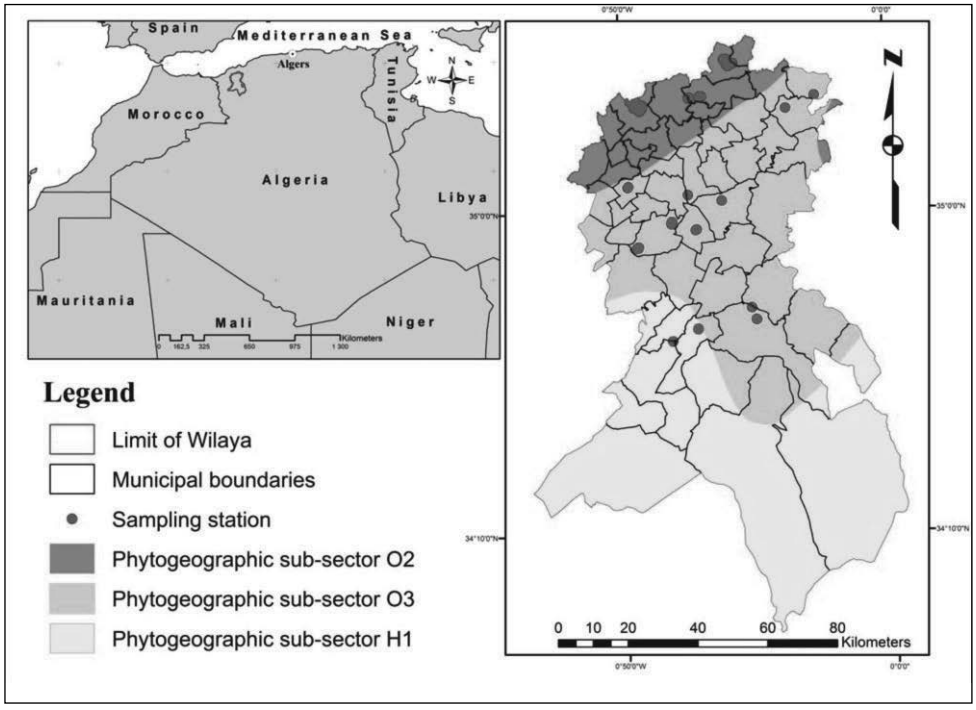


Fig. 1. Geographical location of the Sidi Bel Abbès region, the delimitation of the sub-sector of the study area and the orchids distributions stations in the Sidi Bel Abbès region.

spreading over an area of 1.386.16 km² (D.P.A.T. 2013). The plain areas cover a total area of approximately 3239.44 km², making up 35.40% of the province's territory. They are represented by the Sidi Bel Abbès plain, covering around 2102.85 km² with altitudes ranging from 400 to 800 m, and by the high plains of Telagh, covering approximately 1136.59 km² with altitudes varying from 400 to 1000 m. From their sides, the steppe zones from the southern side of the province cover an area of 3660.82 km², which is 40% of the overall territory of the province. The altitude in these areas ranges from 1000 to 1400 m (D.P.A.T. 2013).

The climate of Sidi Bel Abbès is semi-humid, characterized by insufficient and poorly distributed interannual and seasonal precipitation, often resulting in water deficit. The precipitation average recorded for the entire region is 298.5 mm. The rainfall pattern shows annual and interannual irregularities, which can be explained by the climate's current towards aridity. The average annual temperature at the Sidi Bel Abbès station is 16.7°C. The potential evapotranspiration is 825.5 mm, while the actual evapotranspiration is 288.64 mm (Bouasria & al. 2010).

The forested areas (forests, scrublands, and reforested areas) cover a surface of 161697 ha, corresponding to a woodland rate estimated at 17% of the province's total area. This woodland rate is insufficient, with 105699 ha (about 65%) in the form of scrublands, prop-

er forests covering 49423 ha (about 31%), and a reforestation rate of approximately 4% with an area of 6575 hectares. In terms of their legal status, 93% of the 161.697 hectares of forest lands belong to state-owned forests (150289 ha), while 7 % are non-state-owned forest (Dahmani 2010). The forest is mainly located in the Dhaya monts that enclose 87% of the province's forested area. In terms of tree species, Aleppo pine formations are significantly dominant, lying over an area of 54123 ha; which corresponds to 97% of the forested land. The other species, with lesser importance, include Holm oak, Kermes oak, Juniper, Filaria and Lentisk.

Methodological approach

The search for orchid stations was carried out in a subjective way (Gounot 1969), using our prior knowledge of the field and sites likely to contain orchids. Field outings were conducted regularly during the spring season from 2015 to 2022, averaging two outings per week.

From phytogeographical perspective, Sidi Bel Abbès region belongs to the Mauritanian-Mediterranean domain in the Oranian sector, while the southern steppe part belongs to the Mauritanian-Steppe domain (H1). The Oranian sector was divided by Quézel and Santa (1962-1963) into three subsectors, and the study area only encompasses two sub-sectors of the Oranian coastal plains, O2 and O3 (Fig. 1).

The surveyed region for the orchid inventory mainly covers the northern part of Sidi Bel Abbès. It includes the municipalities: Ain Elberd, Ain Trid, Sidi Hamadouche Tessala, Lamtar, Sidi Ali Benyoub, Sfisef, and Tanira. Some orchids have been found in the southern part in the area of Oued Taourira and Telagh (Fig. 1).

In total, 15 sites were visited: Ain Elberd, Sarno, Ain Trid, Mount of Tessala, Ightti, Ain Djohar, Ain Bent Soltane, Bouhriz, Tenira, Tanzara, Lamtar, Guetarnya, Taouzizine, Melkine and Dhaya.

The study period for orchids in the Sidi Bel Abbès region extended from February 2015 to May 2022. This does not exclude the possibility that other sites may host orchid species. Other stations were subject to repeated observations but without a positive presence result. Using GPS, the geographic coordinates, altitudes and field orientation were recorded for each survey, totaling 49 across 15 stations. At each station, a systematic inventory of orchid species was conducted, along with an estimation of the number of individuals for each species. To estimate the number of recorded species, an average abundance index was provided in the form of classes as follows: Class I= 1-5 individuals, Class II = 5-10 individuals, Class III = 10-50 individuals, Class IV = 51-100 Individuals and Class V > 100 individuals.

The species identification was carried out using various old and recent works, namely the flora of Maire (1960), Quézel & Santa (1962-1963) and the work of Dobignard & Chatelain in 2012.

Results and discussions

Twenty-five orchid taxa belonging to four different genera, primarily *Ophrys*, *Orchis*, *Anacamptis* and *Himantoglossum*, have been identified in the Sidi Bel Abbès region (Electronic Supplementary File 1 Table S1).

For the characterization of each species, distribution maps and ecological data are provided in figure 1 and in the ESF 1 table S2.

The various species of orchids recorded in the Sidi Bel Abbès region, along with their ecological characteristics, are presented as follows:

1. *Ophrys battandieri* E. G. Camus, P. Bergon & A. Camus

This species of orchid was only recorded in a single location in the northern part of the Sidi Bel Abbès region: Tessala. It was observed from the year 2019 to 2021. It grows in small, scattered populations of no more than 10 individuals in the maquis with *Calicotome intermedia* (L.) Lam., belonging to the subsector O2 (Fig. 1), at altitudes ranging from 421 to 5771 m. It has been reported as rare in the scrublands, pastures, and forests of the northern Algeria (Quézel & Santa 1962). Its flowering is observed from March to April (Fig. 2a).

2. *Ophrys lutea* Cav.

It is abundant in the stations located in the north and northeast of the Sidi Bel Abbès region: Tessala, Ain Elberd and Sarno. It has been observed from 2015 to 2022 and lying over the forested, pre-forested and open lands (scrublands, grasslands, etc.), belonging to the sub-sector O2 (Fig. 1). It is most often present in populations with more than 50 individuals at altitudes ranging from 414 to 1396 m. Its flowering is observed from March to April (Fig. 2b).

3. *Ophrys* ×*gauthieri* Lièvre (*O. fusca* × *O. lutea*)

According to Maire (1959), Quézel & Santa (1962); this hybrid is known only in the Nador of Médéa, recently (in 2011), observed in the old cemetery of Djenane, Chemini municipality (Khellaf & al. 2021). For the first time in the western side of Algeria, there is a new distribution of this hybrid. This orchid, which appears to be rare, was observed in two locations in the north and northeast of the Sidi Bel Abbès region: Tessala and Sarno. It was investigated during two years of monitoring in 2021 and 2022, with four to five individuals per area, and it was noted that it is growing in open Pine forests and grasslands at altitudes ranging from 752 (Tessala) to 800 m (Sarno), belonging to the sub-sector O2 (Fig. 1). The flowering period of this orchid is reported from March to April (Fig. 2c).

4. *Ophrys marmorata* subsp. ***marmorata*** G. Foelsche & W. Foelsche

This orchid species (The marble *Ophrys*) has been observed exclusively within a single site located in the southwestern expanse of the Sidi Bel Abbès region: Ain Bent Soltane. The observations were conducted during the year 2019, and only two individuals were noted. These specimens were found flourishing within grassy habitats on cliff faces, situated at an altitude of 754 m, and are attributed to subsection O3 (Fig. 1). The period of floral display for this species spans from March to April (Fig. 2d). This particular species is known to occur in various regions of the central-east of Algeria (Rebbas & Véla 2013). As example, in Sétif region, *Ophrys marmorata* was observed at a single location (Madoui & al. 2017).

5. *Ophrys fusca* Link. subsp. ***fusca***

Found within a singular site located in the northeastern expanse of the Sidi Bel Abbès region, namely Sarno; it was identified under observations throughout years 2021 and

2022. This manifestation is characterized by the presence of two individuals, noted within open habitats (grasslands, ermes, etc.) and occasionally within Aleppo pine woodlands. The ecological classification places it within subsection O2 (Fig. 1), at an altitude of 723 m. Its flowering period is observed spanning from March to April (Fig. 2e).

6. *Ophrys fusca* subsp. ***maghrebiaca*** Kreutz, Rebbas, Babali, Miara & Ait Hammou

This orchid is documented within the sites situated in the northeastern and southern parts of the Sidi Bel Abbès region: Tessala, Ain Elberd, Sorno, and Dhaya. The observations were conducted from 2019 to 2022, with a notable prevalence in forested, pre-forested, and Cliffside grassland areas, which fall under the subsections O2 and O3 (Fig. 1). The species is predominantly found in populations ranging from six to nine individuals at altitudes spanning from 552 to 1332 m. Its flowering period is noted from March to April (Fig. 2f). This orchid is considered as a new subspecies in Algeria, which was recently, discovered by Kreutz & al. (2013), and it is well documented in the region of Tlemcen (Babali & al. 2018b).

6.1. *Ophrys fusca* subsp. ***maghrebiaca*** form hypochromic

The hypochromic (pale-colored) form of *Ophrys fusca* has been observed, during years 2021 and 2022, exclusively within a unique location in the northeastern of Sidi Bel Abbès region: Sarno. This particular species is represented by two individuals within a sparse Aleppo pine forest, belonging to the subsection O2 (Fig. 1), situated at an elevation of 800 m. Hypochrome of *Ophrys fusca* subsp. *maghrebiaca* is considered as rare and it was observed for the first time in the station of Sarno. Its flowering period is noted from the March to April (Fig. 2g). It is noteworthy that this hypochrome is surrounded by the two orchid taxa: *Ophrys fusca* subsp. *fusca* and *Ophrys lutea* Cav. in the above-mentioned station.

7. *Ophrys funerea* Viv.

This species has only been observed in two distinct locations situated in the southwest and northeast of the Sidi Bel Abbès region: Ain Bent Soltane and Ain Elberd. It was observed during the years 2019 and 2020, with one individual per location. *Ophrys funerea* is growing in grasslands on cliffs at an altitude of 666 m (Ain Bent Soltane), belonging to sub-sector O3 (Fig. 1), and in a clear Aleppo Pine forest at an altitude of 639 m (Ain Elberd), belonging to sub-sector O2 (Fig. 1). Its flowering period is from March to April (Fig. 2h). However, *O. funerea* Viv. was rediscovered by Rebbas & Véla (2013), Hadji & Rebbas (2014), Kreutz & al. (2013, 2014), Rebbas & Bounar (2014), Bougaham & al. (2015), and Beghami & al. (2015).

8. *Ophrys forestieri* (Rchb. f.) Lojac. = *O. lupercalis* J. Devillers-Terschuren & P. Devillers

Ophrys forestieri is a fairly common taxon in Spain and southern France where it is the first Pseudophrys to flower in the season. This orchid species has been observed only in a single location situated in the southwest of the Sidi Bel Abbès region: Ain Bent Soltane. It was observed during the years 2020 and 2021, with only two individuals, growing in grasslands on cliffs at an altitude of 666 m, belonging to sub-sector O3 (Fig. 1). Its flowering period has been reported from March to April (Fig. 2i).

9. *Ophrys bombyliflora* Link.

This species has been observed exclusively in a single location in the northeast of the Sidi Bel Abbès region: Ain Elberd, during the years 2020, 2021, and 2022. Only six individuals were noted, growing in a sparse Aleppo Pine forest at an altitude of 656 m, belonging to sub-sector O2 (Fig. 1). Its flowering period has been reported from March to April (Fig. 3a).

10. *Ophrys speculum* Link. subsp. ***speculum***

This species is widely distributed in stations located in the north and northwest of the Sidi Bel Abbès region: Tessala, Ain Elberd, Tanzara, and Lamtar, belonging to sub-sector O2, and Tenira, which belongs in their turns to sub-sector O3 (Fig. 1). It has been observed from 2015 to 2022 and is prevalent in forested, pre-forested, and open spaces (scrublands, grasslands, etc.). It is often found in populations comprising more than 25 individuals at altitudes ranging from 415 to 1330 m. Its flowering period has been noted from March to April (Fig. 3b).

11. *Ophrys scolopax* subsp. ***apiformis*** (Desf.) Maire & Weiller (= *O. picta* Link.)

This species has been observed in three stations located in the northwest and northeast of the Sidi Bel Abbès region: Ain Elberd, Sarno, and Lamtar, observed from 2019 to 2022, with five to six individuals per station, growing in clear Aleppo Pine forests at altitudes ranging from 655(Ain Elberd) to 725 m (Sarno), and in an ancient cemetery at an altitude of 750 m (Lamtar), belonging to sub-sector O2 (Fig. 1). Its flowering period has been reported from March to May. According to Maire's classification (1959), three forms have been observed in the study area:

11.1. *Ophrys scolopax* subsp. ***apiformis*** var. ***picta*** f. ***picta*** Batt. (Fig. 3c)

Reported as common only nearby Algiers by Battandier (1886), it represents a new form for the Sidi Bel Abbès region.

11.2. *Ophrys scolopax* subsp. ***apiformis*** var. ***honckensis*** E. G. Camus. (Fig. 3d)

This taxon grows in open forests, shrublands, and pastures of plains and mountains, up to around 2000 m, in well-watered and semi-arid regions. This species represents a new addition to the flora of Algeria.

11.3. *Ophrys scolopax* subsp. ***apiformis*** var. ***chlorosepala*** Thell. (Fig. 3e)

Reported by Gauthier (Maire 1959) in the Msila forest, located in Oran and more recently it was observed in the Tlemcen region (Babali & al. 2018b), near our study area. However, this new variety has been observed in the Sidi Bel Abbès region.

12. *Ophrys tenthredinifera* Willd. subsp. ***tenthredinifera***

This orchid is widely distributed in stations located in the north, northwest, northeast, and south of the present study area: Tessala, Ain Elberd, Sarno, Lamtar, Bouhriz, Melkine, Guettarnya, Ightti, observed from 2018 to 2022. It is very spread in forested, pre-forested, and maquis environments with rosemary and rockrose, grasslands, etc., belonging to sub-sectors O2 and O3 (Fig. 1). This species is often found in populations comprising five to seven individuals at altitudes ranging from 415 to 985 m. Its flowering period has been noted from March to April (Fig. 3f).

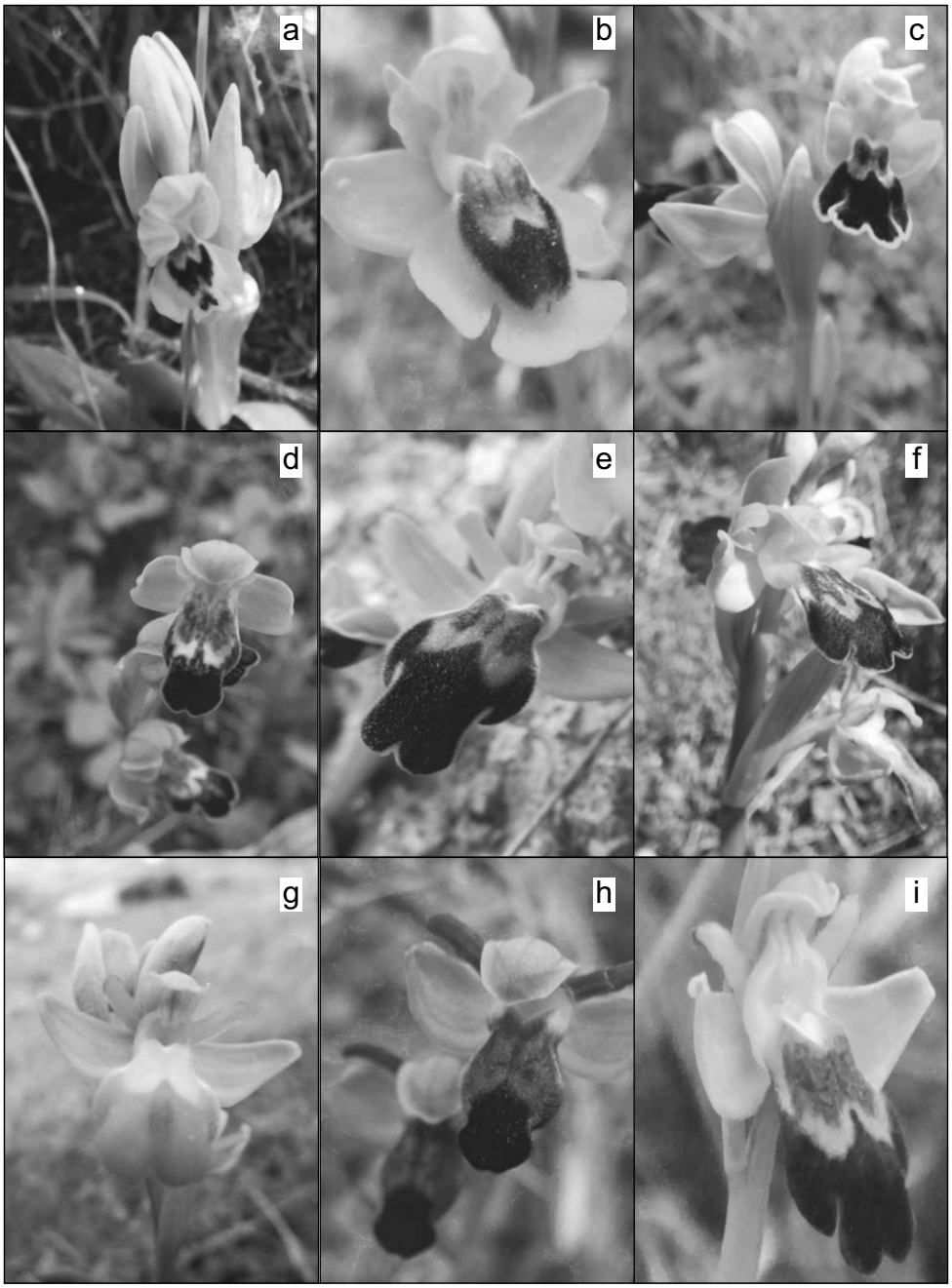


Fig. 2. a) *Ophrys battandieri* G. Camus.; b) *O. lutea* cav.; c) *O.* × *gauthieri* Lièvre; d) *O. marmorata* subsp. *marmorata* G. Foelsche & W. Foelsche; e) *O. fusca* Link subsp. *fusca*; f) *O. fusca* subsp. *maghrebiaca* Kreutz, Rebbas, Babali, Miara & Ait Hammou; g) Hypochrome d'*O. fusca* subsp. *maghrebiaca*; h) *O. funerea* Viv.; i) *O. forestieri* (Rchb. f.) Lojac.

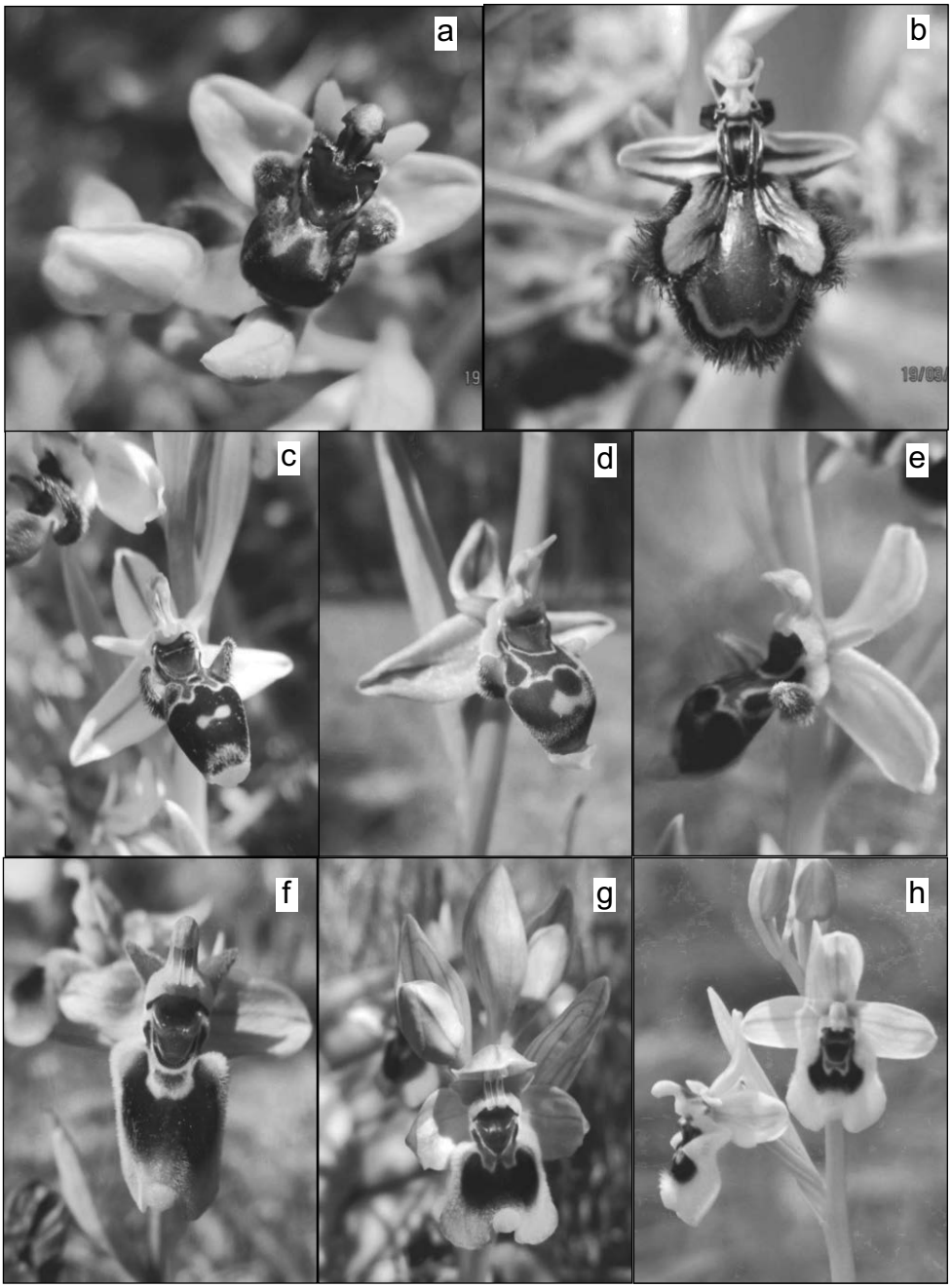


Fig. 3. a) *Ophrys bombyliflora* Link.; b) *O. speculum* Link subsp. *speculum*.; c) *O. scolopax* subsp. *apiformis* var. *picta*; d) *O. scolopax* subsp. *apiformis* var. *honckensis*; e) *O. scolopax* subsp. *apiformis* var. *chlorosepala;* f) *O. tenthredinifera* Willd. subsp. *tenthredinifera*; g) *O. tenthredinifera* subsp. *ficalhoana* (J.A. Guim.) M.R. Lowe & D. Tyteca; h) *O. tenthredinifera* var. *lutescens* Batt.

13. ***Ophrys tenthredinifera*** subsp. ***ficalhoana*** (J.A. Guim.) M.R. Lowe & D. Tyteca

In the present study area, it appears that this orchid species is considered rare. Observed from 2019 to 2022, only one individual has been noted per station. Those stations are located in the northwest and south of the Sidi Bel Abbès region: Tessala, Sarno, Lamtar, and Taouzizine. This species was observed in specific locations, namely, a clear Aleppo Pine forest, an ancient cemetery, and degraded maquis, at altitudes ranging from 710 to 1000 m, belonging to sub-sector O2 (Sarno, Lamtar) and H1 (Taouzizine) (Fig. 1). Its flowering period has been noted from April to May (Fig. 3g).

14. ***Ophrys tenthredinifera*** var. ***lutescens*** Batt.

This orchid species has been observed only in a single station located in the south of the Sidi Bel Abbès region: Melkine. Those observations were conducted during the year 2022 with two (02) individuals, growing in a clear Aleppo Pine forest at an altitude of 740 m, belonging to sub-sector O2. It is considered rare and reported for the first time in the surveyed station of Melkine. Its flowering period has been noted from April to May (Fig. 3h). The var. lutescens was described by Battandier at Tlemcen in 1904.

15. ***Himantoglossum hircinum*** (L.) Spreng.

This species has been observed in a single locality situated in the northwest region of Sidi Bel Abbès: Lamtar. It has been observed from 2020 to 2022, with two individuals found in an ancient cemetery at an elevation of 825 m, belonging to the O2 sub-sector (Fig. 1). Its inflorescence is reported from April to May (Fig. 4a). In Algeria, Quézel & Santa (1962) described it as fairly rare in the regions of north Constantine, Algiers, Aurès and Oran.

16. ***Himantoglossum robertianum*** (Loisel.) P. Delforge.

This species has been observed in three locations in the northern and northeastern regions of Sidi Bel Abbès: Tessala, Ain elbard, and Sarno. It has been observed from 2020 to 2022, with more than 35 individuals per station. It grows in dense Maquis vegetation consisting of *Citysus* and dwarf palm, as well as open Aleppo Pine forests and grasslands at altitudes ranging from 560 m (Tessala) to 1110 m (Ain Elbard), belonging to the O2 subsector (Fig. 1). Its flowering period is reported from March to April (Fig. 4b). It has been noted as common in shrublands and forests of the Tell region but rare in the high plateaus (Quézel & Santa 1962).

17. ***Anacamptis collina*** (Banks & Sol. ex Russell) R.M. Bateman, Pridgeon & Chase.

This species has been observed in two locations in the northwest and northeast regions of Sidi Bel Abbès: Lamtar and Sarno. It has been observed from 2020 to 2022, with five to six individuals per station. It grows in the grasslands of an ancient cemetery at an elevation of 1327 m (Lamtar) and in an open Aleppo Pine forest at an altitude of 1396 m (Sarno), both belonging to the O2 sub-sector (Fig. 1). Its flowering period is reported from March to April (Fig. 4c).

18. ***Anacamptis papilionacea*** subsp. ***grandiflora*** (Boiss.) Kreutz

This orchid found in two locations in the north and northeast regions of Sidi Bel Abbès, specifically Tessala and Ain Elberd, it has been observed from 2019 to 2022. It occupies

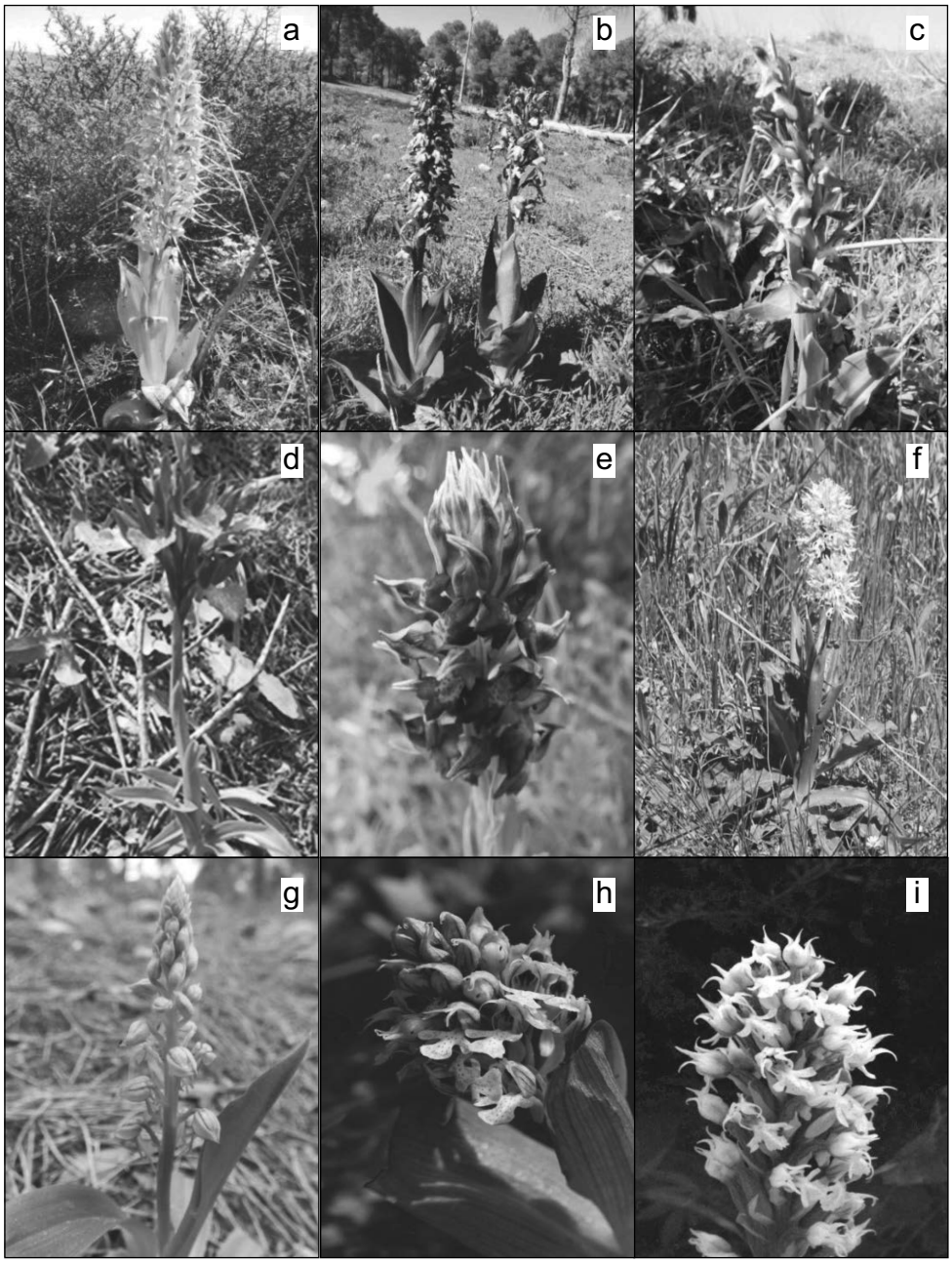


Fig. 4. a) *Himantoglossum hircinum* (L.) Spreng.; b) *H. robertianum* (Loisel.) P. Delforge.; c) *Anacamptis collina* (Banks & Sol. ex Russell) R.M. Bateman, Pridgeon & Chase; d) *A. papilionacea* subsp. *grandiflora* (Boiss.) Kreutz; e) *A. coriophora* (L.) R.M. Bateman, Pridgeon & M.W. Chase subsp. *fragens* (Pollı.) G. Camus; f) *Orchis italica* Poir.; g) *O. anthropophora* (L.) All.; h-i) *Neotinea conica* (Willd.) R.M.Bateman.

various habitats, including forests, pre-forests, and open spaces such as scrublands and grasslands, all falling within the O2 sub-sector (Fig. 1). It is considered fairly rare (Quézel & Santa 1962; Babali & al. 2013). This species is present in the mentioned locations with five individuals in each of them, at altitudes ranging from 570 m (Tessala) to 462 m (Ain Elberd). Its flowering period is reported from March to April (Fig. 4d).

19. ***Anacamptis coriophora*** subsp. ***fragens*** (PolI.) G. Camus

This orchid has only been observed, during the years 2021 and 2022, in a single location in the north of the Sidi Bel Abbès region, specifically Tessala. It grows in small, scattered populations, with no more than four individuals, in Maquis vegetation dominated by *Cytisus intermedius* at an altitude of 1100 m. These observations fall within the O2 sub-sector (Fig. 1). It has been reported as common, typically found on soils with variable pH (ranging from acidic to basic), often associated with moisture and heavy soils (Babali & al. 2013). It flowers from May to June (Fig. 4e).

20. ***Orchis italica*** Poir.

This species has been observed, during the years 2020, 2021, and 2022, only in a single locality in the northeast region of Sidi Bel Abbès: Sarno; where, it is quite abundant, with 42 individuals. It grows in an open Aleppo Pine forest at an altitude of 755 m, within the O2 sub-sector (Fig. 1). If flowers from February to April (Fig. 4f).

21. ***Orchis anthropophora*** (L.) All.

This species has been observed in two localities in the north and northeast regions of Sidi Bel Abbès: Tessala and Ain Elbard. It has been observed from 2019 to 2021, with six to eight individuals per locality. It grows in dense Maquis vegetation consisting of *Cytisus intermedius* and dwarf palm, as well as in open Aleppo Pine forests, at altitudes ranging from 830 m (Tessala) to 650 m (Ain Elbard). These observations fall within the O2 sub-sector (Fig. 1). It flowers from March to April (Fig. 4g).

22. ***Neotinea conica*** (Willd.) R.M.Bateman

We observed this orchid in Tessala (sub-sector O2) (Fig. 1), in forested, pre-forested, and open spaces. Based on the herbarium specimen from the University of Sidi Bel Abbès, the presence of *Neotinea conica* was previously, reported in Tessala in 1987. This orchid is quite common in the Tell (Quézel & Santa 1962). However, we have documented a new variety for the Sidi Bel Abbès region: *O. lactea* var. *hanrici* (Hénon) Maire and Weiller, which is often characterized by a small tooth in the sinus. Its inflorescence is reported from March to April (Figs. 4h, 4i).

Literature reports

According to the bibliography and the work of Battandier and Trabut (1919), other orchids have been reported in the study area. We are specifically referring to three species formerly located in the Bousuit station, now referred to as Daya. These species are: *Orchis latifolia* (=*Dactylorhiza durandii* (Boiss. & Reut.) M. Laínz); *Epipactis*

latifolia (=*Epipactis tremolsii* Pau.); *Cephalanthera xiphophyllum* (= *Cephalanthera longifolia* (L.) Fritsch).

Currently, access to this area is practically impossible or restricted due to local security concerns. This situation poses one of the challenges of the scientific research and exploratory efforts aimed at inventorying and locating rare taxa in general, including these three orchids, and perhaps other orchid species.

Conclusion

This study enabled us to identify and geolocate 25 taxa across four genera in the studied region. *Ophrys* species are the most abundant in most of the sampled stations, totaling 17 species, including one hybrid: *Ophrys* × *gautieri*. This hybrid is considered rare and reported for the first time in the Sidi Bel Abbès region, as is the case with *Ophrys tenthredinifera* subsp. *spectabilis*. In the second position, we find the genus *Anacamptis* with three taxa: *Anacamptis collina*, *A. papilionacea* subsp. *grandiflora*, and *A. coriophora* subsp. *fragens*. The genus *Orchis* is represented by three species (*Orchis italica*, *O. anthropophora*, and *Neotinea conica*). *Himantoglossum* comprises only two species (*H. robertianum* and *H. hircinum*).

Some taxa show a wide distribution throughout the Sidi Bel Abbès region, with significant populations, while others are highly localized in specific biotopes. However, the inventory conducted cannot be considered exhaustive. Furthermore, explorations are planned to inventory more species, gain a better understanding of the frequency and status of different taxa in the region, especially considering that some habitats are being compromised due to prolonged periods of drought and increasing anthropogenic pressures (Cherifi & al. 2021).

The preliminary data obtained from this study open up a highly interesting research axis for this family of orchids, which is at risk of extinction due to the degrading factors affecting the territory of the Sidi Bel Abbès region. This situation calls for sustainable management and adequate protective measures to ensure the preservation of these beautiful flowers. However, sustainable management of this plant heritage necessitates tools for characterization, monitoring, and assessment of interactions with human activities.

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Article

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Catalogue des plantes vasculaires du Djebel Ouarsenis (Tissemsilt, Algérie)

Catalog of vascular plants in Djebel Ouarsenis (Tissemsilt, Algeria)

Résumé

Chelghoum, H., Fertout-Mouri, N., Ait-Hammou, M., Rebbas, K. & Miara, M. D.: Catalogue des plantes vasculaires du Djebel Ouarsenis (Tissemsilt, Algérie). — Fl. Medit. 34: 219-232. 2024. — ISSN: 1120-4052 printed, 2240-4538 online.

Dans le but de conserver la divrtsité végétale et les écosystèmes dont elle coexiste, dans la région de Tissemsilt, notre travail vient d'etre présenté comme une contribution à la conaissance botanique d'Algérie, non seulement locale, mais également celle régionale et nationale. Nous fournissons, ici, pour la premiere fois, un inventaire préliminaire des plantes vasculaires de la zone culminante (et ces environs) de l'Ouarsenis sensu stricto (ou Djebel Ouarsenis). Djebel Ouarsenis qui culmine à 1985 m d'altitude (à Bordj Bounaama), doit à toute une chaine montagneuse, sa typonomie actuelle «Ouarsenis» (au sense plus large du mot), qui s'ettend sur une longueur de 200 km, de l'est en ouest, depuis les monts de Titteri jusqu'à ceux de Beni Chougrane. Avec cette élévation, le pic Sidi Amar représente le sommet le plus haut de toute l'Algérie nord occidentale (Atlas tellien Algérois et Oranais).
Au cours de la période 2018 à 2023, suivant la méthodologie phytosociologique, qui consiste à réaliser des relevés floristique, nous avons réalisés une centaine de relvés (126) de surface préditerminer, a lesquelles s'ajoute, indépendament, de nombreuse autres observations parllèlles. Nous avons pu réaliser un catalogue de plus de 558 taxons, répartis en 316 genres et 78 familles. En ce qui conserne l'identification des plantes. Elle s'est bassée essentiellement sur les anciennes flores d'Algérie et/ou les deux pays voisines et/ou de la région ouest méditerranéenne. Ensuite, avant que la synonymie soit mise a jour (ainsi que la chorologie), elle a été comparée avec les basse de données actuellement en vigeurs. Cela, nous a permis de mettre en exergue une quarantaine de plantes endémiques et 22 nouveaux taxons pour la région.

Mots clés: diversité végétale, inventaire, chorologie, conservation, Afrique du Nord.

Abstract

In order to conserve plant diversity and ecosystems in which it coexists, in Tissemsilt provence, our work will be representing as a contribution, to the botanical knowledge of Algeria, not only at local scale, but also at the regional and national ones. We provide, here, for the first time, a preliminary inventory of the vascular plants of the culminating zone (and its surroundings) of Ouarsenis sensu stricto (or Djebel Ouarsenis). Djebel Ouarsenis which culminates at 1985m altitude (in Bordj Bounaama), owes to a whole mountain range, its current typonomy «Ouarsenis» (in the broader sense of the word), which extends over a length of 200 km, from east to west, from the Titteri mountains to those of Beni Chougrane. With this elevation, the Sidi

Amar peak represents the highest peak in the northwestern Algeria (Algiers and Oran Tell Atlas). During the period 2018 to 2023, following the phytosociological methodology, which consists of carrying out floristic surveys, we carried out about a hundred surveys (126) of predetermined surface, to which added, independently, many other parallel observations. We were able to produce a catalog of more than 558 taxa, divided into 316 genera and 78 families. As for the identification of plants. It based mainly on the old floras of Algeria and/or the two neighboring countries and/or the western Mediterranean region. Then, before the synonymy was updated (as well as the chorology), it was compared with the databases currently in force. This allowed us to highlight around 40 endemic plants, and 22 new taxa for the region.

Keywords: plant diversity, inventory, chorology, conservation, North Africa.

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Introduction

Non seulement parce qu'elle présente un potentiels de résistance, mais egalement due a son adaptation vis-à-vis les conditions écologiques, parfois dure comme la sécheresse et la salinité, la flore de la rive sud du bassin méditerranéen, est préviligé par rapport la région dans sa totalité. Cette dernière qui est déjà reconnu d'avoir une biodiversité qualifié de premiere importance en terme de conservation (Amirouche & Misset 2009), est consédirées comme un point chaud (hotspot) de biodiversité végétale (Médail & Quézel 1997; Myers & al. 2000).

Néanmoins, le début des explorations botaniques en Algérie peut être jugé précoce. Cette histoire âgées d'au moins 4 siècles, commenca au environ d'alger en 1620, mais, elle n'a présenté d'importantes significations qu'après les années 1830 (Bensaid & Gasmi 2008). Pendant cette longue période, le seul référentiel qui a visé l'exhaustivité de la dite flore pour l'ensemble du territoire national actuel est celui de Quézel & Santa (1962-1963), faisant suite à la première flore historique de l'Algérie du Nord (Battandier 1888; Battandier & Trabut 1895). Ainsi la «Nouvelle flore d'Algérie et des régions désertiques méridionales» n'est plus actuellement à jour à cause de la caducité qui l'a frappé. Les experts, et à toute occasion, profitent pour lancer un appel urgent et exiger une nouvelle flore actualisée, qui vont ensemble avec le progrès des sciences naturelles au temps actuel (Véla & Benhouhou 2007 ; Bensaid & Gasmi 2008 ; Amirouche & Misset 2009 ; Miara & al. 2018). Bref, dans ce long chemin, l'Ouarsenis n'a connu que quelques trés rares explorations botaniques, souvent de courtes durées (de quelques jours). Toutes ces expéditions n'ont fait l'objet que de quelques rares citations sur des publications génériques et aucune étude d'ensemble n'a été réalisée (eg. Durieu & Cosson 1855; Cosson 1861, 1883-1887; Battandier 1888-1890, 1893; Maire 1952-1987). De meme, au temps actuels, il reste encore loint d'etre suffisament parcouru, à l'exeption de quelques travaux fragmentaires, limités à quelques lambeaux dans l'Ouarsenis sensu lato (généralement les cédraies de Theniet El Had et d'Ain Antar à Boucaid), des travaux, dans lesquels les auteurs ne fournisent pas ou peu de renseignement en ce qui concerne la richesse spécifiques (Sarmoum & al. 2016; Bourorga 2016).

Cette diversité représente donc un réservoir de premier plan en termes de diversité végétale, hébergeant environ 4000 taxons, (Dobignard & Chatelain 2010-2013), néanmoins, cette biodiversité précieuse est confrontée à une menace croissante résultant de l'intéraction de divers facteurs, notamment les activités humaines et le changement climatique. Une exploitation intensive et ancienne de la nature, motivée par diverses considérations historiques et socio-économiques, a considérablement altéré ces écosystèmes (Aidoud-Lounis 1984; Aidoud 1989; Kadi-Hanifi 1998; Quézel & Barbéro 1993).

Entre la méconnaissance et les menaces, toutes les stratégies de conservation de la biodiversité végétale se trouvent devant une barrière difficile à traverser. La résolution des problèmes est liée en premier lieu à l'ignorance des travaux floristiques, qui présentent dans leur totalité des enjeux importants pour la conservation à l'échelle du globe.

Dans le contexte d'une nouvelle flore actualisée, qui répondra aux différentes contraintes scientifiques et de conservation vécue, nous présentons notre inventaire floristique du Dejbel Ouarsenis et ces zones avoisinantes dans sa version préliminaire. En métant l'accent particulierement sur la discription de sa richesse floristique, sa composition biologique et sa biogéographie, afin de participer a la conservation de la nature.

Enfin, nous espérons voir émerger une période où la biodiversité sera bien connue, raisonnablement valorisée et surtout préservée, comme le souhaite tous les amoureux de la nature, qu'ils soient professionnels ou amateurs.

Matériels & Méthode

Zone d'étude

Ouarsenis, un nom qui représente toute une phrase berbère (war sənnig-s), qui veut dire «Rien n'est plus haut que lui» (le mont) (Sari 1977; Chaker & Chemakh 2013). Un nom qui est utilisé par la population autochtone de la tribu de Beni Hendel, qui représente maintenant l'ensemble des communes qui embrassent le point culminant de toute la chaine montagneuse (Le pic de Sidi Amar, 1985 m) à savoir: Bordj Bou Naâma, Boucaid, Sidi Slimane, Lazharia (Ex-Ain Lellout) et Tamalaht, qui a pour but de montrer la grandeur de ce dernier. Ensuite, le mot dans son large sens est utilisé par les géographes français pour délimiter la chaine elle-même, qui s'étale sur 200 km de long depuis les monts de Titteri à l'est (Médéa) jusqu'à ceux de Beni Chougrane vers l'ouest (Relizane), en passant dans l'ordre par les willayas de AinDefla, Tissemsilt, Chlef et Tiaret. La largeur varie également entre 60 et 100 Km entre la vallée de Chelif au nord et le plateau de Sersou au sud (Sari 1977).

Dans ce travail, à l'exemple de plusieurs botanistes explorateurs de la flore algérienne en général, et de celle de l'Ouarsenis en particulier, comme Cosson (1883-1887; 1861), Battandier (1888-1890; 1893) et Maire (1952-1987), nous avons utilisé le terme «Ouarsenis» pour désigner seulement le mont culminant et ses alentoures immédiats (Fig. 1), conformément à l'usage des autochtones. Ouarsenis, est parfois précédé du mot arabe «Djebel», signifiant montagne, afin de distinguer cette dernière région de toute la chaine montagneuse (de méme nom).

D'un point de vue biogéographique, Djebel Ouarsenis est inscrit dans le sous-secteur de l'Atlas tellien algérois (A2) (sensu Quézel & Santa 1962-1963), plus précisément dans ses

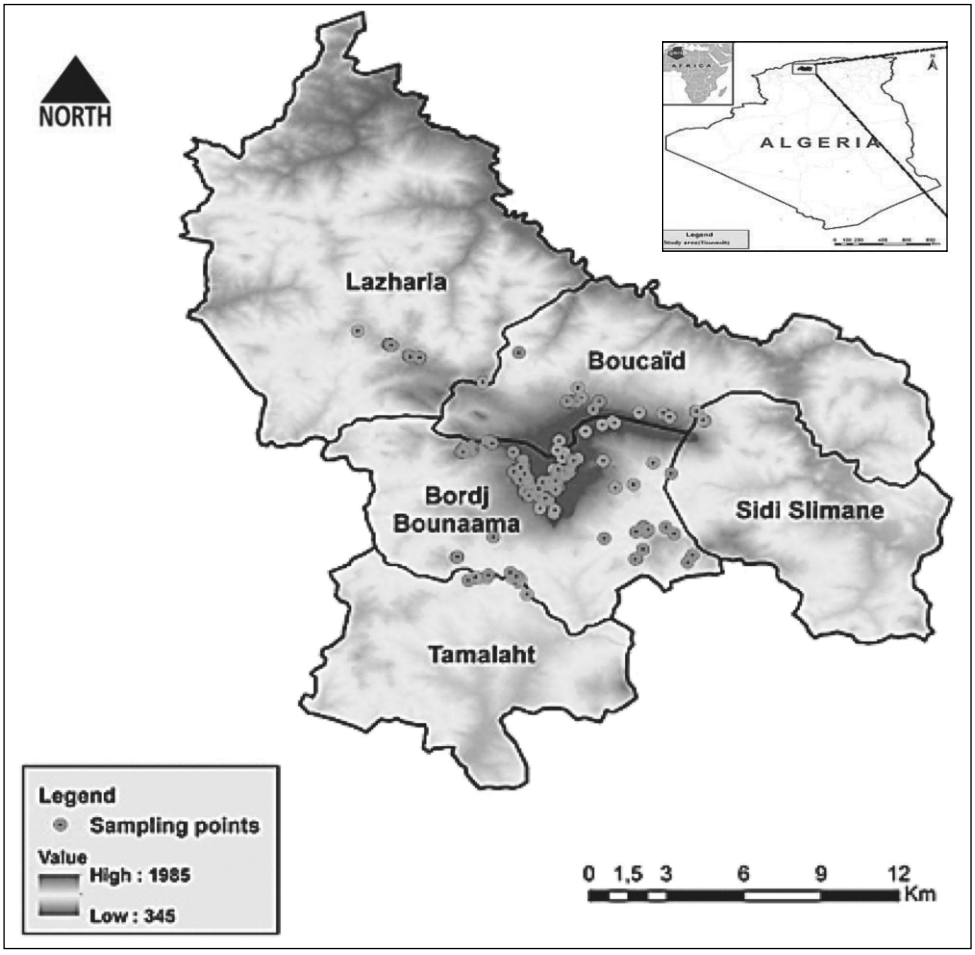


Fig. 1. Carte de la Localisation géographique du « Djebel Ouarsenis », montrant les points échantillonnés et le secteur biogéographiques conserné (extrait de la carte de zonage phytogéographique de Quézel & Santa (1962-1963)).

limites occidentales, en contact direct avec les deux sous-secteurs de l'Atlas tellien oranais et des plaines littorales oranaises, O3 et O2 respectivement. Cette zone est caractérisée par un bioclimat subhumide à hiver froid (Sari 1977; Bourorga 2016). D'un point de vue géologique, elle repose sur le Jurassique calcaire, avec un sol généralement calcaire humifère, comme l'indique Sari (1977).

Le couvert végétal est essentiellement représenté par des forêts pures de chêne vert à feuilles rondes (*Quercus ilex* subsp. *ballota* (Desf.) Samp.) dans les deux versants sud et ouest du Kef Sidi Amar (Kef = mont), tandis que le versant sud du Sra Sidi Abdelkader (Sra = crête) présente un mélange entre le chêne vert et le Pin d'alep (*Pinus halepensis* Mill.). Du côté septentrional de cette dernière crête s'est installé le premier clos de cèdres

(*Cedrus atlantica* (Endl.) Carrière) en Algérie, ce qui déclare à l'ouest le début de son aire de répartition d'aprés la carte phytogéographique d'Algérie-Tunisie de Maire (1926), chez nous (Djebel Ouarsenis) dans les hautes altitudes. En allant vers le nord, la forêt deviendra de plus en plus mixte entre les trois essences précédentes, pour finalement aboutir à une pinède seule (SEF 1930).

Méthodologie

Dans notre étude, la collecte des données s'est concentrée sur le massif de l'Ouarsenis, en mettant particulièrement l'accent sur la zone centrale où le sommet atteint 1985 mètres d'altitude, nommé Kef Sidi Amar, ainsi que ses environs immédiats, incluant les municipalités administratives de Bordj Bounaâma, Boucaïd, Sidi Slimane, Lazharia et Tamalaht. Les observations sur le terrain ont été menées sur une période s'étalant de 2018 à 2024.

Nous avons effectué plus de 126 relevés phytoécologiques dans tout le massif et ses environs en utilisant la méthode d'échantillonnage stratifié de Gounot (1969), en fonction du gradient altitudinal et du couvert végétal (chênaie, cédraie, pinède, matorral…). De plus, nous avons complété ces relevés en explorant la région de manière exhaustive à l'aide d'une méthode subjective-aléatoire, pour couvrir toute l'aire d'étude en essayant autant que possible de remplir les périmètres échappés du premier échantillonnage (ville, habitation rural, bord des routes, propriété privé…). Cette approche combinée nous a permis d'établir une liste régionale représentative de la diversité des plantes présentes dans ce Djebel.

Nous avons exploité initialement la flore algérienne de Quézel & Santa (1962-1963) comme première référence pour l'identification des plantes (prédéterminations) d'une part et l'attribution des types chorologiques d'une autre part. Ensuite, de nombreux travaux nous ont servi à la mise à jour de nomenclature et de la synonymie à l'exemple de l'index synonymique des plantes de l'Afrique du nord (Dobignard & Chatelin 2010-2013) et sa version en ligne «African Plant Database» APD (2024), du jardin botanique de Genève et la base de données «Plants of the Word Online» du jardin royal de Kew (POWO 2024), conformément à la quatrième classification phylogénique (APG IV 2016). La confirmation et/ou révision des premières prédéterminations sont faite sur la base des anciennes flores d'Algérie plus précises (Pomel 1874-1875; Battandier 1888-1890; Battandier & Trabut 1895; Maire 1952-1987) et celles des pays limitrophes plus modernes, tel le Maroc (Fennane & al. 1999-2014; Valdès & al. 2002) et la Tunisie (Pottier-Alapetite 1979-1981). Sauf quelques déviations discutées séparément dans une autre publication en préparation (Chelghoum & al. inédite), qui sont indiqués en astérisque (*) dans le présent catalogue. Les types chorologiques sont alors complétés et/ou modifiés suivant les nouvelles données en vigueur (Carazo & Fernandez 2006; Tison & Foucault 2014).

Les taxons sont identifiés sur place pour les espèces facilement reconnaissables, tandis que les plantes méconnues et/ou problématiques sont photographiés puis récoltées pour confectionner un herbier personnel (qui sera déposé à l'herbier d'Algérie à l'école nationale supérieur d'agronomie (ENSA) à Alger) et ensuite analysés au laboratoire lorsque cela s'avérait nécessaire.

Chez les phanérogames (et les Ptéridophytes), selon le système classification de Raunkiaer (1934), on peut définir les types biologiques des espèces d'après de leurs morphologies et leurs rythmes biologiques, en fonction de la nature et la position de leurs organes (bourgeons) de survie après la ou les mauvaises saisons (période défavorable de

point de vue climatique). Ces éléments illustrent le potentiel adaptatif de la végétation faces aux fluctuations et instabilités des conditions environnantes (Dahmani 1997), en faite, les expériences ont montrés qu'une seule plante peut comporter défèrement en dépond du climat (Kaabache 1995). ce qui nécessite une certaine précaution lors de la détermination de ces types pour une déscription meilleure de la physionomie et la structure de végétation d'une région donnée (Miara & al. 2018). Pour attribuer un type biologique à chaque taxon, conformément à cette classification (Raunkiaer 1934), nous avons consulté diverses sources documentaires, notamment les travaux de Fennane & al. (1999-2014) ainsi que des études régionales détaillées réalisées par Miara & al. (2018), en complément de nos propres observations sur le terrain le cas échéant.

Nous avons présenté nos résultats ci-après sous forme d'un catalogue, dans un ordre systématique des unités supérieures, et alphabétique pour les familles, les genres et les espèces. Pour chaque taxon, nous avons commencé par sa nomenclature actuelle selon Dobignard et Chatellin (2010-2013) et sa version électronique (APD 2024), ensuite, nous avons indiqué sa synonymie dans la flore de référence (Quézel & Santa 1962-1963), ou celle d'Afrique du Nord (Maire 1952-1967). Suivi enfin par son type biologique et chorologique respectivement.

Les types biologiques sont codifiés comme suit: Cham.: Chaméphyte, Hémi.: Hémicryptophytes, Th.: Thérophytes, Ph.: Phanérophytes et Géo.: Géophytes., d'autre sous-types qui sont toujours rattachés aux principaux types, sont mis entre parenthèse: Les lianes: (Lian.), et les parasites (Par.).

De même pour les types Chorologiques, ils sont représentés par les abréviations qui se suivent: Adventice: Adv., Africaine: Afr., Asiatique: Asiat., Bético-Maghrebien: Bético-Magh., Bético-Nord-Africain: Bético-NA., Cosmopolites: Cosm., Cultivée, Endémique: End., Européenne: Eur. Eurasiatique: Euras., Tempéré: Temp. Caucasiennes: Caucas., Holarctique: Holarc., Atlantique: Atl., Touranienne: Tour., Tropicale: Trop., suivi toute fois par les noms des pays (ou région) de la façon précédente: Algérie: Alg., Maroc: Mar., Tunisie: Tun., Libye: Lib, Italie: It., Maghreb: Magh.

Résultats

Le catalogue des plantes vasculaires du Djebel Ouarsenis est présenté dans le Fichier Electronique Supplémentaire (FSE) 1.

Notre exploration botanique dans «Djebel Ouarsenis» nous a permis de compter 558 espèces et sous-espèces de plantes vasculaires, répartie comme l'indique le tabeau 1: en 78 familles et 316 genres.

Les ensembles chorologiques (Tableau 2) montrent une nette dominance du groupe méditerranéen avec une fréquence de 44,62 % soit 249 espèces. Suivent les groupes a Large répartition & Cosmopolites avec une fréquence de 25,81 %, puis les Sub-Endémiques et par les Nordiques avec des fréquences respectives de 12,19 et 9,15 % soit respectivement 68 et 51 espèces. Par ailleurs, les Endémiques constituent 8,24 % de la flore inventoriée soit 46 des 558 espèces au totale.

L'analyse du spectre biologique de la région d'étude (Tableau 3) montre une supériorité numérique considérable des Thérophytes, elles dominent tous les autres types avec 223 taxons (40 %), suivi par les hémicriptophytes avec 123 espèces (24 %). Les géophytes ont pris la troisième place avec 94 plantes (17 %). Les deux derniers, Chaméphytes et Phanérophytes sont respectivement représenté par 58 (10 %) et 51 (9 %).

Tableau 1. Récapitulatif de la richesse floristique de Djbel Ouarsenis.

		Ptéridophytes		Gymnospermes		Angiospermes	
	Total	Nombre	%	Nombre	%	Nombre	%
Familles	78	4	5,1	3	3,85	71	91,03
Genres	316	5	1,6	5	1,58	306	96,84
Espèces (Rang infraspécifique inclus)	558	5	0,9	5	0,9	548	98,21

Tableau 2. Types phytogéographique de la zone étudiée.

Ensembles Chorologiques		Nombre d'espèces	%
Méditerranéennes	Méditerranéennes	148	27
	Ouest Méditerranéennes	74	13
	Sud-Ouest Méditerranéennes	9	1,6
	Sud Méditerranéennes	7	1,3
	Centre & Ouest Méditerranéennes	4	0,7
	Euro-Méditerranéennes	3	0,5
	Nord Africo-Siciliennes	1	0,2
	Nord et Ouest Méditerranéennes	1	0,2
	Sud-Ouest Europe & Nord Afrique	1	0,2
	Sténo-Méditerranéennes	1	0,2
	Total	**249**	**45**
Endémiques	Algériennes	14	2,5
	Algéro-Marocainnes	20	3,6
	Algéro-Tunisiennes	12	2,2
	Total	**46**	**8,2**
Sub-Endémiques	Maghrébines	21	3,8
	Bético-Maghrébines	17	3
	Nord Africaines	13	2,3
	Ibero-Maghrébines	7	1,3
	Ibéro-Nord Africaines	4	0,7
	Bético-Nord Africaines	2	0,4
	Italo-Maghrébines	2	0,4
	Algéro-Maroco-Sardigne	1	0,2
	Algéro-Tuniso-Italiennes	1	0,2
	Ibero-Algériennes	1	0,2
	Maghrebo-Siciliennes	1	0,2
	Total	**70**	**13**
Nordiques	Paléo-Tempéré	37	6,6
	Eurasiatique	7	1,3
	Sud Européennes	2	0,4
	Sud Eurasiatiques	2	0,4
	Euro-Sud-Ouest Asiatiques	1	0,2
	Holarctique	1	0,2
	Paléo-Tropical	1	1
	Total	**49**	**8,8**

Tableau 2. suite.

Large répartition et Cosmopolites	Euro-Méditerranéennes	70	13
	Méditerrano-Atlantique	20	3,6
	Méditerrano-Tourannienne	12	2,2
	Cultivée	5	0,9
	Cosmopilite	4	0,7
	Méditerrano- O Asiatique	3	0,5
	Naturalisé	3	0,5
	Méditerrano- Centre Asiatique	2	0,4
	Méditerrano-Asiatique	2	0,4
	Sub-Cosmopolite	2	0,4
	Sub-Tropical	2	0,4
	Ouest Méditerrano-Atlantique	2	0,4
	Eurasiatique-Nord Africaine	1	0,2
	Eurasiatique et Africaine	1	0,2
	Eurasiatique Tempérée	1	0,2
	Eurocaucasienne	1	0,2
	Méditerrano-Eurasiatique	1	0,2
	Méditerrano-Saharo-Sindienne	1	0,2
	Sud Eury-Méditerranéenne	1	0,2
	Sud Méditerrano-Touranienne	1	0,2
	Sub-Atlantique	1	0,2
	Sud Ouest Asiatique	1	0,2
	Ouest Asiatique	1	0,2
	Ouest Eury-Méditerranéenne	1	0,2
	Ouest Méditerrano- Sub- Atlantique	1	0,2
	Total	**142**	**25**

Tableau 3. Types biologiques de la zone d'étude.

Types biologiques	Nombre d'espèces	Pourcentage
Lianes	8	1,4
Parasites	13	2,3
Phanérophytes	49	8,8
Chaméphytes	57	10
Géophytes	89	16
Hémicryptophytes	142	25
Thérophytes	221	40
Total	558	100

Discussion des résultats

L'exploration botanique que nous avons initié durant la période 2018 à 2023 à Djebel Ouarsenis et ces zones avoisinantes, nous a permis de compter 558 espèces et sous espèces de plantes supérieurs (phanérogames), réparties en 78 familles et 316 genres. Cette diversité représente 12,54 % de toute la flore signalée jusqu'à pèsent en Algérie (incluant le Sahara) par Dobignard & Chatelain (2010-2013), ou encore, 13,8 % des plantes du Maghreb méditerranéen (Algérie, Maroc, Tunisie) (Rebbas 2014). Notons que cette zone ne représente qu'une partie de toute la chaine montagneuse du même nom «Ouarsenis».

Dans ce premier inventaire suffisamment exhaustif, nous avons pu mettre en évidence divers aspects de la flore en question, à savoir l'actualisation de sa nomenclature, sa systématique et sa composition tant chorologique que biologique en changement permanent. Une tache négligée pourtant basique pour la conservation de la phytodiversité (Véla & Benhouhou 2007). Une liste floristique est ainsi parmi les clés essentielles qui conduisent les chercheurs à mieux comprendre la diversité végétale de leurs régions d'études (Boudik & al. 2024).

En Afrique du Nord, la diversité biogéographique revêt une importance cruciale pour la surveillance de la biodiversité et le maintien des écosystèmes. Il est donc primordial de mener une étude phytogéographique, qui constitue une base essentielle pour toute tentative de conservation de la biodiversité (Quézel 1999). Cette région abrite une grande variété d'habitats, allant des déserts aux montagnes en passant par les littoraux, ce qui permet la survie d'une multitude d'espèces végétales adaptées à des conditions environnementales différentes. Ceci est dû sans doute aux modifications climatiques que cette zone a subit depuis le Miocène. Selon (Quézel & Médail 2003) ces modifications ont conduit à la migration d'un certain nombre d'espèces tropicales et extratropicale dans la région méditerranéenne. L'hétérogénéité des origines de la flore méditerranéenne sur différentes espèces par élément biogéographique a été soulevée pour la première fois par Zohary et Hoff (1974). L'expression floristique et phytosociologique d'un territoire étendu bien défini qui englobe les espèces et les collectivités phytogéographiques caractéristiques d'une région ou d'un domaine déterminé constitue l'élément phytogéographique selon Braun-Blanquet (1919).

De point de vue biologique, après l'analyse du spectre biologique, Djebel Ouarsenis, comme la majorité des régions à formations végétales forestières et préforestières de l'atlas tellien en Algérie (eg. Babali 2014 ; Miara & al. 2018) et dans les zones des Haut plateaux comme indiqué par Aiboud (1983) dans l'ouest du pays, sont caractérisées par un taux élevé des thérophytes (ici = 40 %). Malgré qu'on estime déjà qu'elle représentent une portion de 50 % dans l'ensemble de la région méditerranéenne (Olivier & al. 1995), la thérophysation, résultant d'aridisation, de surpaturage et la forte pression anthropique, peut donner une image sur l'état des milieux forestiers, justifiant ainsi l'ouverture et la dégradation de ces derniers (Miara & al. 2018).

Bien que la flore d'Algérie soit caractérisée par une diversité considérable et une importance significative (Véla & Benhouhou 2007; Yahi & al. 2012; Benhouhou & al. 2018), les informations actuelles à son sujet demeurent, dans une certaine mesure, obsolètes en ce qui concerne la répartition géographique des espèces et leurs synonymies (Chelghoum & al. 2020). pour mettre à jour et d'enrichir nos connaissances sur cette flore, visant à lui conférer une dimension plus moderne et actualisée, il apparaît désormais impératif, voire urgent, d'entreprendre la rédaction d'une nouvelle flore (Miara & al. 2014; Véla 2018; Chatelain & al. 2018), que ce soit, à partir des herbiers historiques, en raison du caractère incomplet de la bibliographie disponible, ou par les explorations, en raison de la rareté des recherches floristiques actuelles dans notre pays.

Dans cette optique, nous avons pu résoudre quelques problemes d'ordres taxonomiques et de biogéographie Algérienne de quelques plantes endémiques (sub-endémique inclus) et/ou rares (Chelghoum & al. 2020). A cela, s'ajoute *Delphinium balansae* et *Tuberaria macrosepala* indéqués déjà réspectivement par Cosson (1861) et Battandier (1893) à l'Ouarsenis, oubliées depuis, et ne figure pas dans la flore de Quézel & Santa (1962-1963) (Tableau 4.). En outre, la plus grande partie de ces nou-

Tableau 4. Nouvelle répartition en Algérie de quelque plantes intéressantes observées a l'Ouarsenis. (Nouvelles indication sous-tendu en gris).

Espèces	Chorologie	Répartition en Algérie (Quézel & Santa 1962-1963)	Notes
Bellis rotundifolia (Desf.) Boiss. & Reut.	**End. Alg-Mar.**	RR: O3, H1 + Ouarsenis	Obs. Pers.
Brassica gravinae Ten. sensu lato	**End. NA.**	AC: sur les montagnes et les hauts plateaux à l'E d'Alger. R: Ouarsenis, Sersou ...etc	Obs. Pers.
Crepis foetida L.	**Eury-Médit.**	RR: Cl: Constantine à Sidim'cid + Ouarsenis	Obs. Pers.
Delphinium balansae Boiss. & Reut.	**End. Magh.**	R: Djurdjura, Babors, Aurès, Atlas saharien, Mts de Tlemcen, Ouarsenis	Cosson (1861)
Dianthus atlanticus Pomel	**End. Alg.**	R: K1-2 ; A2: Ouarsenis, Zaccar et Bou Maad ; AS3: Aurès ; C2: Bellezma	Chelghoum & al. (inedit)
Gagea chabertii Terracc.	**End. Alg-Tun.**	R : A2 : Médéa & Ouarsensis, 01 : Oran, 03 : Tlemcen	Obs. Pers.
Iberis peyerimhoffii Maire	**End. Alg.**	RR: A2: Mt du Bou Maad et Ouarsenis	Chelghoum & al. (inedit)
Linaria tristis subsp. *mesatlantica* D.A. Sutton	**End. Alg-Mar.**	R: O1: Nedroma ; A2: Ouarsenis, Boghar? ; K1: Djurdjura ; A1?	Miara & al. (inedit)
Malva stenopetala (Batt.) Soldano, Banfi & Galasso	**End. Alg-Tun.**	AR: A1-2, K1-2, C1, H1-2	Chelghoum & al. (2020)
Muscari neglectum Guss. ex Ten.sensu lato	**Bético-Alg-Mar**	AC : en Oranie et dans le Constantinois, Ouarsenis	Obs. Pers.
Ononis hispida Desf subsp. *hispida*	**Magh-Sicil.**	C: dans le Tell oriental, Ouarsenis	Obs. Pers.
Orobanche clausonis Pomel. subsp. *clausonis*	**End. Alg.**	RR: A2: Mouzaia, Ouarsenis; O3: Mazis à Tlemcen	Chelghoum & al., (inedit)
Phelipanche ducellieri (Maire) Holub	**End. Alg.**	H1: Saïda; A2: Ouarsenis	Chelghoum & al. (inedit)
Plantago atlantica Batt.	**End. Alg.**	R: A2: Téniet el Haad, El Chaouen et Ouarsenis, ~~03: Mt de Tlemcen~~	Chelghoum & al. (inedit)
Reseda collina Müll. Arg.	**End. NA.**	C: 01-2-3. AR: Hl-2, A2: Ouarsenis.	Obs. Pers.
Silene ghiarensis Batt.	**End. Alg.**	R: A2: Ouarsenis, Médéa, 02: Ain Tolba (Guiard), Ain Temouchent, Ain el-Berd (Oued Imbert)	Obs. Pers.
Silene velutinoides Pomel	**End. Alg-Mar-Sard.**	R : 03 : Tlemcen, Ghar-Rouban, Hl, Cl : Constantine.	Obs. Pers.
Sixalix daucoides (Desf.) Raf.	**End. Alg-Tun.**	AC: A2: Moyen Cheliff. RR: ailleurs. Cl : St Armand, Al : Sahel d'Alger	Obs. Pers.

Tableau 4. suite.

Teucrium aureiforme Pomel	**End. Alg.**	R : O1: Dahra; O3: Tiaret; A2: Ouarsenis	Miara & al. (2018); Chelghoum & al. (inedit)
Tuberaria macrosepala (Boiss.) Willk.	**Ibero-Magh.**	R: 01-3, K2, A2: Ouarsenis	chelghoum & al. (inedit)
Verbascum battandieri (Murb.) Hub.-Mor.	**Alg-Mar.**	RR: Hl: Boghar, Djelfa, A2: Ouarsenis, 02: Oran, O3: Tlemcen & Tiaret	chelghoum & al. (inedit)
Verbascum faurei (Murb.) Hub.-Mor. subsp. *faurei*	**End. Alg-Mar.**	R : 02-3, A2: Ouarsenis	Obs. Pers.

vauté existent dans l'un des secteurs voisins de l'atlas tellien Algérois (A2), l'atlas tellien et les plaines littorale Oranais (O3 et O2 respectivement). Ce qui fait de notre région, située à la limite ouest de l'Algérois, une bonne zone de transition entre les trois sous secteurs, encore une cause de plus pour justifier sa richesse spécifique ! D'autre part, ces indications, ne pourraient être toutes considérées «nouvelles» du fait que la région est très peut explorées comme déjà indiqué ci-dessus.

Conclusion

Au début de nos explorations botaniques dans la région de l'Ouarsenis, nous avons fixés plusieurs objectifs. Premièrement, de contribuer à l'enrichissement des connaissances sur les végétaux de la région de l'Ouarsenis s.s (ou Djebel Ouarsenis), l'Ouarsenis s.l (toute la chaine de l'Ouarsenis), et l'Algérie à grand échelle. Nous avons commencé par le Djebel central (El-Wancharis = Ouarsenis), à nos jours, après 6 ans de recherches botaniques approfondies, on estime la présence de plus de 12,5 % de la flore Algérienne, soie 558 taxons répartie en 78 familles et 316 genres, ce chiffre qui peut augmenter avec l'intensité des travaux scientifiques exploratoires (sur la botanique comme sur d'autre domaine biologique). Il est important de noter que 20,43 % sont des endémiques ou des subendémiques, essentielles dans toutes méthodologies conservationnistes.

Dans une autre optique, nous avons essayé d'attirer l'attention sur une région autant menacée et négligé que méconnue, par l'évaluation de sa richesse spécifique. En fait, on ne peut ni conserver ni valoriser ce qui n'est pas connu, parlant sur le cas en Algérie, la majeure partie des zones naturelles souffrent d'une forte action anthropozoïque conjugué d'un réchauffement climatique, sous la vision des autorités responsable de conservation de diversité biologique qui se trouvent devant une grave carence de données. Nous donnons l'exemple ici par la zone culminante, le rythme actuel des carrières va ravager toute la forêt, une niche écologique «de première importance» de nombreuse plantes endémiques ou rares (ou les deux à la fois), autrement qualifié de plantes à hautes valeurs de conservation, tant pour des plantes que d'autre organisme vivants (à suivre). L'Ouarsenis sensu-stri-

co ainsi que les autres monts de la chaine, surtout orientale (la forêt de Boughar, Echaouen, Djebel Elouh, Amrouna…), n'échappe pas à ces menaces et restent également inexplorés dans son ensemble. De même, vers l'oranais et les hauts plateaux de l'Ouarsenis, il n'y a qu'au niveau de la région de Tiaret qu'il ya eu des explorations récentes et exaustives.

En ce qui concerne le parc national de Theniet el Had, bien qu'il soit connu par sa richesse en biodiversité et qu'il a fait sujet de nombreuses études en grande partie inédites, il reste loin d'être complètement exploré. Les données disponibles se limitent, entre autres à des catalogues ou des listes timides, affichées au niveau du siège de l'administration du dit parc national. Néanmoins même ces données restent loin d'être mises à jour selon les données actuellement en vigueur.

Notre région d'etude le Djebel Ouarsenis qui a toutes les chances d'être classée parc national ne possède aucun statut de protection, bien qu'elle l'eût été à l'époque coloniale (SEF 1930).

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Article

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Two new taxa for the flora of Georgia (Sakartvelo, Caucasus)

Abstract

Lachashvili, N., Kereselidze, K. & Khetsuriani, L.: Two new taxa for the flora of Georgia (Sakartvelo, Caucasus). — Fl. Medit. 34: 233-238. 2024. — ISSN: 1120-4052 printed, 2240-4538 online.

Two new species for the flora of Georgia - *Cerastium perfoliatum* and *Valerianella sclerocarpa* are recorded. They were found in the semiarid climate zone (BSxa) on the eastern ending of Iaghluja Ridge in the Rustavi vicinity (Kvemo Kartli region, East Georgia). They grow in the hemixerophytic and xerophytic shrubberies on the dry grey-cinnamonic soils. Coordinates, altitude and a map of the new location of target species are given in the article. The voucher herbarium specimens are housed at the National Herbarium of Georgia (TBI).

Key words: new records, *Cerastium perfoliatum*, *Valerianella sclerocarpa*, distribution area, Caucasus.

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Introduction

The flora of Georgia is distinguished by a great diversity. In this small area of 69.700 km² 4275 species of vascular plants are recorded (Davlianidze & al. 2018). However, the discovery of new taxa for the flora of Georgia continues to this day (Lachashvili & al. 2004, 2007; Lachashvili 2014; Jinjolia & Shakarishvili 2014; Lachahsvili & Eradze 2017; Kereselidze & al 2021, etc.). For comparison, we note that 4130 species are included in the first edition of the Checklist of the Flora of Georgia (Gagnidze 2005). Such a difference is related to new field and literature data.

During the phytosociological studies conducted in 2021-2023 two new species for the flora of Georgia were found on the Iaghluja Ridge (East Georgia, Kvemo Kartli). They are *Cerastium perfoliatum* L. (*Caryophyllaceae*) and *Valerianella sclerocarpa* Fisch. & C.A. Mey. (*Valerianaceae*).

The native range of *Cerastium perfoliatum* includes Mediterranean (Spain, Morocco, Lebanon-Syrian desert), Balkan peninsula (Bulgaria and Turkey-in-Europe), east part of Europe, Caucasus, Crimea, Anatolia, south part of Central Asia, South-West Asia (south-east of Iran, Iraq). In the South Caucasus it was known from Armenia and Azerbaijan until

now (Khalilov 1952; Shishkin & Avetisyan 1956; Sell & Whitehead 1964; Cullen 1967; Akhani 1998; Sokolova 2012; Euro+Med 2006-; POWO 2023).

Valerianella sclerocarpa is characterized by disjunctive distribution area. Its total native range includes Central Asia (Mountain Turkmenistan and Tajikistan), South-West Asia (north part of Iran, Afghanistan), Caucasus, East Mediterranean (Israel, Jordan and Palestine) and Arabian Peninsula. In the Caucasus it was known from Armenia, Azerbaijan and Russian Federation (south part of Dagestan) until now (Karyagin 1961; Avetisyan 1980; Galushko 1980; Akhani 1998; Mikheev 2008; Llewellyn & al. 2011; Euro+Med 2006-; Danin & Fragman-Sapir 2016+: Ali-Shtayeh & Jamous 2018; POWO 2023).

Materials and Methods

Collection of floristic and phytosociological data was carried out over 2021-2023. Phytosociological descriptions (relevés) of plant communities were carried out using the Braun-Blanquet method (1964). Observation and monitoring of target species, as well as phytosociological surveys of plots, were conducted flowering and fruiting periods. The number of individuals of the target species was counted in each plot. Target species were assessed using IUCN Red List (2021) categories and criteria.

Results

Description of the study area. – *Cerastium perfoliatum* and *Valerianella sclerocarpa* were found on the eastern ending of Iaghluja Ridge in the Rustavi vicinity (Kvemo Kartli region, East Georgia) (Fig. 1).

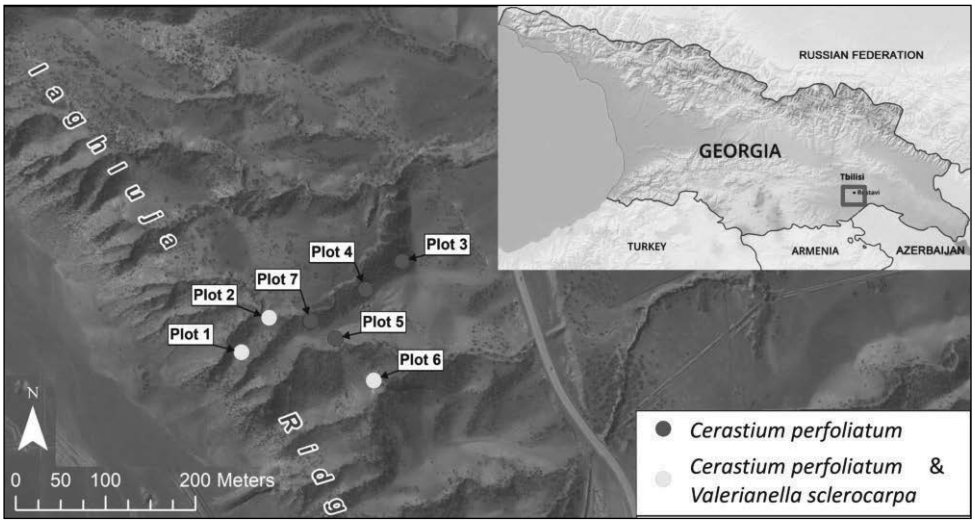


Fig. 1. Map of distribution of *Cerastium perfoliatum* and *Valerianella sclerocarpa* in Georgia.

The Iaghluja Ridge is located in the Kvemo Kartli lowland, which it divides into two parts. The new distribution area of these species is characterized by the alternation of slopes and ravines of different inclinations and exposures. The area belongs to moderately warm steppe climate zone with hot summer and precipitation with two minimum per year (BSxa). The average annual temperature is up to 13°C. The average annual precipitation is in the range of 400-440 mm. Evaporability exceeds 1000 mm. Humidity ratio is lower than 0.6 (Gobejishvili 2012; Bolashvili & al. 2018). Various modifications of gray-cinnamonic soils with varying degrees of salinity are developed. In most cases the soils are skeletal (stony) or clayey (Urushadze 1999, 2016).

This territory is used for pasture and are under permanent anthropogenic pressure.

New data on target species. – The key data on the distribution of the mentioned species in Georgia on the Iaghluja Ridge are presented below.

Cerastium perfoliatum grows on the dry slopes and ravines in the various hemixerophytic and xerophytic shrubberies, in particular in the plant communities of *Paliurus spina-christi* Mill., *Atraphaxis spinosa* L. and *Caragana grandiflora* (M. Bieb.) DC. both on the skeletal (stony) or clayey gray-cinnamonic soils.

- N 41.541667°, E 44.973889°; 475 m a.s.l.; approximately 100 individuals;
- N 41.541389°, E 44.973333°; 475; 4 individuals;
- N 41.540833°, E 44.973611°; 475-485 m a.s.l.; approximately 2300 individuals;
- N 41.540833°, E 44.972778°; 497 m a.s.l.; 7 individuals;
- N 41.541083°, E 44.972217°; 500-550 m a.s.l.; approximately 300 individuals;
- N 41.540833°, E 44.972222°; 498 m a.s.l.; approximately 100 individuals.

Total area of occupancy of *Cerastium perfoliatum* on the Iaghluja Ridge is about 14440 m². The total number of individuals of *C. perfoliatum* in the new sites is approximately 2850.

Valerianella sclerocarpa was found in the xerophytic shrubberies, in particular in the plant communities of *Atraphaxis spinosa* and *Caragana grandiflora*. Its individuals are recorded only on the gray-cinnamonic soil containing clay.

- N41.540833°, E44.973611°; 475-485 m a.s.l.; approximately 240 individuals;
- N41.541083°, E44.972217°; 500-550 m a.s.l.; approximately 200 individuals;
- N41.540833°, E44.972222°; 498 m a.s.l.; approximately 200 individuals.

Total area of occupancy of *Valerianella sclerocarpa* on the Iaghluja Ridge is about 6400 m² and total number of individuals is approximately 640.

It should be noted that no target species were observed outside the above plots.

Target species in the new distribution area are under permanent anthropogenic pressure (grazing). Nevertheless, the condition and vitality of both species are satisfactory. Most of their individuals blooms, bear fruit and complete their life cycle (Fig. 2).

In accordance with the IUCN regional assessment, *Cerastium perfoliatum* and *Valerianella sclerocarpa* were preliminarily assessed as critically endangered [CR B1ab(iii) + 2ab(iii)].

The herbarium specimens are housed at the National Herbarium of Georgia (TBI). Barcodes of the herbarium specimens are given below:

***Cerastium perfoliatum*:** TBI1068168, TBI1068169, TBI1068170, TBI1069321, TBI1069322, TBI1069323, TBI1069324, TBI1069325, TBI1069326

***Valerianella sclerocarpa*:** TBI1068162, TBI1068163, TBI1068164, TBI1068165, TBI1068166, TBI1068167, TBI1069327, TBI1069328, TBI1069329, TBI1069330, TBI1069331, TBI1069332, TBI1069333, TBI1069334



Fig. 2. *Cerastium perfoliatum* (a) and *Valerianella sclerocarpa* (b) in various phases on the Iaghluja Ridge (photos by N. Lachashvili).

Discussion

Cerastium perfoliatum and *Valerianella sclerocarpa* in Georgia are distributed in the characteristic of them semi-arid climate conditions and on the corresponding dry soils. Moreover, they grow in the natural plant communities. Their individuals were not observed in the ruderal areas, roadsides and other similar secondary habitats.

Therefore, in our opinion, they are not newly common in Georgia. We think that due to the smallness of the distributed area, these species did not fall into the field of view of scientists. Proof of this is *Tulipa biflora* Pall., which was found a few years ago in this exact location (Kereselidze & al. 2021). It must be noted that *Cerastium perfoliatum* and *Valerianella sclerocarpa* were found during the study of *Tulipa biflora*.

In addition, the distribution area of these species is far away from the highway and has no connection with it, which excludes the invasiveness of these plants. In case of invasion, these species should first spread on the roadsides and in the ruderal areas.

The discovery of new species with such a small area within Georgia is regular, because the country is located in the intersection area of different floristic centers, which conditions the natural distribution of typical and widespread species for different regions.

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Article

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V. Spadaro, P. Marino, L. Scuderi, G. Venturella & F. M. Raimondo

Biodiversity in some populations of *Crataegus* (*Rosaceae*) from western Sicily: Description of two new species and notes on conservation and valorisation

Abstract

Spadaro, V., Marino, P., Scuderi, L., Venturella, G. & Raimondo, F. M.: Biodiversity in some populations of *Crataegus* (*Rosaceae*) from western Sicily: Description of two new species and notes on conservation and valorisation. — Fl. Medit. 34: 239-255. 2024. — ISSN: 1120-4052 printed, 2240-4538 online.

The genus *Crataegus*, distributed across the temperate regions of almost all continents, constitutes an extremely variable taxon within *Rosaceae* family. Hundreds of tree and shrub species have been described within it, along with an unknown number of subspecies, varieties and hybrids, partly of medicinal interest and in some cases also with edible fruits. According to recent studies, Sicily – an island in the center of the Mediterranean – constitutes a biodiversity hotspot for this genus in Italy. In this article the authors outline the biological diversity of Sicilian populations recognized at various taxonomic levels. In addition to the known specific and infraspecific taxa, two new species are described: *Crataegus drepanensis* and *Crataegus zichichii*. Also, the results of recent studies on the biological activity of extracts of flowers or fruits of some Sicilian populations of hawthorn investigated so far are recalled, thus proving that they represent a valuable resource of natural health products. Regarding one of the described species (*C. zichichii*), on the basis of the environmental and landscape value it possesses – as well as decorative – a possible enhancement of it in the forest nursery field and in urban greenery is advocated. Finally, in view of the dangers to which the populations are subjected – particularly that of *C. drepanensis* – ways of i*n situ* and *ex situ* conservation are envisaged, and for this possible actions to be implemented are proposed.

Key words: dendrological biodiversity, Central Mediterranean, *Crataegus drepanensis*, *Crataegus zichichii*, bioactive compounds, safeguard measures.

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Introduction

In the Mediterranean region, Sicily is one of the most heterogeneous and biologically rich territories due to its unique geo-morphological, pedological and climatic features, as well as its central location in the Mediterranean Sea. This combination creates numerous environments that contribute to its remarkable biodiversity (Raimondo 2004).

In the native vascular flora of Sicily, consisting of about 2,770 specific and infraspecific taxa (Bartolucci & al. 2024), trees are represented by a modest number of units, which amount to about 135 taxa. The Sicilian dendroflora is diverse and enriched by woody or shrubby polycormic species that, under certain conditions and with age, can attain tree-like dimensions. Some genera, such as *Quercus* L., *Crataegus* L., *Tamarix* L., *Pyrus* L., *Aria* (Pers.) Host, exhibit high taxonomic diversity (Raimondo 2013; Spadaro & Raimondo 2023).

Crataegus, contains 140-265 or even up to 1,200 species; these are shrubs or trees, widespread mainly in the temperate regions of the northern hemisphere (Christensen 1992).While it is a well-defined genus, it presents taxonomic challenges due to its variability resulting from extensive hybridization, apomixis and polyploidy (Dickinson & Campbell 1991; MirAli & al. 2011). Intense and prolonged human activity appears to be an important evolutionary factor that has shaped the taxonomic diversity of hawthorn. The creation of new habitats has disrupted dispersal barriers, increased gene flow between isolated populations, and facilitated hybridization, potentially leading to new species adapted to human-induced environmental changes (Oklejewicz 2013).

Moreover, *Crataegus* species are ecologically significant, providing excellent nesting sites for birds, while their fruits serve as a food source for songbirds, game birds, small mammals, and ungulates (Fichtner & Wissemann 2021).

In addition to their ornamental and ecological value, *Crataegus* species are renowned for their medicinal and nutraceutical properties. Hawthorn fruits, leaves and flowers are rich in bioactive compounds, such as antioxidants, flavonoids and phenolic acids, which have beneficial effects on human health. These components are used in traditional medicine to treat various conditions, including heart and digestive disorders (Nazhand & al. 2020).

Species of the genus *Crataegus*, commonly known as hawthorn, represent a significant element of biodiversity in Sicily. It includes the following specific and infraspecific taxa and nothotaxa: *Crataegus azarolus* L. var. *azarolus, C. azarolus* var. *aronia* L., *C. azarolus* var. *chlorocarpa* (Moris) K.I. Chr., *C. laevigata* (Poir.) DC., *C. monogyna* Jacq. var. *monogyna, C. monogyna* subsp. *azarella* (Griseb.) Franco, *C. monogyna* var. *lasiocarpa* (Lange) K.I. Chr., *C. laciniata* Ucria*, C. orientalis* subsp. *presliana* K.I. Chr., *Crataegus* × *media* nothovar. *sicula* (K. Koch) K.I. Chr., *Crataegus* × *sinaica* nothosubsp. *rossii* (Lange) K.I. Chr. Doubt remains *C. insengae* (Tineo ex Guss.) Bertol. (Pignatti 1982, 2017; Barone & al. 2023).

The study of Sicilian *Crategus* populations, particularly those in the western part of the island, revealed that those populations do not correspond to any of the aforementioned taxa, nor to those occurring in the rest of the Italian, European, Middle Eastern and North African regions. Due to the population size and the recurrence of unique morphological, phenological, ecological and distributional features, these populations deserve to be described at a specific level.

Materials and Methods

Field trips were conducted across western Sicily, particularly in the provinces of Palermo and Trapani where the *Crataegus* populations that occur there are very diversified. Phenological observations were made in the field, and ecological data were collected.

Additionally, specimens were also collected for taxonomic analysis in the laboratory and dried for preservation as documentation at the *PLANTA* Research Center in Palermo and at the herbaria of Palermo (PAL-Gr) and Florence (FI). The taxonomic study was carried out using analytical keys and comparisons with *exsiccata* preserved in major herbaria and available online.

Regarding pharmacognostic aspects, the data presented and discussed come from existing literature and recent studies, of which we are co-authors (Mirabile & al. 2024; Cacciola & al. 2024).

Results

List of taxa and nothotaxa of the genus Crataegus *occurring in the studied area*

Based on previous literature (Giardina & al. 2007; Christensen & Zieliński 2008; Raimondo & al. 2023) and the authors' collections kept at the *PLANTA* Center in Palermo, as along with field and laboratory observations, we can confirm the presence in western Sicily of populations referable to the following specific, infraspecific and hybrid taxa:

Crataegus azarolus L. var. *azarolus*
C. azarolus var. *chlorocarpa* (Moris) K.I.Chr.
C. azarolus var. *aronia* L.
C. laevigata (Poir.) DC.
C. laciniata Ucria
C. monogyna Jacq. var. *monogyna*
C. ×*sinaica* Boiss.
C. ×*media* Bechst.

Although *C. insengae* (Tineo ex Guss.) Bertol. ('*insegnae*') has been considered a distinct species (Lojacono-Pojero 1891; Bartolucci & al. 2024), its taxonomic status remains uncertain. Similarly doubts have also arisen regarding the presence of *C. monogyna* subsp. *azarella* (Griseb.) Franco in western Sicily, as recently highlighted by Raimondo & al. (2023).

In conclusion, two populations from the Trapani area mainly following the taxonomic study carried out on a phenotypic, ecological and phenological basis, are difficult to attribute to already known taxa. Therefore, their establishment as new species is proposed here. These are *Crataegus drepanensis* (sect. *Azaroli* Loud.) and *C. zichichii* (sect. *Crataegus*).

New specific taxa

The analysis of the diagnostic features of the two populations studied, compared with the specific characters of the taxa mentioned above, therefore allows us to recognize the following new species:

Crataegus drepanensis Raimondo, Marino & Scuderi **sp. nov.**

Diagnosis. – Planta fruticosa, affinis C. azarolus var. aronia cum qua convivet, differt ab eo compacto habito, rigido ac potius spinoso; ab foliis parvis, angustis et elongatis; ab ramulis juvenilibus rubro-violaceis, spinis brevibus robustisque, longis, robustis et pluricuspidatis in macroblastis; ab inflorescentia densa, floribus numerosis brevibus pedunculis pubescentibus sustentis; petalis minoribus, item calice sepalis pubescenti-

bus dorso constituto. Differt etiam ab fructu minore (2-)3 semina continente; ab calicis reliquiis condensatis et prominentibus.

Types. – Holotype (Fig.1): Sicily, near Tonnara del Secco, San Vito Lo Capo (Trapani), 38°10'08.40"N -12°45'55.49"E, carbonatic lithosol, c. 8 m a.s.l., 3-09-2023, *Raimondo* (PAL-Gr); isotype (FI).

Etymology. – The name recalls the province in which the *locus classicus* falls and the know distribution area of the species.

Description (Fig. 2). – Shrub about 1.5–2 m tall, branched from the base, with stiff, intricate, very thorny branches. Conical thorns, short in brachyblasts, very long, stiff and pluricuspidate in macroblasts, stout and grayish. Twigs and young thorns red-violet. Leaves 3–5 lobed, narrow and elongated, 2–4 cm × 1.5–2.5 cm, hairy, the upper ones shorter and trilobed. Flowers numerous, with short hairy pedicels and grouped in dense corymbs, entirely pubescent; Petals minute, white-cream, trilobed yellowish stylus, stamens 20 with pale-yellow anthers. Pome subspherical to obovate, about 13–15 × 12–14 mm, yellow-orange when ripe, crowned by prominent residual calyx; seeds (2)3 in number.

Phenology. – Flowering in April and ripening its fruits in September-October.

Ecology (Fig. 3). – This shrub, adapted to hot-arid environments, is found along the north-western coastal plain of Sicily. It occurs in phytocoenoses where it contributes to dominance along with other woody plants of *Rosaceae* family, especially *Crataegus azarolus* var. *aronia*, and various Mediterranean scrub elements, including *Chamaerops humilis* L. A notable feature is the frequent occurrence of *Asparagus pastorianus* Webb & Berthel. Occasionally, this new taxon is also found in aspects of steppe grasslands dominated by *Hyparrhenia hirta* (L.) Stapf on calcareous lithosols.

Distribution (Fig. 4). – *C. drepanensis* is found in the Trapani area across the entire coastal plain from San Vito Lo Capo to Monte Cofano (Trapani).

Affinities. – A species related to *C. azarolu*s var. *aronia,* with which it coexists, but differs in its compact, rigid and rather spiny habit; in its small, narrow and elongated leaves; in its short, stout, red-violet young twigs with conical thorns; and in its inflorescence consisting of numerous flowers with short pubescent peduncles. The petals are smaller, as is the calyx, which consists of pubescent sepals on the back. It also differs in pome shape, which ranges from subspherical to obovate, and is smaller (Fig. 5). Biologically, it differs from all other native species in Europe and the Mediterranean. It is characterized by an annual biological cycle that includes autumn vegetative regrowth, spring flowering, and fruit ripening in late summer. Leaf fall occurs when the fruit ripens, marking the end of the cycle, while the simultaneous opening of vegetative buds signals the beginning of the new one (Fig. 6).

Conservation status. – The entire distribution area of this species lies in a densely populated territory that has undergone radical environmental transformation over the past 50 years, due to agricultural activities, pastoralism, and coastal fishing. The expansion of tourism-related infrastructure and the surge in residential construction, particularly around the coastal areas, have drastically reduced subnatural and seminatural areas, resulting in the loss of biodiversity and, for our species, its habitat. A recent fire (Fig. 7) that affected a large area west of the inhabited area of San Vito Lo Capo has reduced the natural distribution area of the species by half, significanlty reducing its population.



Fig. 1. Holotype of *Crataegus drepanensis* (PAL-Gr).



Fig. 2. *Crataegus drepanensis*: a) flowering plant in the *locus classicus*; b) young twings; c) corymbs in anthesis; d) detail of the corymb showing floral structures; e) twigs showing details of thorns and leaf morphology; f) branches with ripe pomes.

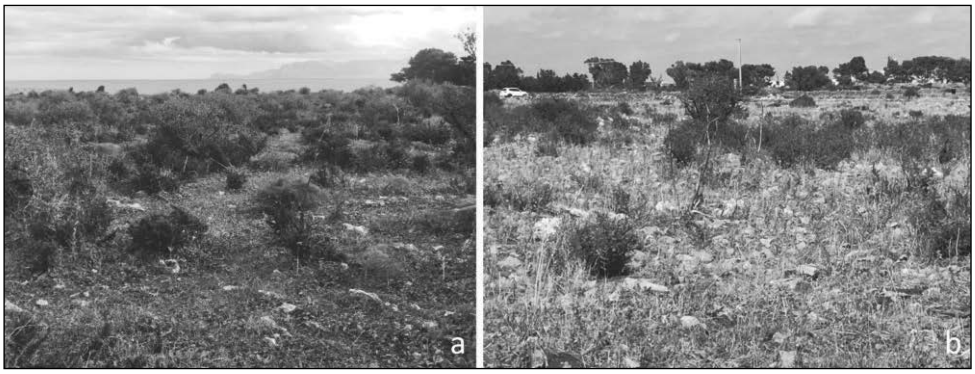


Fig. 3. Phytocoenosis physiognomised by *Crataegus azarolus* var. *aronia* and *C. drepanensis*: a) winter and b) summer aspects.

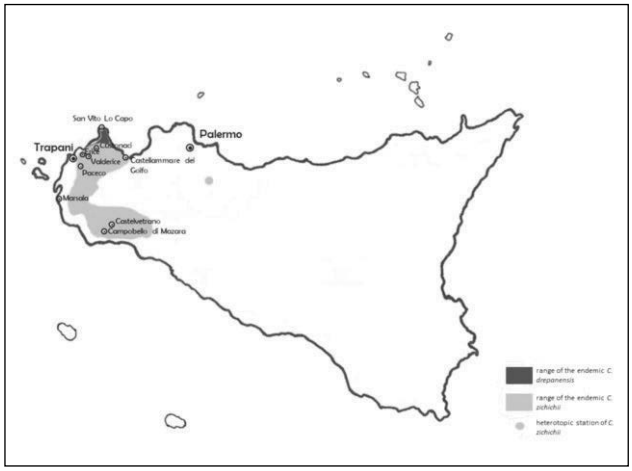


Fig. 4. Localization and distribution range of *Crataegus drepanensis* and *C. zichichii* populations.



Fig. 5. Comparison of the pomes of *Crataegus drepanensis* (a) and *C. azarolus* var. *aronia* (b) from the same locality.



Fig. 6. Some phases of annual biological cycle of *Crataegus drepanensis*: a) spring flowering; b) late summer defoliation; c) autumn vegetative regrowth.

This catastrophic event, which may worsen in the coming years due to ongoing climate change, underscores the urgent need for protective measures.

According to the IUCN Red List categories and criteria (2001), *C. drepanensis* should be classified as "*Critically Endangered"* (CR–B1,2:a,b[iii]).



Fig. 7. Post-fire effect of distant heat on a) leaves and b) pomes of *Crataegus drepanensis.*

Crataegus zichichii Raimondo, Spadaro & Venturella **sp. nov.**

Diagnosis. – Frutex vel arbor parva affinis C. laevigata; differt ab eo habito arborescente, foliis maioribus et distincte lobatis; foliis macroblastorum magnis, stipulis valde inciso-dentatis praeditis. Differt etiam ab fructu maiore, subsphaerico vel obovato. Pomum maturitate cum calice persistente et sepalis triangularibus, primo carnosis deinde squamosis, reflexis et fructui adhaerentibus.

Types. – Holotype (Fig, 8): Sicily, Erice (Trapani), northern slopes of Monte S. Giuliano, 38°02'37.16"N – 12°35'35.50"E, on carbonatic soil, 455 a.s.l., 5-09-2023, *Raimondo* (PAL-Gr); isotype (FI).

Description (Fig. 9). – Shrub or treelet up to 3–5 m tall, branched, with decumbents twigs and short brownish thorns. Leaves up to 7(8) cm long and up to 6 cm wide with lamina incised more or less deeply, with 3–7 irregularly toothed lobes; petiole up to about 2 cm. Stipules wide, irregularly incised or dentate. Flowers 3–10, white, in drooping corymbs. Pedicels 1–3 cm. Stylus (bi-)trilobed; stamens 20 with purple anthers. Pome subspherical to spherical (10)14–15 × (11)15–16 mm, crowned by persistent calyx with triangular sepals, first fleshy and then scaly, reflected and adherent to fruit, usually containing 2(3) seeds.

Phenology. – Flowering in April and ripening its fruits in (September) October- November.

Etymology. – The species is named in honor of Professor Antonino Zichichi, physicist emeritus and native of Trapani (1929), recognizes for his tireless promotion of the cultural and scientific life of the City of Erice and its territory.



Fig. 8. Holotype of *Crataegus zichichii* (PAL-Gr).



Fig. 9. *Crataegus zichichii*: a) plant in the *locus classicus*; b) fertile twigs; c) macroblasts with leaves showing the wide stipules and deeply incised lobed lamina; d) detail of the corymb showing the flower structures; e) detail of the twigs in full fruiting; f) detail of the ripe pomes crowned by persistent calyx.

Ecology. – A species of open hilly environments, it characterizes clearings and pioneer communities dominated by *Fraxinus ornus* L., *Celtis australis* L., *Osyris alba* L., *Spartium junceum* L., *Rosa canina* L., *R. sempervirens* L., *Smilax aspera* L., *Rubus* sp., *Ampelodesmos mauritanicus* (Poir.) T. Durand & Schinz, etc.

Distribution (Fig. 4). – *C. zichichii* is distributed in northwestern Sicily, particularly in the province of Trapani. Frequent from Castellammare del Golfo to Custunaci, Valderice, Erice, Trapani, Paceco, Marsala, Castelvetrano and Campobello di Mazara. Its primary dispersal center is the ancient Punic Epicracy of Erice (Caruso 2019). Heterotopic, to date, is the presence close to the inhabitated area of Marineo in the province of Palermo.

Affinities. – A species of the sect. *Crataegus*, it is closely related to *C. laevigata* than to other species and subspecies of the same section. It differs from the latter taxon in its arborescent habit, larger and markedly lobed leaves; lobes not rounded at the margins but acutely toothed; those of the macroblasts endowed with broad, irregularly incised or toothed stipules (Fig. 7c). The fruits are also significantly larger (Fig. 7f), and typically contain 2(-3) seeds.

Conservation status. – Due to its small population size and the location of its distribution area, which is highly susceptible to anthropogenic disturbance, *C. zichichii* should be classified as *"Vulnerable"* (VU), as it meets the D2 criterion of the IUCN Red List categories and criteria (2001).

Valorisation of Sicilian hawthorns

Generality on pharmacognostic aspects:

Ethnobotanical uses

Hawthorn (*Crataegus* sp. pl.) holds significant cultural and economic value, with a long tradition of medicinal use. Dioscorides recommended consuming its fruits to treat dysentery and heavy menstrual bleeding. In folk medicine, a poultice made from fresh, pounded roots was used externally to extract thorns and arrows embedded in tissues, while a poultice of fresh leaves was used to heal wounds and ulcers. Hawthorn flower infusion was consumed as a sedative and antispasmodic, and a decoction of flowers and leaves was used as a digestive. The enolite of flowers and leaves was employed as a cardiac tonic (Peroni 2012). Various ethnobotanical studies have also reported the traditional use of common hawthorn (*C. monogyna*) flowers infusion as a sedative, heart regulator, and hypotensive (Leporatti & Ivancheva 2003; Cornara & al. 2009).

Biological activities

Currently, extracts of *Crataegus* sp. pl. are primarily used for the treatment of mild congestive heart failure according to New York Heart Association (NYHA) functional class II (Veveris & al. 2004). The effectiveness of hawthorn in the treatment and prevention of cardiovascular diseases is related to its cardioprotective (Weihmayr & Ernst 1996; Wang & al. 2013) antioxidant (Škerget & al. 2005; Cui & al. 2006) and antihypertensive activities (Chang & al., 2002; Olcay & Kültür 2020), mainly attributed to proanthocyanidins and flavonoid glycosides, compounds found in the leaves, flowers, and fruits of hawthorn. These compounds may also benefit various inflammatory diseases (Ahumada & al. 1997; Taleghani & al. 2024).

Extracts of *C. oxyacantha* leaf, stem, bark, and fruit, due to their content of polyphenols, flavonoids, and tannins, may be useful for treating various diseases because of their anti-inflammatory, gastroprotective, antimicrobial, lipid-lowering, immunomodulatory, antioxidant, and cardioprotective properties (Ali & al. 2017; Aguilera-Rodríguez & al. 2021).

Nutritional health benefits

Several studies suggest that incorporating hawthorn into the diet can help prevent chronic diseases linked to oxidative stress (Zhang & al. 2001; Güven & al. 2006). In addition to its pleasant taste, hawthorn fruit is valued for its antioxidant content (Gurlen & al. 2020; Alirezalu & al. 2020). Some studies have shown that hawthorn fruits improve heart health, regulating arrhythmias, relieving spasms, and lowering blood pressure, as well as having laxative, diuretic, and antitumor properties (Gundogdu & al. 2014). In Sicily, *C.*

monogyna subsp. *monogyna* and *C. azarolus* are used raw in salads and their fruits are eaten fresh, dried, or in jam (Lentini & Venza 2007).

Biological activity of some Sicilian hawthorn populations

In the context of the health-promoting properties of hawthorn, it is pertinent to highlight the results of recent phytochemical studies, involving some of the present authors, conducted on several Sicilian populations of hawthorn. These studies have identified new natural sources of bioactive molecules.

Specifically, a recent phytochemical investigation on *Crataegus laciniata*, a species growing wild in western Sicily, showed that the extract of its flowers, could be a potential source of bioactive compounds, useful for the treatment of metabolic disorders and skin hyperpigmentation (Mirabile & al. 2024).

Additionally, similar biological activities are also confirmed by the findings of another recent study, currently in publication. This study analyzed fruits collected from wild *Crataegus* plants in different provinces of western Sicily, namely *C. laciniata*, *C. azarolus* var. *aronia*, and *C. laevigata*. The results indicate that most of the fruits examined are a rich source of antioxidants, suggesting their potential use in managing diabetes by mitigating postprandial hyperglycemia (Cacciola & al. 2024).

While flowers and fruits of various *Crataegus* species - including *C. azarolus* var. *aronia* coexisting with the new species *C. zichichii* - are sources of medicinal and nutraceutical products, the same species are also of fundamental ecological value in natural and semi-natural ecosystems, as a source of food for wildlife. In this regard, the importance of *Rosaceae* in general – thus also of plants of the genus *Crataegus* – in diversifying the forest topsoil has recently been highlighted. For this reason, hawthorns constitute plants to be valorised in reforestation plans, with the primary objective of supporting wildlife feeding in phytobiologically poor areas (Campisi & Raimondo 2023). In this perspective, the first form of valorisation of these species is therefore nursery gardening aimed at supporting the new direction of urban, peri-urban and extra-urban forestation (Blasi 2023), which also has the objective of bringing nature back into the city (Capotorti & al. 2020). Relative to one of the two species described here, namely *C. zichichii*, the copious spring flowering, but especially the showy autumn fruiting that is kept alive on the plant until mid-January, give the species a considerable decorative value, and this makes it economically interesting in nursery and therefore commercially, because it is not only suitable for animating green spaces of all kinds but can be cultivated to obtain branches to use in the preparation of Christmas decorations, just like other wild species such as holly (*Ilex aquifolium* L.).

Discussion and conclusion

Based on the conclusions of the taxonomic study performed by the classical method of analysis phenetic, biological, ecological, and phytogeographic features, the diversity of the genus *Crataegus* in Sicily is enriched by two new species of a great interest: *C. zichichii* is linked to applications in forestry and decorative fields, *C. drepanensis* is primarily of bio-ecological and phytogeographic interest. In any case, the description of the two new species

not only enriches the diversity of Sicilian dendroflora but also offers new potential sources of bioactive molecules of pharmaceutical, nutraceutical, and cosmeceutical interest.

The greater diversity highlighted by the study is not found throughout the rest of the western and central Mediterranean region. For the genus *Crataegus,* this makes Sicily a biodiversity hotspot. In this regard, concerns arise from both the urban expansion of the seaside town of San Vito Lo Capo and the recurrence of fires that in recent years have compromised, sometimes irreversibly damaging, the population of *C. drepanensis* in particular, which has so far been little considered by all directives aimed at conserving European biodiversity, as it is not known and therefore not protected as an extremely localized endemic species.

This study, therefore, serves as a basis for initiating awareness actions aimed at ensuring greater protection of the distribution area of the new species and the conservation of its fragile natural habitat.

Regarding *C. drepanensis* – the more endangered of the two new species – there is concern about what happened last summer in the eastern coastal area of San Vito Lo Capo, where the highest concentration of its population is found. A severe fire scorched several thousand plants (Fig. 10). Of these, only a small portion managed to sprout again from the base after the autumn rains. Therefore, *in situ* conservation measures are urgently needed to help the fire-damaged plants regenerate by promoting resprouting. In this context, there is no better technique than cutting the damaged parts. Simultaneously, given the successful outcome of seed regeneration, experimented in a nursery directly by one of the authors (L. Scuderi) in the family business (Fig. 11), *ex situ* conservation strategies and *in situ* repopulation actions could be successfully implemented.



Fig 10. (a, b) Devastating effects of the recent fire on *Crataegus drepanensis* plants and its phytocoenosis.



Fig. 11. a) *In situ* conservation strategies thanks to the regenerative capacity of compromised *Crataegus drepanensis* plants in the winter months following the fire; b) possibility of *ex situ* and *in situ* conservation through transplanting seedlings obtained from seeds; c) characteristic one year old *C. drepanensis* seedling obtained in a private nursery.

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First records of *Dysphania atriplicifolia* (*Amaranthaceae*) from Africa

Abstract

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Dysphania atriplicifolia (*Amaranthaceae*), a species native to North America, has been recorded in 2024 from Algeria (Aïn Sefra, Naâma). This is the first record from Algeria and the second from the African continent; an unpublished old record from Egypt is published here. Brief information is provided about its morphology, distribution and habitat, and its biological traits and potential for invasiveness are discussed.

Key words: Aïn Sefra, Algeria, alien plant, Egypt, neophyte, new records, xenophyte.

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Introduction

The genus *Dysphania* R.Br., like the entire tribe *Dysphanieae* (*Chenopodioideae*, *Amaranthaceae*), which was recently revised by Uotila & al. (2021), contains about 50 species. It is a segregate genus from the formerly large genus *Chenopodium* L. (Fuentes-Bazan & al. 2012) and has a world-wide distribution mainly in tropical and subtropical regions (Uotila & al. 2021; POWO 2024). *Dysphania atriplicifolia* has some special morphological characters, especially the transverse wing on the perianth, which is why it was earlier treated as the monospecific genus *Cycloloma* Moq. However, phylogenetically it belongs to *Dysphania* and it was placed in sect. *Adenois* (Moq.) Mosyakin & Clemants by Uotila & al. (2021), but due to its specific characters and its status as the possible sister lineage to the other species of sect. *Adenois* Mosyakin (2021) preferred to place it in a monospecific section *Cycloloma* (Moq.) Mosyakin.

With the present reports of *Dysphania atriplicifolia* and the recent reports of the Australian *D. cristata* (F.Muell.) Mosyakin & Clemants (El Mokni & al. 2024) and *D. pumilio* (R.Br.) Mosyakin & Clemants (El Mokni 2024) from Tunisia, the number of species (native and exotic) of the genus amounts to eleven in Africa and six in the Mediterranean North Africa. In Algeria, *Dysphania* included earlier only three species, two naturalized from the Americas (*D. ambrosioides* (L.) Mosyakin & Clemants and *D. multi-*

fida (L.) Mosyakin & Clemants), and *D. botrys* (L.) Mosyakin & Clemants, which is an East European – Central Asiatic species, and doubtfully native in North Africa (Quézel & Santa 1962; Uotila 2006; Dobignard & Chatelain 2011; APD 2024; El Mokni & al. 2024).

Unlike the native flora of the Western Saharan Atlas (the Ksour Mountains), which is now well known (Gordo 2021; Gordo & al. 2021), the exotic flora is still incompletely studied. Apart from a few common xenophytes in Algeria, for instance *Ailanthus altissima* (Mill.) Swingle, *Erigeron canadensis* L., *Datura stramonium* L., *Oxalis pes-caprae* L. var. *pes-caprae, Solanum elaeagnifolium* Cav. and *Xanthium spinosum* L., no species new to the alien flora of Algeria has been observed in the region. Since 2021, this has led the first author to direct explorations towards urban environments and agricultural ecosystems. In the course of these studies, a few individuals of the North American species *Dysphania atriplicifolia* were observed in 2024 at a small farm located east of the city of Aïn Sefra (Naâma).

Material and Methods

The site of *Dysphania atriplicifolia* in Algeria was visited by the first author several times to collect specimens, take photographs and describe the plants and the population. The specimens were deposited in the Herbarium of the University Center of Naâma (Naâma) and that of the University of Oran 1 (Oran), both in Algeria. During herbarium work at Berlin (B) in October 2024 by the second author, an additional African specimen, collected from Egypt, was found. For morphological comparison herbarium specimens and several floras and articles were used (in particular, Scott 1978; Wilson 1984; Mosyakin 2003; Vidéki 2005 and Uotila & al. 2021). For the global distribution of the species, Uotila (2006); GBIF (2024) and POWO (2024) were consulted. The nomenclature adopted for the species mentioned follows International Plant Names Index (IPNI 2024).

Results

***Dysphania atriplicifolia* (Spreng.) G.Kadereit, Sukhor. & Uotila** in Taxon 70: 542. 2021 (≡ *Salsola atriplicifolia* Spreng., Nachtr. Bot. Gart. Halle: 35. 1801, ≡ *Cycloloma atriplicifolium* (Spreng.) J.M. Coult. in Mem. Torrey Bot. Club 5: 143. 1894).

Egypt: Orient, Cairo, [1834–]1835, A. Wiest (B 100672946; in Herbarium Baschant, acc. 1959). – New to Egypt.

Algeria: Naâma, Aïn Sefra, Dzira, 1097 m, 32°43.5950’N, 0°36.5710’W, 31 May 2024, Belkacem Gordo s. n. [Herb. Univ. C. Naâma and Univ. Oran 1]. – New to Algeria.

Erect bushy annual plant 10–30(60) cm high (Fig. 1); leaves sessile or shortly petiolate, ovate to oblong 1.5–4 cm long, sinuate-dentate (usually with 3–4 long teeth with a mucro); flowers bisexual or polygamous forming a loose paniculate inflorescence; the axis of the inflorescence 1–5 cm long, gradually lengthening during flowering and fruit ripening; fruiting perianth (2.5)3–4(5) mm in diameter, depressed from above, crustaceous, with transverse, broad, irregularly toothed membranous wing in the middle; perianth lobes free above the wing; fruit a hairy achene.



Fig. 1. *Dysphania atriplicifolia* in the Dzira agricultural periphery (Aïn Sefra, Naâma) (31 May 2024, Belkacem Gordo). a) Habitat in weedy vegetation; b) Leaves; c) Branches of the inflorescence in fruiting stage. Note the transverse wing on fruiting perianths; this character separates this species from all other *Dysphania*.

Distribution and habitat in Algeria

Around thirty individuals of *Dysphania atriplicifolia* in an area of 16 m^2 were observed at a small farm located in the Dzira agricultural periphery in Aïn Sefra, Algeria (Fig. 2). These are sand dunes which were enhanced by development work in the 1990s. The residual vegetation



Fig. 2. The location of the present find in Algeria is marked with a black square.

which persists here and there indicates that these environments were covered with the chamaephytic desert vegetation of *Calobota saharae* (Coss. & Durieu) Boatwr. & B.-E.van Wyk and *Retama raetam* (Forssk.) Webb & Berthel. Now in the small, irrigated plot, where *D. atriplicifolia* infiltrates, the following species were found: *Chenopodium album* L., *Cynodon dactylon* (L.) Pers., *Erigeron canadensis* L., *Melilotus indicus* (L.) All., *Nolletia chrysocomoides* Cass., *Onopordum arenarium* (Desf.) Pomel, *Polycarpaea repens* (Forssk.) Asch. & Schweinf., *Portulaca oleracea* L., *Salsola tragus* L., *Senecio glaucus* subsp. *coronopifolius* (Maire) C.Alexander, *Setaria verticillata* (L.) P.Beauv. subsp. *verticillata*, and *Tribulus terrestris* L. The dominant species were the annuals *C. album*, *S. tragus* and *D. atriplicifolia*. In the densest parts of this disturbed habitat the vegetation cover could be 80%.

Discussion

The original area of this species is mostly the central parts of North America west of the Mississippi River, but it has currently expanded its area to southern Canada and eastern USA (Mosyakin 2003; POWO 2024). It had been introduced to Europe already at end of the 1800s to northern Italy and in the early 1900s to Germany (Aellen 1960); at present it is said to be naturalized at least in Italy, France, Slovakia and Hungary (Mandak & Prach 2001; Vidéki 2005; Tison & de Foucault 2014). In the recent compilation of European alien plants (Kalusová & al. 2024), *D. atriplicifolia* was listed as casual in one territory (+ Finland: Kurtto & al. 2019), naturalized in three territories, naturalized/invasive in one territory and invasive in one territory. In addition, there are records with unknown or casual status from Australia (Prov. Victoria: Wilson 1984), South America (Argentina, Prov. Buenos Aires, Córdoba, La Pampa and San Luis: Brignone 2020), Asia (Japan, Sendai: Ebihara 2024), and from North Africa (Egypt and Algeria: present study; Fig. 2). Undoubtedly the species was recently accidentally introduced into the site in Algeria with

seeds imported to grow food and fodder, as, for instance, the fodder plant *Medicago sativa* L. (alfalfa), but it had reached the southern side of the Mediterranean Sea in Egypt at about the same time as the northern side.

Dysphania atriplicifolia is a spring-flowering psammophytic theropyte, i.e., its typical growing habitats in both the original and introduced areas are sandy accumulations such as dunes. Algerian plants were tall and richly branched and a single plant can produce a considerable number of seeds. Furthermore, loose, whole plants are easily rolled along by the wind (tumbleweed; Sukhorukov 2014). This may result in effective spreading, especially since in recent years the effects of wind have been more frequent throughout the Naâma Region (Bouarfa & al. 2018). Due to the risk of uncontrolled propagation of this species in sandy natural environments and/or those threatened by wind erosion, it is strongly recommended that regular monitoring be carried out in protected areas such as wetlands (lakes, oases, wadis) and coastal dunes.

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Article

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Étude floristique et biogéographique de la forêt de Tababort (Nord-Est algérien)

Floristic and biogeographic study of the Tababort forest (North-East Algeria)

Résumé

Bouchibane, M., Zemouri, M. & Bougaham, A. F.: Étude floristique et biogéographique de la forêt de Tababort (Nord-Est algérien). — Fl. Medit. 34: 263-276. 2024. — ISSN: 1120-4052 printed, 2240-4538 online.

Afin d'actualiser les connaissances sur la flore de La Kabylie des Babors (Nord-Est algérien), dans le but de conservation de la flore locale, une étude floristique et biogéographique a été réalisée sur la végétation d'un massif montagneux peu étudié (Tababort, 1969 m). Les relevés effectués au niveau des formations forestières et préforestières de *Cedrus atlantica*, de *Quercus canariensis*, de *Abies numidica* ainsi que les pelouses avoisinantes nous ont conduits à recenser 290 taxons appartenant à 207 genres et 68 familles de plantes vasculaires. La flore étudiée appartient essentiellement à l'élément méditerranéen (53,4%), suivi par l'ensemble septentrional (28,6%). L'élément endémique est appréciable avec 14,1% de la flore étudiée. Les hémicryptophytes prédominent dans le spectre biologique.
Mots clés: végétation, biogéographie, endémisme, conservation, Afrique du Nord.

Abstract

In order to update the knowledge on the flora of the Babors' Kabylia (North-East algeria), with the objective of conservation of the local flora, a floristic and biogeographical analysis was conducted on the vegetation of one mountain very little studied (Tababort, 1969 m). The surveys carried out at the level of forest and pre-forest formations of *Cedrus atlantica*, *Quercus canariensis*, *Abies numidica* as well as mountain grasslands, led us to identify 290 taxa belonging to 207 genera and 68 families of vascular plants. The studied flora essentially belongs to the mediterranean element (53.4%), followed by the northern element (28.6%). The endemic element is appreciable with 14.1% of the flora analyzed. The hemicryptophytes predominate the biological spectrum.
Keywords: vegetation, biogeography, endemism, conservation, North Africa.

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Introduction

Mis à part les dernières grandes régions sauvages encore préservées (forêts équatoriales), près de la moitié du reste de la biodiversité mondiale se concentre au niveau de «points chauds» de biodiversité ou *hotspots* (Myers 2003). Le bassin méditerranéen figure

comme l'un des principaux points chauds de biodiversité végétale (Médail & Quézel 1997) et forme un centre d'endémisme majeur. Cette forte biodiversité s'esplique en partie par l'existence de refuges glaciaires (ex. Médail & Diadema 2009).

L'Algérie qui fait partie du bassin méditerranéen, est un pays à forte diversité biologique compte tenu de son paysage contrasté (Yahi & al. 2012). Le Tell (Nord du pays) est considéré par plusieurs auteurs comme une zone d'intérêt majeur vu la richesse biologique et l'endémisme élevés qui le caractérisent (Véla & Benhouhou 2007). Faisant partie du Tell, la région de la Kabylie des Babors qui appartient au secteur de la petite Kabylie (K2 : Quézel & Santa 1962-63) est considérée comme une zone importante pour les plantes en Algérie (Yahi & al. 2012; Benhouhou & al. 2018); elle posséde avec le secteur de la grande Kabylie (K1), l'indice de biodiversité le plus élevé à l'échelle nationale (Véla & Benhouhou 2007).

Malgré l'importance de ce secteur pour la biodiversité végétale, plusieurs zones au sein de la chaine des Babors restent encore méconnues (Chelli-Tabti & al. 2020). Les études réalisées récemment dans cette région de la Kabylie des Babors, ont délivré d'importantes découvertes floristiques. C'est le cas de la récente découverte d'une fougère *Christella dentata* Forssk. (Rebbas & al. 2019) et d'un nouveau habitat pour *Cephalanthera rubra* (L.) Rich. (*Orchidaceae*) au mont Babor (Bougaham & al. 2020).

Le djebel Tababort (1969 m) est le massif le plus élevé après le mont Babor (2004 m) dans le sous-secteur de la petite Kabylie et compte un nombre appréciable d'espèces rares et endémiques dont certaines trouvent là leur unique station en Algérie (Garzouli 2007). Cependant, cette végétation exceptionnelle est maintenant dégradée dans son ensemble surtout en basse altitude ; il est primordial de concevoir des stratégies de protection et de conservation de ce patrimoine végétal inestimable. Cela ne peut se faire qu'avec une meilleure connaissance de la diversité floristique et phytogéographique des milieux naturels (Bouchibane 2019).

La présente étude vise à combler les lacunes existant sur l'état des connaissances actuelles de la flore vasculaire du site d'étude et de faire ressortir non seulement l'originalité et la diversité floristique du massif forestier de Tababort (Nord-est algérien) afin d'apporter des arguments en vue de son classement en réserve naturelle, mais aussi les menaces qui pèsent sur elle, afin de mettre en place des mesures visant leur conservation, protection et valorisation.

Matériel et méthodes

Zone d'étude

La Kabylie des Babors est située entre le littoral de Bejaia au nord, et les plaines Sétifiennes au sud. A l'ouest elle est limitée par la vallée de la Soummam à l'est par une ligne qui va d'El Aouana à Oued Djendjen, et au sud par Texenna (Jijel) (Fig. 1). Cette région de la Kabylie des Babors est constituée de massifs organisés en chaînons sensiblement parallèles. Cette présente étude concerne un massif de haute altitude qui est le djebel (montagne) Tababort (1969 m.) composé de calcaires liasiques (Duplan 1952).

Les données climatiques du djebel Tababort (1969 m) sont obtenues par extrapolation à partir des données relevées de la station météorologique de Kherrata (470 m) sur une période de 15 ans (1996-2010). Les valeurs des températures maximales (M), minimales (m) et

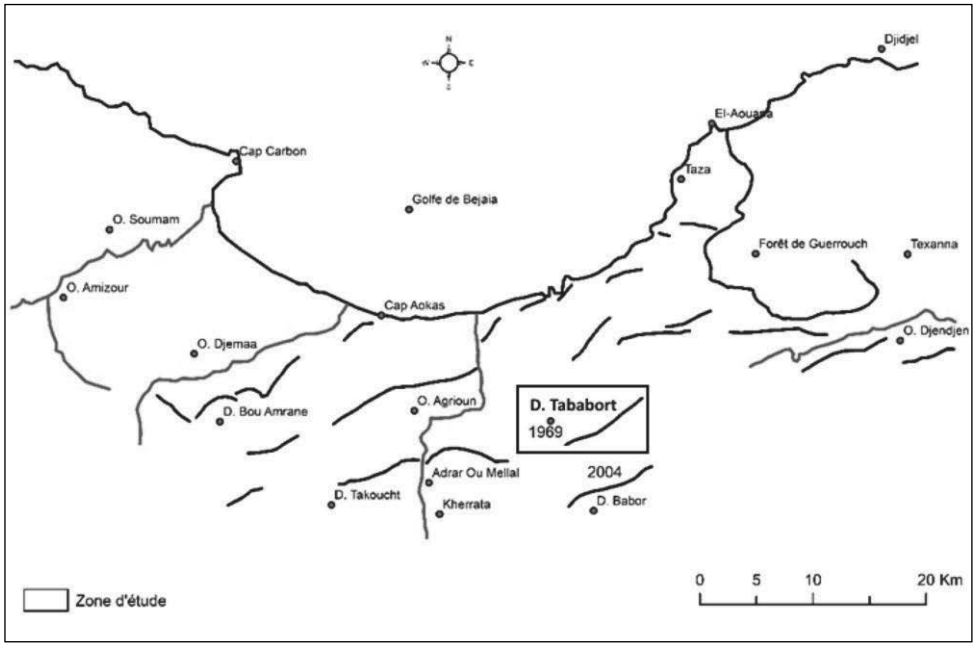


Fig. 1. Carte schématique de la localisation géographique de la zone d'étude

les précipitations sont estimées à l'aide des gradients altitudinaux mis au point par Seltzer (1946) pour la station de Kherrata. Il a déterminé pour les températures maximales (M), une diminution de 0,7°C pour une élévation de 100 m d'altitude, pour les températures minimales (m) 0,4°C tous les 100 m de dénivelé, et pour les précipitations une augmentation de 40 mm pour 100 mètres de hauteur. De ce fait, Les températures maximales du mois le plus chaud et les températures minimales du mois le plus froid moyennes annuelles au sommet du massif de Tababort (1969 m) sont estimées à 23,7°C et à -2,1°C respectivement (Tableau 1). En outre, les précipitations moyennes annuelles sont estimées à 1494,2 mm au sommet du massif de Tababort. Le djebel Tababort (1969 m) appartient ainsi à l'étage bioclimatique per-humide à hiver froid (sensu Emberger 1955).

Les types de végétations de la région des Babors, ou notre étude a été réalisée sont

Tableau 1. Données climatiques du massif de Tababort (station météorologique de Kherrata et formules d'extrapolation selon Seltzer, 1946). Alt. (altitude) ; P (cumul des précipitations annuelles) ; m (moyenne des minima du mois le plus froid) ; M (moyenne des maxima du mois le plus chaud) ; Q (indice climatique d'Emberger) ; EB (étages bioclimatiques sensu Emberger 1955).

Station	Alt. (m)	P (mm)	M (°C)	m (°C)	Q	EB
Kherrata	470	894,6	34,2	4,0	101,6	Sub-humide
Tababort	1969	1494,2	23,7	-2,1	198,6	Per-humide

représentés par des formations forestières à base de conifères constituées par les cédraies et les sapinières. Le cèdre (*Cedrus atlantica* (Endl.) Manetti ex Carrière) couvre plusieurs massifs montagneux algériens et marocains, tandis que le sapin de Numidie (*Abies numidica* de Lannoy ex Carrière), est circonscrit aux djebels Babor et Tababort (Ghazouli 2007). Des formations forestières qui sont représentées par le chêne zéen (*Quercus canariensis* Willd.) et les forêts sclérophylles à chêne liège (*Q. suber* L.) à basse altitude, et à chêne vert (*Q. ilex* L.) en altitude moyenne et élevée. Des forêts hygrophiles existent dans des ravins forestiers et forment des répisylves.

On trouve aussi les matorrals qui sont des formations végétales dominées par les arbustes dérivant directement ou indirectement d'une forêt climacique par dégradation anthropozoogène (Donadieu 1985). Dans notre zone d'étude, ces milieux sont représentés par *Bupleurum spinosum* Gouan.; *Buxus sempervirens* L.; *Cytisus spinosus* (L.) Lam.; *C. villosus* Pourr. ; *Erodium battandieranum* Rouy.; *Prunus prostrata* Labill; *Pistacia terebinthus* L. Les pelouses sont assez nombreuses, localisées essentiellement sur les crêtes dénudées. Ces formations sont représentées par des plantes herbacées, notamment les géophytes et les thérophytes (Ghazouli 2007).

Echantillonnage

Nous avons réalisé un inventaire floristique basé sur un échantillonnage systématique dans différents groupements forestiers et préforestiers de sapin de Numidie (*Abies numidica*), de cèdre (*Cedrus atlantica*), de chêne zéen (*Quercus canariensis*), pelouses de montagne et ravins forestiers pour dresser une liste globale des taxons répertoriés. L'investigation sur le terrain a débuté à partir du mois de mars 2019 et s'est poursuivie jusqu'au mois de novembre 2022, en effectuant 65 relevés sur des surfaces floristiquement homogènes de 30 m^2 pour les pelouses, 60 m^2 en contexte préforestier et jusqu'à 200 m^2 en forêt. Un herbier a été conçu sur la base des spécimens récoltés sur le terrain et une collection de photographies a été constituée. Les spécimens de plantes récoltés ont été déposés dans l'herbier du laboratoire de recherche en Ecologie et Environnement (université de Bejaia).

La détermination des différents taxons recensés a été réalisée en se référant aux flores de Battandier (1888-1890), Battandier & Trabut (1895), Maire (1952–1987) et Quézel & Santa (1962-1963). Pour l'actualisation des données sur la nomenclature, nous avons consulté Dobignard & Chatelain (2010-2013) et l'African Plant Database (APD 2021). Les types chorologiques de nos taxons ont été faits en ayant recours aux ouvrages de Pignatti (1982), Gharzouli (2007), Blanca & al. (2009), Jeanmonod & Gamisans (2013) et Fennane & al. (2014). La nomenclature suivie pour les endémiques est issue de Dobignard & Chatelain (2010-2013). L'information sur les types biologiques (sensu Raunkiaer 1934) des espèces inventoriées est effectuée par le biais des ouvrages de Pignatti (1982), Gharzouli (2007), Jeanmonod & Gamisans (2013) et Fennane & al. (2014). La liste des espèces menacées du massif étudié a été réalisée sur la base de critères de rareté établis par Quézel & Santa (1962-1963) et de vulnérabilité à l'échelle globale établis par l'Union Internationale de la Conservation de la Nature en 2024. Les espèces figurant sur le Décret n° 03-12/12-28 complétant la liste des espèces végétales non cultivées protégées en Algérie (J.O.R.A. 2012) et/ou sur la liste rouge de l'UICN 2024 (https://www.iucnredlist.org/) et/ou rares et très rares sont considérées comme des taxons patrimoniaux.

Résultats

Cortège floristique

Nous avons comptabilisé dans cette présente étude 290 taxons appartenant à 207 genres et 68 familles de plantes vasculaires. Les ptéridophytes sont représentées par quatre familles, les gymnospermes comportent trois familles. Les angiospermes sont majoritaires avec 61 familles botaniques. Au niveau des familles, les *Asteraceae* sont les mieux représentées avec 35 taxons et 31 genres, suivies par les *Fabaceae* (23 taxons et 17 genres), les *Poaceae* (22 taxons et 18 genres), les *Lamiaceae* (15 taxons et 13 genres), les *Rosaceae* (15 taxons et 9 genres), les *Apiaceae* (14 taxons et 13 genres), les *Orchidaceae* (12 taxons et 8 genres), les *Caryophyllaceae* (11 taxons et 6 genres) et les *Brassicaceae* (10 taxons et 7 genres). Les autres familles comptent moins de 10 espèces.

Spectre biogéographique

Une diversité des origines biogéographiques a été observée sur la liste floristique obtenue (Tableau 2). L'analyse du spectre phytogéographique brut révèle que la composante méditerranéenne est la plus importante de toute la flore du djebel Tababort. Elle compte 155 espèces (53,4%). Ces taxons se répartissent sur 49 (72,1%) familles. Les mieux représentées sont les *Asteraceae* (26 taxons), suivie par les *Fabaceae* (18 taxons), les *Lamiaceae* (12 taxons), les *Apiaceae* (9 taxons), et les *Poaceae* (8 taxons).

Malgré la dominance de l'ensemble méditerranéen, l'élément septentrional garde une place assez importante avec 83 taxons, soit 28,6% de la flore répertoriée. 34 familles (50,0%) présentent des espèces nordiques (septentrionales). Les plus riches sont les *Poaceae* avec 10 taxons, suivie par les *Rosaceae* (9 taxons), les *Brassicaceae* et les *Orchidaceae* avec 5 espèces chacune, suivie par les *Asteraceae* (4 taxons), les *Fabaceae* (4 taxons), et les *Plantaginaceae* (4 taxons).

Les taxons se classant dans l'ensemble endémique régional sont au nombre de 41, représentant ainsi 14,1% de la flore inventoriée (Tableau 3). Ces taxons sont répartis selon cinq statuts d'endémisme. Les endémiques algériens stricts sont représentés par 13 taxons, dont quatre sont exclusivement localisés dans la région de la Kabylie des Babors (*Abies numidica* De Lannoy; *Epimedium perralderianum* Coss.; *Erodium battandieranum* Rouy; *Saxifraga numidica* Maire). Les endémiques algéro-tunisiens sont représentés par huit taxons et les endémiques algéro-tunisiens-marocains (End Alg-Tun-Mar) comptent 12 espèces, les endémiques algéro-marocains sont au nombre de sept taxons. Par contre, les endémiques algéro-tunisiens-italiens sont les moins abondants avec un seul taxon (Tableau 3). En tout, 24 familles (35,3%) présentent des taxons endémiques. Le plus grand nombre de taxons endémiques se trouve dans la famille des *Asteraceae* (5 espèces), suivie des *Caryophyllaceae* (4 espèces), *Lamiaceae*, *Orchidaceae* et *Primulaceae* avec 3 endémiques chacune. Les autres familles comptent 1 à 2 espèces endémiques.

L'ensemble à large répartition est faiblement représenté en se positionnant à la quatrième place avec huit taxons, soit 2,8% de la flore inventoriée, ce qui correspond à six (8,8%) familles botanique. L'élément subtropical est présent avec deux taxons (0,7%). Par contre, les subcosmopolites comptent six espèces (2,1%).

L'ensemble des espèces introduites arrive en dernière position en totalisant seulement trois taxons (1,1%). Les familles *Adoxaceae*, *Valerianaceae* et *Apocynaceae* comptent les taxons appartenant à cet ensemble. En Algérie, ces espèces introduites font actuellement partie des plantes spontanées ou ont été utilisées dans les reboisements depuis longtemps.

Tableau 2. Spectre chorologique global.

Ensembles chorologiques	Nombre	Pourcentage (%)
Ensemble méditerranéen	**155**	**53,4**
- Méditerranéen strict	33	
- Ibéro-Maghrébin	16	
- Circumméditerranéen	24	
- Sténo-méditerranéen	12	
- Eury-méditerranéen	16	
- Atlantique-Méditerranéen	11	
- Méditerranéen-Touranien	1	
- Méditerranéen- Montagnard	5	
- Méditerranéen-Macaronésien	6	
- Oro-Méditerranéen	6	
- Bético-Maghrébin	1	
- W. Méditerranéen	11	
- C. Méditerranéen	2	
- S. Méditerranéen	1	
- Sub- Méditerranéen	5	
- Médierranéen-Irano	2	
Ensemble nordique (septentrional)	**83**	**28,6**
- Eurasiatique	28	
- Européen	25	
- Paléo-tempéré	11	
- Holarctique	9	
- Europe-Sibérie	4	
- Europe-Caucase	3	
- Circumboréal	2	
- Atlantique	1	
Ensemble large répartition	**8**	**2,8**
- Cosmopolite et sub-cosmopolite	6	
- Paléo-subtropicale	1	
- Subtropicale	1	
Ensemble d'espèces introduites	**3**	**1,1**
Ensemble endémique	**41**	**14,1**
- Endémique Algérien strict	13	
- Endémique Algéro-tunisien	08	
- Endémique Algéro-marocain	07	
- Endémique Algéro-tunisiens-marocain	12	
- Endémique Algéro-tunisiens-italien	1	

Tableau 3. Taxons endémiques observés au niveau du massif étudié. End Alg : Endémique Algérien strict. End Alg-Tun : Endémique Algéro-tunisien. End Alg-Mar : Endémique Algéro-marocain. End Alg-Mar-Tun : Endémique Algéro-marocain-tunisien. End Alg-Tun-Ita : Endémique Algéro-tunisien-italien.

Taxons	**Endémisme**	**Taxons**	**Endémisme**
Abies numidica Carrière	End Alg	*Fritillaria oranensis* Pomel	End Alg-Mar-Tun
Androrchis patens (Desf.) D. Tyteca & E. Klein.	End Alg-Tun-Ita	*Hedera algeriensis* Hibberd.	End Alg-Tun
Bupleurum montanum Coss.	End Alg-Mar	*Helianthemum helianthemoides* Desf.	End Alg-Mar-Tun
Campanula trachelium subsp. *mauritanica* (Pomel) Quezel.	End Alg-Mar	*Iris unguicularis* Poir.	End Alg-Tun-Mar
Cedrus atlantica (Endl.) Carrière	End Alg-Mar	*Lapsana communis* subsp. *macrocarpa* (Coss.) Nyman	End Alg-Mar-Tun
Cerastium atlanticum Durieu	End Alg-Mar-Tun	*Plagius maghrebinus* Vogt & Greuter.	End Alg-Mar-Tun
Conopodium glaberimum (Desf.) Engstrand.	End Alg-Mar-Tun	*Lonicera kabylica* Rehder	End Alg
Convolvulus sabatius subsp. *mauritanicus* (Boiss.) Murb.	End Alg-Mar	*Lysimachia cousiniana* Coss. & Dur.	End Alg-Tun
Coronilla valentina subsp. *speciosa* (Uhrova) Greuter & Bur	End Alg	*Moehringia stellarioides* Coss.	End Alg
Cyclamen africanum Boiss. & Reut.	End Alg-Tun	*Ophrys numida* Devillers-Tersch. & Devillers	End Alg-Tun
Dactylorhiza munbyana (Boiss. & Reut.) Aver.	End Alg-Mar-Tun	*Origanum vulgare* subsp. *glandulosum* (Desf.) Letswaart	End Alg-Tun
Delphinium sylvaticum Pomel	End Alg-Tun	*Paeonia mascula* (L.) Mill. subsp. *atlantica* (Coss.) Greuter & Burdet.	End Alg
Doronicum plantaginum subsp. *atlanticum* (Chabert.) Rouy.	End Alg-Mar-Tun	*Patzkea durandoi* (Clausson) G. H. Loos.	End Alg-Mar-Tun
Epimedium perralderianum Coss.	End Alg	*Phlomis bovei* De Noé.	End Alg-Tun
Erodium battandieranum Rouy	End Alg	*Primula acaulis* subsp. *atlantica* (Maire & Wilczek) Greuter & Burdet.	End Alg-Mar
Saxifraga numidica Maire	End Alg	*Taraxacum inaequilobum* Pomel	End Alg-Mar-Tun
Sedum multiceps Coss. & Dur.	End Alg	*Thymus dreatensis* Batt.	End Alg
Silene atlantica Coss.	End Alg-Tun	*Vicia ocholeuca* subsp. *baborensis* (Batt. & Trab.) Greuter & Burdet	End Alg
Silene choulettii Coss.	End Alg	*Viola mumbyana* Boiss. & Reut.	End Alg-Mar-Tun
Senecio perralderianus Coss & Dur.	End Alg	*Aquilegia vulgaris* subsp. *cossoniana* (Maire & Sennen). Dobignard & Djord.	End Alg-Mar
Cynoglossum maghrebicum Sutory	End Alg-Mar		

Spectre biologique global

Le spectre biologique global réalisé indique que les hémicryptophytes sont dominantes avec 119 taxons (41,0%), suivi de loin par les thérophytes avec 56 espèces (19,3%). Les phanérophytes et les géophytes occupent respectivement la troisième place (45 taxons, soit 15,5%) et la quatrième place avec 41 taxons (14,1%). Tandis que le type chaméphytique apparaît nettement le moins abondant avec 29 taxons (10,0%).

Les espèces rares et menacées

L'analyse de l'abondance des espèces d'après Quézel & Santa (1962-1963), nous a permis de mettre en exergue 105 taxons rares s.l, soit 36,2% de la flore étudiée, dont 19 taxons très rares, 54 rares et 32 assez rares. Parmi eux, 23 taxons recensés figurent sur la liste rouge de l'UICN 2024 (https://www.iucnredlist.org/), soit 7,9% de la flore étudiée (tableau 1 en annexe). Sur les 290 espèces répertoriées, 30 (10,3%) bénéficient d'un statut de protection nationale (D.E. 2012). Dans cette étude, le nombre de taxons patrimoniaux s'élève à 110 taxons, représentant ainsi 37,9% de la flore étudiée (tableau 1 en annexe).

Discussion

Diversité floristique

L'inventaire floristique comportant 290 taxons, reflète une assez forte richesse du milieu, d'autant plus que l'échantillonnage n'a concerné qu'un seul massif montagneux. Cette richesse est liée a la diversité des conditions climatiques et édaphiques qui prédominent dans la région d'étude ; elle peut s'expliquer aussi par une exploitation relativement faible du milieu par rapport à d'autres écosystèmes. Il représente 9,2% de la flore d'Algérie estimée à 3150 taxons par Médail & Quézel (1997). Ce nombre de taxons inventorié est inférieur à ceux donné par Gharzouli (2007) pour les massifs du sud de la Kabylie des Babors (520) et par Messaoudene & al. (2007) pour la forêt d'Akfadou (435 taxons). En outre, le massif étudié compte cinq taxons (*Asphodeline lutea* L.; *Buxus sempervirens* L.; *Cervaria rivini* Gaertn.; *Dactylorhiza munbyana* (Boiss. & Reut.) Aver.; *Ribes petraeum* Wulf.) remarquables qui ne sont pas représentés sur les autres massifs de la Kabylie des Babors (Ghazouli 2007; Bouchibane & al. 2021). Les proportions de la contribution des principales familles, ainsi que les genres dominant ces dernières, sont dans l'ensemble les mêmes qui ressortent des travaux similaires d'inventaire dans les régions forestières du nord du pays (Ghazouli 2007; Bounar 2014; Bouchibane & al. 2017).

Chorologie

L'étude phytogéographique constitue un véritable modèle pour interpréter les phénomènes de régression des espèces (Olivier & al. 1995). L'élément qui domine la flore étudiée est l'ensemble méditerranéen avec 53,4% de la flore répertoriée. Cette situation reste commune pour tout le bassin méditerranéen (Quézel & Médail 2003). Ce pourcentage se rapproche de celui avancé par Bouchibane & al. (2021) pour certains massifs montagneux de la Kabylie des Babors (Adrar Ou Mellal et Agouf) avec près de 55% de la flore analysée.

Certains taxons de cet élément sont très rares sur le terrain. C'est le cas de *Buxus sempervirens* L. qui figure dans deux de nos relevés seulement. En plus, Tababort reste la seule

station dans laquelle, on peut encore observer cette espèce dans le secteur de la petite Kabylie et en Algérie (Quézel & Santa 1962-1963). Par contre, *Viburnum lantana* L. (assez rare obs. pers) est assez bien représenté sur le terrain.

Le massif de Tababort heberge 83 taxons appartenant à l'élément septentrional, soit 28,6% de la flore inventoriée. Ce pourcentage est très important, il est supérieur à ceux donné par Bounar (2014) pour le parc national de Taza (24%) et par Yahi & al. (2008) pour la cédraie de l'Atlas tellien (21%). La présence de ces espèces en domaine méditerranéen remonte probablement à une période glaciaire. Mais le retrait des glaciers accompagné du réchauffement climatique a conduit à leur raréfaction, voire leur disparition dans certaines régions (Quézel & Médail 2003). Celles qui restent se limitent actuellement aux montagnes bien arrosées et aux zones humides (Maire 1928 ; Quézel 1995). Ce massif constitue un refuge pour de nombreuses espèces septentrionales comme *Euvonymus latifolius* Scop. et *Populus tremula* L. qui figurent respectivement dans cinq et trois de nos relevés floristiques.

Cette dernière espèce a été relevée entre 1752 et 1890 mètres d'altitude, souvent associé au Sapin de Numidie (*Abies numidica* De Lannoy) et au Cèdre de l'Atlas (*Cedrus atlantica* (Endl.) Carrière).

Cervaria rivini est une espèce très rare (Quézel & Santa 1962-63) d'origine européenne. Sa répartition géographique est limitée au mont Tababort en Algérie (Quézel & Santa 1962-1963) voire en Afrique du Nord (APD 2021). Elle figure dans un seul relevé que nous avons réalisé au massif de Tababort. Ce taxon ne figure pas dans l'inventaire floristique effectué récemment en Kabylie des Babors (Gharzouli 2007). Quant à *Dryopteris disjuncta* subsp. *calcarea* (Sm.) Roug, nous l'avons pas retrouvé et ne se retrouve guère dans l'étude effectuée dernièrement par Gharzouli (2007) dans cette région des Babors.

Le groupe des espèces de l'élément endémique régional mérite une attention particulière compte tenu de leur proportion non négligeable et de la valeur de ses espèces. Il totalise 41 taxons, soit 14,1% de la flore inventoriée, représentant ainsi 8,8% des endémiques d'Algérie estimée à 464 taxons par Dobignard & Chatelain (2010-2013) et 40,6% des endémiques du secteur K2 (Véla & Benhouhou 2007). Ce pourcentage d'endémisme est supérieur à celui donné par Larbi & al. (2021) pour la forêt d'Ait-Ouabane (Djurdjura) avec 6,7% de la flore étudiée, mais comparable à celui indiqué par Messaoudene & al. (2007) pour la forêt d'Akfadou (12%).

En région méditerranéenne, la richesse régionale en endémisme est due principalement à l'existence de nombreuses zones de persistance des espèces pendant les glaciations (Médail & Diadema 2009). Parmi les espèces endémiques répertoriées, le Sapin de Numidie (*Abies numidica* De Lannoy), inventorié dans nos relevés à partir de 1536 mètres d'altitude. Il est en mélange soit avec le Cèdre de l'Atlats (*Cedrus atlantica* (Endl.) Carrière), soit avec le Chêne zéen (*Quercus canariensis*), mais surtout en mélange avec les deux espèces (*Cedrus atlantica*; *Quercus canariensis*). Cette espèce (*Abies numidica*) est très nettement cantonnée à l'exposition nord, sur des pentes moyennes à fortes. Sa répartition géographique est limitée au massif étudié (Tababort) et à celui du mont Babor (Quézel 1956 ; Quézel & Santa 1962-63 ; Gharzouli 2007). Selon Quézel (1985), le Sapin de Numidie (*Abies numidica*), comme tous les sapins méditerranéens est cantonné exclusivement sur les substrats calcaréo-dolomitiques et surtout sur les reliefs karstifiés.

Une espèce rarissime qui est *Hieracium ernestii* Maire signalée par Quézel & Santa (1962-1963) comme une endémique stricte de Tababort, ne figure pas dans nos relevés floristiques, ni dans l'étude effectuée dernièrement par Ghazouli (2007). Ce taxon semble trouver refuge sur les rochers calcaires des endroits les plus inaccessibles pour l'homme.

L'ensemble à large répartition compte huit taxons (2,8%) dans cette présente étude. Ce pourcentage est comparable à celui avancé par Bouchibane & al. (2021) pour certains massifs montagneux de la Kabylie des Babors (Adrar Ou Mellal et Agouf) avec 4,0% de la flore analysée. Parmi elles, les cosmopolites qui présentent une aire de répartition très grande. Elles sont en nombre de six et ne représentent que 2,1% de la flore totale étudiée. Ce faible taux peut s'expliquer par le fait que l'échantillonnage a concerné une forêt de haute altitude où la pression anthropozoïque est moins forte que sur les bas de versants (Gharzouli 2007).

Types biologiques

Les formes de vie des végétaux représentent un outil précieux pour la description de la physionomie et de la structure de la végétation. Ces éléments sont considérés comme une expression de la stratégie d'adaptation de la végétation aux conditions du milieu (Messaoudéne & al. 2007).

L'exam se compose surtout de hémicryptophytes (41,0%). Les hémicryptophytes augmentent en milieu forestier et en hautes altitudes, cela est dû à la richesse du sol en matière organique (Barbero & al. 1989) et par l'importance des mycorhizes dans le sol (Whigham 2004 ; Fetnaci & al. 2019). Ce pourcentage des hémicryptophytes se rapproche de celui avancé par Larbi & al. (2021) pour la forêt d'Ait-Ouabane (Djurdjura) avec 44,0% de la flore étudiée.

Les thérophytes viennent en deuxième position avec 56 taxons (19,3%). Ce pourcentage (19,3%) est inférieur à celui donné par Messaoudene & al. (2007) pour la forêt d'Akfadou (28%). Les thérophytes caractérisent les forêts méditerranéennes et arides où domine un fort stress hydrique (Gharzouli 2007). L'abondance des espèces annuelles dans la région d'étude est liée aux incendies répétés, aux défrichements (Siab Farsi & al. 2016) et à l'importance du pâturage (Meddour 2010). La thérophytisation est une forme de résistance à la sécheresse ainsi qu'aux fortes températures des milieux arides (Daget 1980). Selon Hammada (2007), l'abondance des thérophytes peut être expliquée par la forte représentativité des habitats à immersion saisonnière, propices au développement de plantes annuelles à germination et croissance rapides.

Les phanérophytes sont assez bien représentés avec 45 taxons (15,5%). Malgré leur faible diversité spécifique elles dominent souvent par leur phytomasse. Les géophytes sont représentés par 41 taxons (14,1%). Elles ne présentent pas de tendance particulière, mais semblent avoir une préférence pour les milieux localisés aux altitudes élevées. D'après Dahmani (1996), les géophytes sont moins diversifiées en milieu dégradé.

Les chaméphytes sont représentées par 29 taxons (10,0%). Les chaméphytes sont généralement plus fréquentes dans les matorrals. Leur proportion augmente dés qu'il y a dégradation des milieux forestiers. Ces chaméphytes peuvent développer diverses formes d'adaptation à la sécheresse (Quézel 2000).

Rareté

La valeur patrimoniale des espèces repose en partie sur la définition de leur degré de rareté. La flore étudiée est riche en espèces rares s.l. avec 105, soit 36,2% des taxons recensés. Ces proportions de rareté correspondent à 21,4% des espèces rares du secteur de petite Kabylie (K2) selon Véla & Benhouhou (2007) qui en comporte 487. Le nombre de taxons inventorié et qui se retrouvent sur la liste des espèces protégées par la loi Algérienne (D.E. 2012) s'élève à 30 (10,3%). D'autres espèces, comme *Abies numidica*; *Acer campestre* L.; *Androrchis patens* (Desf.) D. Tyteca & E. Klein; *Buxus sempervirens* L.; *Cedrus atlantica*; *Cephalanthera longifolia* (L.) Fritsch.; *Chelidonium majus* L.; *Crataegus laciniata* Ucria.; *Dactylorhiza munbyana* (Boiss. & Reut.) Aver.; *Gallium odorataum* L.; *Himantoglossum hircinum* (L.) Spreng.; *H. robertianum* (Loisel.) P. Delforge; *Ilex aquifolium* L.; *Juniperus phoenicea* subsp. *turbinata* (Guss.) Nyman; *Lysimachia cousiniana* Coss. & Dur.; *Neotinea tridentata* subsp. *conica* (Willd.) R.M. Bateman, Pridgeon & M. W. Chase; *Orchis intacta* Link; *O. italica* Poir.; *Populus tremula* L.; *Quercus ilex* subsp. *ballota* (Desf.) Samp.; *Rhamnus cathartica* L; *Sorbus torminalis* (L.) Crantz; *Taxus baccata* L. figurent sur la liste rouge de l'UICN 2024 (https://www.iucnredlist.org/) avec des statuts différents: En danger critique pour *Abies numidica*, en danger pour *Androrchis patens* et *Cedrus atlantica*, quasi menacées pour *Juniperus phoenicea* subsp. *turbinata*; *Lysimachia cousiniana*; *Quercus ilex* subsp. *ballota* et préoccupation mineure pour les autres taxons. Ces plantes bénéficient d'un statut légal de plantes protégées, car elles sont jugées vulnérables et menacées. Certains taxons présentent un risque élevé d'extinction en raison de les conditions anthropiques défavorables pour leur survie.

Les espèces patrimoniales sont au nombre de 110, soit 37,9% de la flore recensée. Parmi ces espèces, 37,3% sont des endémiques, 31,8% sont des espèces nordiques, 28,2% d'origines méditerranéennes, 1,8% sont des espèces introduites et 0,9% sont de l'élément à large répartition. En outre, la majorité de ces espèces patrimoniales sont rares (66,4%), et doivent donc être protégées.

Certains taxons inventoriés sont très rares tels *Dryopteris filix-mas* (L.) Schott qui n'avait jamais été signalé auparavant dans la Kabylie des Babors. Le mont Tababort constitue une nouvelle station pour ce taxon, la plus proche connue étant celle de Djurdjura.

Conclusion

La flore du mont Tababort (Nord-Est algérien) caractérisée par un bioclimat per-humide à hivers froid est riche et diversifiée avec 290 taxons recensés. La famille des *Asteraceae* est la plus représentée dans le cortège floristique de la forêt étudiée. Les formations végétales les mieux préservées sont situées sur les versants dépassant 1500 mètres d'altitudes. En plus, cinq taxons recensés ne figurent pas sur les autres massifs du secteur des Babors.

Cet inventaire a permis la redécouverte du *Cervaria rivini* qui n'a pas été revue depuis longtemps dans la région d'étude.

La caractérisation biogéographique a montré la dominance de l'ensemble méditerranéen (53,4%), suivie par l'élément septentrional avec 28,6% de la flore recensée. L'ensemble endémique régional est relativement bien représenté (14,1%) (Tableau 3). Les hémicryptophytes avec 41,0% de la flore analysée prédominent. En outre, 36,2% de la flore étudiée est rare.

La zone d'étude comprend 110 (37,9%) espèces patrimoniales. Cela montre la haute valeur patrimoniale du site d'étude. Le mont Tababort mérite amplement son classement en réserve naturelle afin de maintenir l'état de cette forêt et de préserver son patrimoine floristique exceptionnel.

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Article

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Some new additions to the exotic vascular flora of continental Portugal

Abstract

Domingues de Almeida, J.: Some new additions to the exotic vascular flora of continental Portugal. — Fl. Medit. 34: 277-294. 2024. — ISSN: 1120-4052 printed, 2240-4538 online.

In this paper, based on recent and old bibliography and some own field observations, 69 more taxa (neophytes) are added to the catalogue of the exotic (or xenophytic) naturalised or subspontaneous vascular flora of continental Portugal, which includes now 841 taxa (species, subspecies, varieties and hybrids), a growth corresponding to more than 8.9% of the previous total number of 772 taxa, since our last reassessment, published in 2018, and our earlier surveys.

Key words: neophytes; subspontaneous flora; vascular plants; xenophytes.

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Introduction

After studying this subject for almost thirty years (since 1996), and given the importance of this kind of checklist, I thought it would be a good idea to update the list of the xenophytic flora of continental Portugal.

At the present time (2024), I conclude that the exotic naturalised or subspontaneous flora of continental Portugal includes now at least 841 neophytic taxa (species, subspecies, varieties and hybrids), 341 more than the number of 500 taxa attained at my original work on this theme (Domingues de Almeida 1999).

As we have written before (Domingues de Almeida & Freitas 2000, 2001, 2006, 2012), the expansion of exotic invasive plants is threatening the Portuguese native flora, representing a severe environmental problem, as it happens in many other parts of the World.

As we already know, continental Portugal is a territory very rich in weeds, shrubs and trees of exotic origin, at some cases even threatening the Portuguese native flora (Chodat 1913; Pereira Coutinho 1920; Fernandes 1955; Pinto da Silva 1971, 1975; Pinto da Silva & al. 1989; Domingues de Almeida & Freitas 2000, 2001; Greuter 2002).

Material and methods

The species are arranged in alphabetic order. Classification used in this paper follows the most recent concepts: APG III (2009) and APG IV (2016) for the delimitation of families, and *Flora iberica* (Castroviejo & al. 1986–2021) for the nomenclature of taxa. Ecological classification of the referred taxa follows Kornas (1990). Phytotypes or plant life-forms are given according to Raunkiaer classification (1934).

These 69 new taxa are mainly from recent (or ancient, in some cases) bibliographic references, but also from observations in the field and personal communications, and represent an increment of more than 8,9 % to the exotic flora of continental Portugal, since my last survey (772 taxa), published in 2018 (Domingues de Almeida 2018).

These 841 exotic taxa represent about 21 % (more than one fifth) of the total number of taxa of the continental Portuguese vascular flora, which includes circa 4000 taxa (species, subspecies, varieties and hybrids), according to our most recent estimations (Domingues de Almeida 2009; Domingues de Almeida & Freitas 2012; Domingues de Almeida 2018).

Results

1. ***Acacia podalyriifolia*** A. Cunn. ex G. Don [*Fabaceae*]
Phanerophyte, from NE Australia (Mabberley 2017), recently found naturalised in the northern Portuguese province of Minho: Viana do Castelo (Sousa Homem 2019), and Paredes de Coura (Matias 2017).

2. ***Acer opalus*** Miller [*Sapindaceae*]
Phanerophyte, from Eurasia, recently found naturalised in Beira Alta: Vouzela, maybe as an agriophyte, in oakwoods (Pereira & al. 2013).

3. ***Albizia julibrissin*** Durazz. [*Fabaceae*]
Phanerophyte, from Eurasia, introduced as an ornamental tree, now probably an epoecophyte, recently found naturalised somewhere in Portugal, although not really invasive (Marchante & al. 2014; Presidência do Conselho de Ministros 2019; https://invasoras.pt/pt/planta-invasora/albizia-julibrissin).

4. ***Aloe* × *nobilis*** Haw. [*Asphodelaceae*]
Chamaephyte, from South Africa; this species was recently (2013) found naturalised in Portugal, maybe as an agriophyte, in the Algarve: "in dune vegetation at Praia do Amado, near Portimão" (Smith & al. 2023).

5. ***Aloiampelos ciliaris*** (Haw.) Klopper & Gideon F. Sm. var. ***ciliaris*** (= *Aloe ciliaris* Haw.) [*Asphodelaceae*]
Chamaephyte, from South Africa (Mabberley 2017); this species "has escaped from cultivation, especially along the west-central coast of Portugal in the vicinity of Lisbon and indications are that it is on the brink of becoming naturalised" (Smith & al. 2023).

6. ***Alternanthera philoxeroides*** (Mart.) Griseb. (= *Bucholzia philoxeroides* Mart.) [*Amaranthaceae*]
Chamaephyte, from South America, recently found becoming invasive (probably as an epoecophyte) in continental Portugal (Ledo Mendes, 2023).

7. ***Amsinckia calycina*** (Moris) Chater (= *Lithospermum calycinum* Moris) [*Boraginaceae*]
Therophyte, from America, recently found as an epoecophyte in Trás-os-Montes: Bragança, in a field of *Lolium multiflorum* (Carlos Aguiar in Facebook, 26.IV.2021). It was already found naturalised in the neighbour countries Spain and France (Chater 1972; Juan 2012).

8. ***Anethum graveolens*** L. [*Apiaceae*]
Therophyte, native of the Old World, is "Widely cultivated as a herb and often more or less naturalised, particularly in the Mediterranean region", including Portugal (Tutin 1968), in several provinces: Algarve, Alto Alentejo, Beira Baixa, Beira Litoral and Estremadura (Grisley 1661; Brotero 1804a; Mariz 1895; Franco 1971; Pinto da Silva 1993).

9. ***Aptenia*** ×**'Red Apple'** (*Aizoaceae*)
Chamaephyte; this cultivar, of hybrid origin, from the crossing of *Aptenia cordifolia* (L. f.) Schwantes and *A. haeckeliana* (A. Berger) Bittrich ex Gerbaulet was found naturalised in continental Portugal: Estremadura, at least since 2014 (Silva & al 2015; Smith & al 2019).

10. ***Aristida adscensionis*** L. [*Poaceae*]
Hemicriptophyte, native of the Americas, was recently found naturalised as ruderal epoecophyte in the south of Portugal: Algarve (Portugal), at the margin of a road, at 31.VIII.2019 (Sánchez Gullón & Peña Ramos 2019).

11. ***Aucuba japonica*** f. ***variegata*** (Dombrain) Rehd. (= *Aucuba japonica* var. *variegata* Dombrain) [*Garryaceae*]
Phanerophyte, from East Asia, was recently found naturalised in Portugal, Estremadura: "29SMC6193, Sintra, Colares, *V. Silva & A. Flor*. 17-VI-2021" (Silva & al. 2023).

12. ***Billbergia zebrina*** (Herb.) Lindley (= *Bromelia zebrina* Herb.) (*Bromeliaceae*)
Hemicriptophyte, native of South America, was found some years ago naturalised in Portugal, Estremadura: "Ramada, Odivelas, Lisboa (E) 29SMC8395" (Silva & al. 2012).

13. ***Borago officinalis*** L. [*Boraginaceae*]
Therophyte, from the Mediterranean Region, probably an archaeophyte, introduced a long time ago as an edible, medicinal and ornamental plant, already referred by Grisley (1661), and by Brotero (1804a) as "spontanea , seu quasi indigena in ruderatis , solo raro , ad hortos , quibus colitur , et circa loca habitata"; it is also considered "planta culta" (Dias Baptista 1783) and "planta exotica" (Vandelli 1788); for more recent authors it seems to be a common spontaneous plant (Pereira Coutinho 1905; Pereira Coutinho 1913; Sampaio 1947; Franco 1984; Valdés 2012).

14. ***Bromus caroli-henrici*** Greuter [*Poaceae*]
Therophyte, from the Eastern Mediterranean Region (Greuter 1971), rarely naturalised in Portugal as an epoecophyte ot diaphyte, possibly introduced with italian wheats (Franco & Rocha Afonso 1998, sub *Bromus alopecuros* Poiret subsp. *alopecuros*), recently considered subspontaneous or adventitious in continental Portugal (Romero-Zarco 2023).

15. ***Chloris gayana*** Kunth [*Poaceae*]
Hemicriptophyte, from Africa, already known as subspontaneous in several Spanish provinces (Velayos 2021), was recently found in the Algarve, probably as an epoecophyte, by Valter Jacinto (2009, photo, Naturdata: https://naturdata.com/especie/Chloris-gayana/39407/0/) and Paulo Alves (2018, in Facebook), and also in Olhão (Algarve), by J. M. Neiva, "jul 23, 2021", "Growing on the slope of the road, origin unknown but likely a garden escapee" (Biodiversity4all 2024a).

16. ***Citrullus colocynthis*** (L.) Schrader (= *Cucumis colocynthis* L.) [*Cucurbitaceae*]
Hemicriptophyte, native of the Mediterranean Region, recently found naturalised in Portugal, Baixo Alentejo: Mértola, Corte do Pinto, by the margin of the river Guadiana (David Cardeira in Facebook, 5.XI.2023).

17. ***Coreopsis lanceolata*** L. [*Asteraceae*]
Hemicriptophyte, from E North America (Mabberley 2017), sometimes cultivated in continental Portugal and rarely naturalised, probably as a diaphyte, at several Portuguese provinces: Baixo Alentejo (Alcácer do Sal: Barrosinha), Beira Litoral (Águeda; Coimbra; Oliveira de Azeméis), Douro Litoral (Gondomar: Rio Tinto; Póvoa de Varzim), and Minho (Guimarães) (Biodiversity4all 2024b).

18. ***Coreopsis tinctoria*** Nutt. (= *Calliopsis tinctoria* (Nutt.) DC.) [*Asteraceae*]
Therophyte, from E North America (Mabberley 2017), sometimes cultivated in continental Portugal (Greuter 2006+), rarely naturalised in the South of Spain (Crespo & Buira 2019), was recently found subspontaneous in Douro Litoral: Vila Nova de Gaia, "Reserva Natural Local do Estuário do Douro" (José Luís Sousa in Facebook, 12.VII.2023), and also in Algarve (São Brás de Alportel), Alto Alentejo (Avis, Montemor-o-Novo), Beira Litoral (Tábua: Midões); Douro Litoral (Porto), Estremadura (Lisboa, Algés, Almada: Sobreda), Minho (Ponte de Lima: Feitosa, Vizela), and Trás-os-Montes e Alto Douro (São João da Pesqueira) (Biodiversity4all 2024c). I saw this plant as as casual escape in Beira Litoral (Figueira da Foz: Praia de Quiaios, Murtinheira, 28.VIII.1994, and Cantanhede: Olhos de Fervença, 13.X.2002).

19. ***Cotoneaster pannosus*** Franch. [*Rosaceae*]
Phanerophyte, from Eurasia (China), recently found naturalised (Senar Lluch & Cardero Aguilera 2022), probably as an epoecophyte, in several provinces of continental Portugal: Algarve (Lagoa), Baixo Alentejo (Almodôvar), Beira Litoral (Batalha, Coimbra, Leiria, Miranda do Corvo), Estremadura (Almada, Amadora, Arruda dos Vinhos, Bucelas, Caparica, Carcavelos, Lisboa, Mafra, Odivelas, Setúbal, Trafaria), Ribatejo (Alcanena, Tomar), and Trás-os-Montes e Alto Douro (Valpaços: Carrazedo de Montenegro), at least since 2019 (Biodiversity4all 2024d).

20. ***Crassula helmsii*** (Kirk) Cockayne (= *Tillaea helmsii* Kirk) [*Crassulaceae*]
Hemicriptophyte or helophyte, from Australia and New Zealand; agriophyte, semi-aquatic plant, probably introduced as an ornamental aquary and pond oxygenator plant, was recently (XI.2022) found naturalised in Beira Litoral, in swamps near Soure, not far from the Mondego river, by Jael Palhas (Biodiversity4all 2024g; iNaturalist, 2024; Jael Palhas in Facebook, VI.2023); it was also found naturalised in our neighbour region Galicia (Fagúndez & al. 2024) and in several other European countries (Robert & al. 2013; Global Invasive Species Database (GISD) 2024).

21. ***Crassula ovata*** (Mill.) Druce **'Baby Jade'** [*Crassulaceae*]
Phanerophyte, of hybrid origin, was recently found as a casual species (diaphyte), in Portugal: Estremadura, "29SMC5990, Cascais, Alcabideche, Biscaia, *V. Silva & S. Saraiva*. 29-IV-2017 (LISI s/n)" (Silva & al. 2023).

22. ***Crepis bursifolia*** L. [*Asteraceae*]
Hemicryptophyte, from the Mediterranean Region; ruderal epoecophyte, found naturalised in Portugal, Estremadura: Almada, since 2023 (Clamote, 2023a).

23. ***Cryptomeria japonica*** (Thunb. ex L. f.) D. Don (= *Cupressus japonicus* Thunb. ex L. f.) [*Cupressaceae*]
Phanerophyte, from Eurasia, introduced as an ornamental tree, found, at least, since 1950, subspontaneous in Parque da Pena, Sintra (Estremadura) (Alves & al., 2003), also naturalised in the archipelago of Azores) (Menezes de Sequeira & al. 2011).

24. ***Digitaria sanguinalis*** (L.) Scop. (= *Panicum sanguinale* L.) [*Poaceae*]
Therophyte, of subcosmopolitan, naturalised in Portugal as an archaeophyte (introduced before the year 1500), according to recent authors (Menezes de Sequeira & al. 2011; Alonso & Crespo 2021).

25. ***Echinochloa crus-galli*** var. ***hispidula*** (Retz.) Honda (= *Panicum hispidulum* Retz. = *Echinochloa hispidula* (Retz.) Nees ex Royle) [*Poaceae*]
Therophyte, from Tropical East Asia, naturalised in five Portuguese provinces: Baixo Alentejo, Beira Litoral, Douro Litoral, Estremadura, Trás-os-Montes e Alto Douro (Vasconcelos & al. 2020; Martínez Azorín & Crespo 2021).

26. ***Echinochloa oryzoides*** (Ard.) Fritsch (=*Panicum oryzoides* Ard.) [*Poaceae*]
Echinochloa phyllopogon (Stapf) Stapf)
Therophyte, from Tropical East Asia, collected for the first time in Portugal before 1940, in the rice-fields of Quinta de Foja (Montemor-o-Velho, baixo Mondego) (Vasconcellos 1940); occurring in several Portuguese provinces: Beira Litoral, and probably also in Alto Alentejo, Baixo Alentejo, Douro Litoral, Estremadura, Minho and Ribatejo (Vasconcelos & al. 2020; Martínez Azorín & Crespo 2021).

27. ***Freesia leichtlinii*** subsp. ***alba*** (G.L. Mey.) J.C. Manning & Goldblatt (= *Freesia refracta* (Jacq.) Ecklon ex Klatt var. *alba* G.L. Mey.) [*Iridaceae*]

Geophyte, from South Africa, recently found naturalised in Portugal, possibly as an epoecophyte, in Estremadura: "29SMC6083, Cascais, Guia, *V. Silva & S. Saraiva*. 13-I-2018" (Silva & al. 2023).

28. ***Gazania rigens*** var. ***leucolaena*** (DC.) Roessler (=*Gazania leucolaena* DC.) [*Asteraceae*]
Chamaephyte, from South Africa, was recently found naturalised in Portugal, possibly as an epoecophyte, in the province of Estremadura: Oitavos (Cascais) and Colares (Sintra) (Silva & al. 2023; Talavera & Talavera 2017).

29. ***Gazania rigens*** var. ***uniflora*** (L. fil.) Roessler (= *Gorteria uniflora* L. fil.) [*Asteraceae*]
Chamaephyte, from South Africa, was recently found naturalised in Portugal, possibly as an epoecophyte, in E: Cabo Raso, in Cascais (Silva & al. 2015; Silva & al. 2023), and also in the province of Baixo Alentejo (Talavera & Talavera 2017).

30. ***Gladiolus cunonius*** (L.) Gaertn. (=*Antholyza cunonia* L.) [*Iridaceae*]
Geophyte, from South Africa, recently found naturalised in Portugal (Estremadura), possibly as an agriophyte, at the "arriba fóssil da Costa de Caparica", and "Mata dos Mêdos, Fonte da Telha, Almada, 26/03/2021" (Ana Cristina Antunes in Facebook, 27.III.2021).

31. ***Heteranthera limosa*** (Sw.) Willd. [*Pontederiaceae*]
Hydrophyte, from America, found naturalised in Portugal at least since 1997, epoecophyte in rice fields (Vasconcelos & al. 1999).

32. ***Ipomoea cairica*** (L.) Sweet (= *Convolvulus cairicus* L.) [*Convolvulaceae*]
Hemicryptophyte, from Africa and the Mediterranean Region; ruderal epecophyte, found naturalised in Estremadura: Almada, since 2023 (Clamote, 2023b).

33. ***Kniphofia uvaria*** (L.) Oken (= *Aloe uvaria* L.) [*Asphodelaceae*]
Chamaephyte, from South Africa, introduced as an ornamental plant and recently (2017) found as a casually naturalised species in Estremadura: "Cascais, Alcabideche, Abuxarda" (Silva & al. 2023).

34. ***Larix decidua*** Mill. (= *Pinus larix* L.) [*Pinaceae*]
Phanerophyte, from Europe (Raab-Straube 2014+), introduced as a cultivated tree in the mountains of Cabreira and Gerês (Minho), Marão, Montezinho and Nogueira (Trás-os-Montes e Alto Douro), and Estrela (Beira Alta, Beira Baixa) (Franco 1943; Franco 1993b; Ribeiro & al. 2008), and also in Douro Litoral (Arouca), and in Estremadura (Cadaval: Cercal, and Loures: Lousa) (Biodiversity4all 2024e).

35. ***Leptochloa fusca*** subsp. ***fascicularis*** (Lam.) N. Snow (= *Festuca fascicularis* Lam.) [*Poaceae*]
Therophyte, semiaquatic, from North America, recently found naturalised in the centre of Portugal, as an epoecophyte infestant weed in rice fields in Ribatejo (Aedo 2021; Carvalho Santos 2022).

36. ***Linaria maroccana*** Hooker fil. [*Plantaginaceae*]
Therophyte, from the Western Mediterranean Region, endemic to Morocco, rarely naturalised in other countries (Marhold 2011+), frequently cultivated as an ornamental plant and rarely escaped from cultivation, as a diaphyte, observed in Coimbra (Beira Litoral, in the centre of Portugal), at both margins of rhe river Mondego, at least since 2014 (own observation and photos).

37. ***Ludwigia grandiflora*** (Michx.) Greuter & Burdet (= *Jussiaea grandiflora* Michx.) [*Onagraceae*], including *Ludwigia grandiflora* (Michx.) Greuter & Burdet subsp. *hexapetala* (Hook. & Arn.) G. L. Nesom & Kartesz (= *Jussiaea hexapetala* Hook. & Arn.)
Hydrophyte, from tropical America, now considered invasive and banned in other regions (Mabberley 2017; Raab-Straube 2018+); agriophyte, probably introduced as an ornamental aquatic plant, already naturalised in several Spanish provinces (Nieto Feliner 1997), and presently considered a serious invasive species in continental Portugal (Presidência do Conselho de Ministros 2019; Município da Figueira da Foz 2020; Flora-On: Flora de Portugal Interactiva 2024; Plantas invasoras em Portugal 2024a), found present in the provinces of Beira Litoral (Arganil: Coja, and Figueira da Foz) and Alto Alentejo (Castelo de Vide: Serra de S. Mamede Natural Park) (Município da Figueira da Foz 2020; Palhas & al. in Flora-On: Flora de Portugal Interactiva 2024; Plantas invasoras em Portugal 2024a; Biodiversity4all 2024f).

38. ***Mahonia japonica*** (Thunb.) DC. (= *Ilex japonica* Thunb. = *Berberis japonica* (Thunb.) Spreng.) [*Berberidaceae*]
Phanerophyte, from Tropical Asia, frequently cultivated as an ornamental plant and rarely escaped from cultivation, as a diaphyte, very recently (2023) found naturalised in the province of Estremadura: "Cascais, Alcabideche, Malveira da Serra" (Silva & al. 2023).

39. ***Marsilea schelpeana*** Launert [*Marsileaceae*]
Helophyte; exotic fern, from the Cape Region of South Africa, "which grows on seasonal pools, along watercourses or reservoirs in seasonally dry areas", recently found naturalised as an agriophyte in Alentejo "at the Guadiana basin", "on the field campaign of 2017" (Aguiar & al. 2019).

40. ***Myrtus communis*** subsp. ***tarentina*** (L.) Nyman (= *Myrtus communis* var. *tarentina* L.) [*Myrtaceae*]
Phanerophyte, probably of horticole origin (Brotero 1804b; Pereira Coutinho 1916), rarely naturalised in Portugal (Paiva 1997), "*mainly near the coast*" (Campbell 1968), "però forse solo come relitto di antiche colture" (Pignatti 1982), which was traditionally "worn by judges & victors at orig. Olympic Games" (Mabberley 2017).

41. ***Najas gracillima*** (A. Braun ex Engelm.) Magnus (= *Najas indica* (Willd.) Cham. var. *gracillima* A. Braun ex Engelm.) [*Hydrocharitaceae*]
Cryptophyte (hydrophyte), from Eurasia and North America; agriophyte, maybe casually introduced, already found introduced/naturalised in rice-fields in Spain and Italy (Dandy 1980b; Uotila 2009+; Talavera & Gallego 2010); aquatic plant found naturalised in Beira

Litoral (Figueira da Foz, two places, by Jael Palhas), and in Algarve (Tavira, by João Neiva), 2021 (J. Neiva & J. Palhas in Facebook, 23.VIII.2021: https://www.facebook.com/groups/246571202123569).

42. ***Narcissus* × *intermedius*** Loisel. (= *N. jonquilla* L. × *N. tazetta* L.) [*Amaryllidaceae*]
Cryptophyte (geophyte), of hybrid origin; diaphyte, introduced as an ornamental plant, sometimes subspontaneous or escaped from cultivation in continental Portugal, found as a casual species in Minho: Póvoa de Lanhoso, at least since 1887 (Henriques 1887; Pereira Coutinho 1913; Fernandes 1936).

43. ***Narcissus* × *odorus*** L. (= *N. jonquilla* L. × *N. pseudonarcissus* L. subsp. *pseudonarcissus*, *N.* × *calathinus* L.) [*Amaryllidaceae*]
Cryptophyte (geophyte), of hybrid origin; diaphyte, introduced as an ornamental plant, sometimes subspontaneous or escaped from cultivation in continental Portugal, found as a casual species in the Algarve (Faro), and also in Minho (Melgaço, Póvoa de Lanhoso), having been found at least since 1883 (Tait 1886; Henriques 1887; Thellung 1912; Pereira Coutinho 1913; Menezes de Sequeira & al. 2011).

44. ***Nepeta cataria*** L. [*Lamiaceae*]
Hemicryptophyte, probably an archaeophyte from Eurasia, very rare in Portugal, likely introduced a long time ago as a medicinal and ornamental plant, «*Hab.* in ruderatis, ad vias et sepes Lusitaniae montanae, ut videtur haud frequens» (Pereira Coutinho 1907), already found by Tournefort (Henriques 1890), and also mentioned by Grisley (1661), Vandelli (1788, 1789) and Brotero (1804a), and as "*formerly cultivated as a medicinal herb and widely naturalized in N. & W.C. Europe*" (Turner 1972), and "often naturalised" (Hedge & Lamond 1982).

45. ***Nothoscordum* × *borbonicum*** Kunth [*Amaryllidaceae*]
Geophyte, of hybrid origin, from South America, was recently (2018) found as an epoecophyte, naturalised in the city of Lisbon (Estremadura) (Silva & al. 2023).

46. ***Nymphaea* × *marliacea*** Lat.-Marl. [*Nymphaeaceae*]
This aquatic species (hydrophyte), of hybrid origin, was recently found in one river in the South of Portugal, in the province of Algarve: "Ag: Odeleite. 15-1-2018. MA926165" (Sánchez Gullón & al. 2020).

47. ***Nymphaea mexicana*** Zucc. [*Nymphaeaceae*]
Hydrophye, from North America, legally considered as an invasive species in continental Portugal (Presidência do Conselho de Ministros 2019; Invasoras.pt. 2024; Plantas invasoras em Portugal 2024b), was recently found in rivers in the South of Portugal (Jael Palhas in Facebook, 10.V.2024).

48. ***Oenothera speciosa*** Nutt. [*Onagraceae*]
Chamaephyte, from North America, recently (2017) found in the Algarve: Tavira, on a riverbank, as an ergasiophygophyte (Sánchez Gullón & al. 2020).

49. ***Opuntia bonaerensis*** Speg. [*Cactaceae*]
Phanerophyte, from South America; this taxon, formerly included in *Opuntia elata* Salm-Dyck, *sensu lato*, was recenty recognized as being naturalised in several Portuguese provinces as an epoecophyte: Beira Alta, Beira Litoral, Estremadura and Trás-os-Montes e Alto Douro (Aymerich & Font 2023). I've already found this plant in 2004, at the top of the hill Senhora do Monte, near the river Douro (Trás-os-Montes e Alto Douro), not far from Vila Nova de Foz Coa (Domingues de Almeida 2009, sub *Opuntia maxima* Mill.).

50. ***Oryza sativa*** subsp. ***silvatica*** Chiappelli [*Poaceae*]
Therophyte, from South Asia, occurring as an epoecophyte in rice-fields, along with other infestant species, mainly in the Centre and South of Portugal, at the rivers Mondego, Tejo and Sado basins (Dias & al. 2020; Vasconcelos & al. 2020).

51. ***Parablechnum chilense*** (Kaulf.) Gasper & Salino (= *Lomaria chilensis* Kaulf. = *Blechnum chilense* (Kaulf.) Mett.) [*Blechnaceae*]
Hemicryptophyte, from Souh America; agriophyte, introduced as an ornamental plant. The presence of this fern was recently confirmed in Estremadura: Sintra (Molino de Miguel 2022).

52. ***Paulownia tomentosa*** (Thunb.) Steud. (= *Bignonia tomentosa* Thunb.) [*Paulowniaceae*]
Phanerophyte, from China, introduced as an ornamental and useful tree, this species, naturalised in several European countries (Marhold 2017+), was recently considered invasive in Central Portugal: Serra da Estrela (Raposo & al. 2021; Presidência do Conselho de Ministros 2019).

53. ***Picea abies*** (L.) Karsten (= *Pinus abies* L.) [*Pinaceae*]
Phanerophyte, from Europe (Raab-Straube 2014+), cultivated and sometimes naturalised in the mountains: Buçaco, Cabeceiras de Basto, Manteigas, Montalegre and Vieira do Minho, (Franco 1943; Franco 1951; Franco 1993a; Ribeiro & al. 2008).

54. ***Picea orientalis*** (L.) Link (= *Pinus orientalis* L.) [*Pinaceae*]
Phanerophyte, from Eurasia (Raab-Straube 2014+) found, at least, since 1950, naturalised in Parque da Pena, Sintra (Estremadura) (Alves & al. 2003).

55. ***Pinus nigra*** subsp. ***laricio*** Maire [*Pinaceae*]
Phanerophyte, from the Mediterranean Region (Raab-Straube 2014+); it was once introduced for wood in the mountains: Barroso, Cabreira, Estrela, Gerês, Lousã, Marão, Montezinho, Nogueira and Padrela (Ribeiro & al. 2008).

56. ***Pteris tremula*** R. Br. [*Pteridaceae*]
Hemicriptophyte, from Australia, New Zealand, found as a casual escaped plant (2021): "Já ocorre assilvestrado também no Continente, como casual em ambientes ruderais, mais ou menos sombrios e com alguma humidade no solo, nomeadamente em áreas urbanas" (Flora-On 2024: https://flora-on.pt/#/1Pteris+tremula).

57. ***Pyracantha angustifolia*** (Franch.) C. K. Schneid. (= *Cotoneaster angustifolius* Franch.) [*Rosaceae*]
Phanerophyte, from Eurasia, commonly used as an ornamental plant, and sometimes escaped, as an epoecophyte, at the provinces of Beira Alta, Beira Litoral and Baixo Alentejo (Ribeiro 2006; Domingues de Almeida 2009; Sánchez Gullón & al. 2020).

58. ***Reseda odorata*** L. [*Resedaceae*]
Hemicriptophyte, from the Eastern Mediterranean Region (Valdés Bermejo 1993), in continental Portugal considered "In large-scale cultivation" in continental Portugal (Martín-Bravo 2011), "*Commonly cultivated for its fragrant flowers and locally naturalized in S. & C. Europe*" (Yeo 1964; Yeo 1993).

59. ***Rhododendron macrophyllum*** D. Don ex G. Don [*Ericaceae*]
Phanerophyte, from North America; agriophye, introduced as an ornamental, found naturalised since 1999, in Parque da Pena, Sintra (Estremadura) (Alves & al. 2003).

60. ***Roldana petasites*** (Sims) H. Rob. & Brettel (= *Cineraria petasitis* Sims = *Senecio petasitis* (Sims) DC.) [*Asteraceae*]
Chamaephyte, from tropical North America, found naturalised in Estremadura, near Lisbon: near Lisbon: Arruda dos Vinhos: Arruda dos Vinhos, 29SMD91, 15.III.1974, by T. Vasconcelos, and in Cascais, Alcabideche, Malveira da Serra, 29SMC6190, 14.II.2014, by V. Silva & S. Saraiva (Silva 2015).

61. ***Rosa* × *wichuraiana*** Crép. **'Excelsa'** (= *Rosa luciae* Franch. & Rochebr. × *Rosa* 'Crimson Rambler') [*Rosaceae*]
Phanerophyte, of hybrid origin, becoming an invasive (epoecophyte) rose common mainly in the North of continental Portugal: Minho and Douro Litoral (Silva. & al. 2019; Paulo Alves in Facebook, 16.IX.2023).

62. ***Rumohra adiantiformis*** (G. Forst.) Ching (= *Polystichum adiantiforme* G. Forst.) [*Dryopteridaceae*]
Hemicriptophyte, mainly from Southern Hemisphere, was recently found naturalised in the North of Portugal: Douro Litoral): Maia, Gemunde, 29TNF36, at the trunk of a dead palm-tree, by Carlos Silva (in Facebook, 1.I.2024), and was identified by Paulo Alves (in Facebook, 3.I.2024).

63. ***Salvia hispanica*** L. [*Lamiaceae*]
Hemicryptophyte, from North America; seems to be an agriophyte, possibly escaped from cultivation: "*Salvia hispanica,* muito viçosa e nalguns pontos dominava uma margem ribeirinha sombreando o solo", em Caldas da Rainha (Paulo Lemos in Facebook, 28.X.2021).

64. ***Scilla hyacinthoides*** L. [*Asparagaceae*]
Geophyte, from Eurasia, probably escaped from gardens, as an epoecophyte, where it was cultivated as an ornamental plant (Almeida da Silva & Crespi 2013).

65. ***Senecio brasiliensis*** (Spreng.) Less. (= *Cineraria brasiliensis* Spreng.) [*Asteraceae*]
Hemicriptophyte, from South America, was "reported for the first time as a naturalized alien species from Europe (near Porto; Portugal)" (Dana & al. 2021), as an epoecophyte "found in highly disturbed habitats with many alien species near Porto" (Dana & al. 2021).

66. ***Tecomaria capensis*** (Thunb.) Spach (= *Tecoma capensis* (Thunb.) Lindley = *Bignonia capensis* Thunb.) [*Bignoniaceae*]
Phanerophyte, from South Africa, was recently found naturalised, probably as an epoecophyte, in Estremadura: "Cascais, ribeira dos Mochos, 29SMC6284, 14-II-2014, V. Silva & S. Saraiva, LISI 87/2014" (Silva 2015).

67. ***Trifolium miegeanum*** Maire [*Fabaceae*]
Therophyte, from the Western Mediterranean Region, endemic to Morocco (Dobignard & Chatelain 2012), introduced in the Botanic Garden of Coimbra and casually escaped and found in the arboretum of Vale de Canas, near Coimbra, 20-VI-1948 (Fernandes 1949; Fernandes 1955; Pinto da Silva 1971).

68. ***Ulmus minor*** var. ***vulgaris*** (Aiton) Richens (= *U. campestris* var. *vulgaris* Aiton; *U. procera* Salisb.) [*Ulmaceae*]
Phanerophyte; archaeophyte, probably introduced by the Romans to support the vines, cultivated and subspontaneous in most of continental Portugal (Brotero 1804a; Pereira Coutinho 1913, 1936; Sampaio 1947; Domingues de Almeida 2009); according to Gil & al. (2004), the "English elm is a 2,000-year-old Roman clone", which "is very effective in vegetative propagation", "spread over Spain and Britain", and "it corresponds to the Atinian elm, which was used for vinetraining by the Romans" (Gil & al. 2004; cf. Portela-Pereira 2016, in Flora-On: Flora de Portugal Interactiva 2024); it was already cited as "*Hab.* prope *Cintra*, in vallibus, et ad pagos in Extremadura, Beira, et Lusitania boreali quasi spontanea" by Brotero (1804a), being mainly "confined to the north-west of the country" (Richens & Jeffers 1986; Franco 1971).

69. ***Vallisneria americana*** Michx. [*Hydrocharitaceae*]
Hydrophyte; agriophyte, found subspontaneous in water ponds in the provinces of Beira Litoral: Mira (Jael Palhas in Facebook, 22.VIII.2019), Estremadura: "Grande Lisboa", in public parks, about 20 years ago (ca. 2004) (Udo Schwarzer in Facebook, 22.VIII.2019), and Algarve: Aljezur: Odeceixe (Udo Schwarzer in Facebook, 22.VIII.2019), probably introduced as an aquary plant. *Valisneria spiralis* L. is the only species of the genus *Vallisneria* L. spontaneous in Europe (Dandy 1980a; Uotila 2009+).

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Article

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Diversité floristique dans les reboisements du pin d'Alep en Oranais, nord-ouest Algérien

Floristic diversity in reforestations with Aleppo pine in Oran, north-western Algeria

Résumé

Cherifi, M. M. & BMedjahdi, B.: Diversité floristique dans les reboisements du pin d'Alep en Oranais, nord-ouest Algérien. — Fl. Medit. 34: 295-306. 2024. — ISSN: 1120-4052 printed, 2240-4538 online.

En Algérie, durant les années 1970, de vastes projets de reboisement ont été menés, notamment dans la région oranaise, ce qui a suscité de vives critiques. Parmi celles-ci, la pauvreté floristique des pinèdes en comparaison avec d'autres formations végétales a souvent été mise en avant. Dans cette étude, nous avons examiné la diversité floristique de quelques reboisements représentatifs du nord-ouest algérien. Nous avons établi un catalogue floristique révélant la présence de 389 espèces, un chiffre comparable à ceux observés dans les peuplements naturels d'autres essences forestières de la région. L'analyse des types biologiques, de la rareté et de l'endémisme a également montré des résultats similaires à ceux des autres peuplements. Ces constatations encouragent la poursuite de ce type de plantation, tout en soulignant la nécessité d'appliquer une sylviculture appropriée.
Keywords: Biodiversité, biogéographie, endémisme, conservation, North Africa.

Abstract

In Algeria during the 1970s, large-scale of reforestation projects were carried out, particularly in the Oran region and have been subject to great criticism. One of these criticisms is the floristic poverty of pinewoods compared with other plant formations. In this study, we examined the floristic diversity of few representative reforested areas in north-western Algeria. We established a floristic catalogue that revealed the presence of 390 species, a figure similar to those found in natural stands of other forest species in the region. Analysis of biological type, rarity and endemism also showed similar results to those of other stands. Our results encourage such type of plantation, but require the application of appropriate silviculture.
Keywords: Biodiversity, biogeography, endemism, conservation, Afrique du Nord.

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Introduction

La surface de la forêt en Algérie est nettement dominée par les peuplements de pin d'Alep (*Pinus halepensis* Mill.). Si cette surface est en partie occupée par des peuplements naturels

telles les pinèdes de Tlaghe-Saïda et des Aurès (Maire 1926), une grande part est actuellement occupée par des peuplements artificiels. En effet, d'intenses opérations de reboisement ont été lancées après l'indépendance surtout durant les années 70 du siècle dernier, où le pin d'Alep a été largement planté principalement en Oranais. Ce choix a été imposé par les conditions difficiles (climatiques et édaphiques) de cette zone, mais aussi par certaines caractéristiques de ce résineux (facile à multiplier en pépinière et aussi facile à planter car il est moins exigeant que les autres essences forestières) (Letreuch Belarouci 1991).

Cette utilisation excessive a fait l'objet de nombreuses critiques, le plus souvent sans aucun fondement scientifique (Medjahdi 2010). En effet, certains auteurs pensent que le pin d'Alep qui produit une litière de mauvaise qualité et à lente décomposition acidifie le sol (Bonneau 1984; Aloui & Couteaux 1999; Peltier & al. 2001). De ce fait la litière s'accumule avec le temps sous les arbres, empêchant les premières racines de la plupart des jeunes plants du sous-bois d'atteindre le sol. Cette accumulation s'accompagne souvent d'une acidification du sol (Richert 1978). Ainsi cette litière entrave le bon développement des espèces herbacées du sous-bois d'où une éventuelle baisse de la richesse floristique. Nous pouvons confirmer que ces remarques ont été réalisées dans un contexte climatique différent. En effet, l'acidification des sols par les résineux a été souvent observée sous des climats tempérés et plus humides où la lixiviation et le lessivage sont très importants, contrairement aux climats méditerranéens (Chatzistathis & Therios 2013; Dambrine & Ulrich 1993). Pour la baisse de richesse floristique, Hadjadj Aoual (1995) dans une étude menée sur les tétraclinaies (forêts à *Tetraclinis articulata* (Vahl) Mast.) de l'Algérie a remarqué que la régénération de thuya de Berbérie est mauvaise sous les boisements de pin d'Alep à cause de l'importance de la litière qui reste sèche en été et qui entrave l'enracinement des plantules de toutes les espèces ligneuses. Medjahdi (2001) confirme que les remarques précitées sont relativement justes dans des cas très limités mais dans la plupart du temps les semis du thuya s'associent à ceux du pin d'Alep. Cela est dû aux coupes et aux incendies. Ce même auteur souligne que les coupes qui sont généralement illicites contribuent à l'ouverture du milieu, mais le plus grand rôle est joué par les incendies. L'absence du sous-bois empêche le passage du feu aux autres strates. Le feu détruit cependant l'abondante litière caractéristique des boisements de pin d'Alep et permet ainsi aux racines des jeunes plantules d'arriver au sol. Pour répondre aux interrogations précitées, nous avons mené une étude floristique dans des reboisements de pin d'Alep de la région oranaise. Ces reboisements sont généralement réalisés sur des terrains fortement dégradés, avec une végétation clairsemée et rabougrie, dans le but principal de lutter contre l'érosion. Le présent travail consiste à inventorier, décrire et comparer, la richesse floristique de ces reboisements sur les plans qualitatif et quantitatif avec les autres formations naturelles. Cela nous permettra de vérifier la validité des critiques relatives à la faiblesse de la diversité spécifique des pinèdes artificielles dans un premier temps, et connaitre les situations qui abritent la plus grande richesse floristique dans un deuxième temps.

Sites et Méthodes

Dix reboisements répartis sur trois wilayas de l'extrême nord-ouest de l'Algérie (Tlemcen, Ain Temouchent et Sidi Bel Abbess) ont été choisis. Les reboisements sélection-

nés sont représentatifs des autres peuplements artificiels du pin d'Alep en Oranie (Fig. 1). Nous avons sélectionné des stations situées dans trois types de milieux: le littoral, les plaines sublittorales et les zones montagneuses (correspondant aux trois zones biogéographiques O1, O2 et O3 selon Quézel & Santa 1962-1963). Ces stations se trouvent principalement sur des sols calcaires, qui constituent le substrat dominant en Oranie. De plus, les sites choisis varient en fonction de l'âge des pinèdes et des conditions bioclimatiques, allant des zones humides (bioclimat subhumide) aux régions plus sèches (bioclimat semi-aride). En outre, les stations sont soumises à différents niveaux de pressions anthropozoogènes, notamment le pâturage excessif.

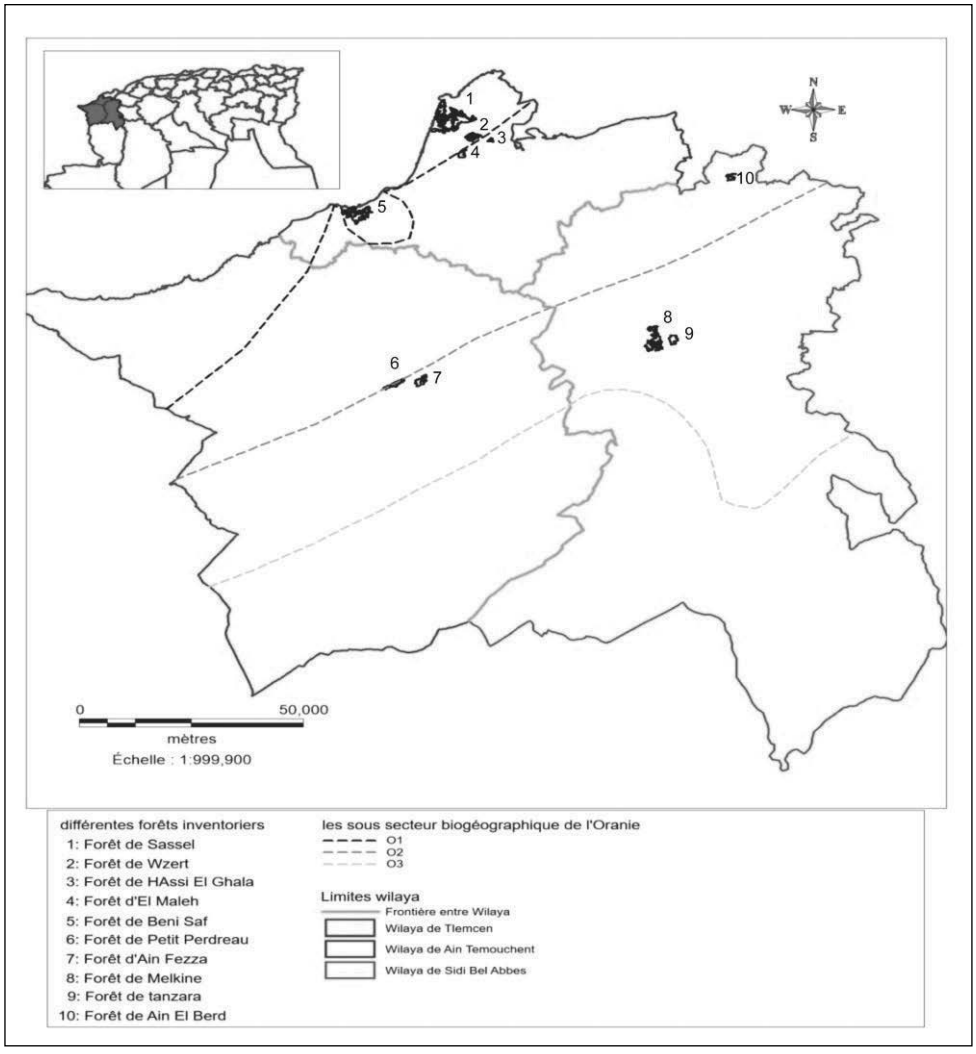


Fig.1. Carte des situations des différents reboisements inventoriés.

Le bioclimat est semi-aride à hiver doux pour les stations littorales et sublittorales et semi-aride à subhumide à hiver frais pour les stations des montagnes (Aimé 1991; Benabdeli 1996). Les sols sont principalement calcaires, à l'exception de quelques stations dans les monts de Tlemcen où le sol est gréseux (non calcaire). La profondeur du sol varie énormément (dépassant les 1,5 m pour les rares sols ferrallitiques conservés, à quelques centimètres pour les sols tronqués ou les rendzines) (Gaouar 1980). Les reboisements ont été essentiellement installés dans l'aire de thuya de Berbérie sur le littoral et les zones sublittorales et le chêne vert (*Quercus ilex* L., *Q. rotundifolia* Lam.) dans les montagnes (Maire 1926; Alcaraz 1982).

Au sein de chaque reboisement nous avons suivi un échantillonnage stratifié en fonction de l'altitude, de l'exposition, de la pente et du substrat à partir des cartes géomorphologiques (pentes, lithologie et occupation des sols). Nous avons ainsi réalisé 80 relevés de végétation suivant la méthode phytosociologique classique, par l'établissement de la liste de toutes les espèces végétales (vasculaires) présentes sur 400 m^2. En effet, une placette dendrométrique de 400 m^2 (20 × 20 m) a été subdivisée en quatre quadrats de 10 m^2 chacun, répartis de manière homogène sur l'ensemble de la placette. Ces quadrats permettent de recueillir des données phytosociologiques sur la végétation herbacée, les arbustes, et les espèces de sous-bois présentes dans la placette dendrométrique (following e.g., Kent & Coker 1992; Avery & Burkhart 2015). Les relevés ont été réalisés durant les années 2018-2021 principalement au printemps (Mars-Mai) avec des visites en automne (Octobre-Novembre). Pour l'identification du matériel végétal récolté, nous avons utilisés les flores de l'Algérie et du Maroc (Maire 1926; Quézel & Santa 1962-1963; Fennane & al. 1999, 2007, 2014; Valdès & al. 2001).

Les résultats obtenus ont été organisés dans un catalogue (Tableau 1S en annexe) où nous avons noté pour chaque espèce:

Nom scientifique: selon la nomenclature adoptée dans le projet *efloremaghreb* (https://efloramaghreb.org/).

Type biologique, pour chaque espèce nous avons précisé sont type biologique : Ph. (Phanérophyte), Nph (Nanophanérophyte), Phl (Phanérophyte lianescente), Ch. (Chaméphyte), H. (Hémicryptophyte), G (Géophyte), Th. (Thérophyte).

Type chorologique, Atl. Méd. (Atlantique-Méditerrané), Intro. (introduite), Méd. (Méditerrané), Méd.-Macar. (Méditerrané- Macaronesienne), Sub-cosm. (sub-cosmopolites), on a indiqué pour les taxons endémiques la catégorie suivante d'endémisme; AMI (Endémique de l'Algérie, du Maroc et de la Péninsule Ibérique), AfnI (Endémique de l'Afrique du Nord et de la Péninsule Ibérique), Afn (Endémique de l'Afrique du Nord), AM) (Endémique de Algérie et du Maroc) .

Rareté, le degré d'abondance dans le territoire national est donné selon Quézel & Santa (1962-1963) : CC (pour les taxons très communs), C (pour les taxons communs), AC (pour les taxons assez communs), AR (pour les taxons assez rares), R (pour les taxons rares), RR (pour les taxons très rares).

Résultats et Interprétations

L'inventaire floristique des reboisements de la zone d'étude [Ain Temouchent (forêts de Sassel, Beni Saf, Hassi el Ghala, Wzert, Emir Abd Kader, el Maleh), Sidi Bel Abbes (forêt

de melkin, tanazra et Ain el berd), Tlemcen (forêt de petit perdreau et Ain fezza)] nous a permet de mettre en évidence 389 taxons de rang spécifique et sous spécifique, répartis entre 64 familles, les angiospermes dicotylédones forment le groupe systématique le plus important avec 46 familles et 173 genres et 313 espèces, les monocotylédones incluent 14 familles et 41 genres et 66 espèces, le groupe des ptéridophytes compte une seule espèce et les gymnospermes dénombrent seulement 3 familles avec 5 genres. Les catalogues floristiques insérés à la fin de ce manuscrit, regroupe tous les taxons (Fig. 2a).

La figure 2a montre le nombre des genres et des espèces pour chaque famille. Les familles les plus représentées sont classées ci-après par ordre décroissant: les *Asteraceae*, *Fabaceae*, *Poaceae*, *Lamiaceae*, *Apiaceae*, *Cistaceae*, *Caryophyllaceae*, *Brassicaceae;* avec respectivement 62, 46, 39, 27, 20, 16, 15 et 12 espèces, le reste des familles inventoriées comportent moins de dix espèces chacune, il s'agit des *Hyacinthaceae*, *Cupressaceae*, *Plantaginaceae*, *Orobanchaceae*, *Resedaceae* et *Asparagaceae* avec respectivement 8,7,7,6,6 et 5 espèces. Le reste des familles sont faiblement représentées. Ainsi la diversité floristique des reboisements de pin d'Alep de la région oranaise est dominée par les *Asteraceae, Fabaceae et Poaceae.* Ces familles représentent à elles seules 147 espèces (»37% des espèces inventoriées). Les *Lamiaceae*, *Apiaceae*, *Cistaceae*, *Caryophyllaceae* et *Brassicaceae* représentent 23% du total. Ces mêmes familles prédominent la flore algérienne (Quézel & Santa 1962-1963).

L'analyse du spectre biogéographique de la flore (Fig. 2b) est dominée essentiellement par les éléments méditerranéens, enrichie par l'apport d'éléments d'origines diverses. Les endémiques Nord-africaine Ibérique (AfnI) et Algéro-Marocaine Ibérique (AMI) sont les types les plus riches en espèces avec 26 espèces respectivement (soit 7% pour chaque catégorie), suivis par les endémiques Algéro-Marocaine (AM) avec 20 espèces, les endémiques Nord-Africaine (Afn) sont au nombre de 16 espèces (soit 4% du total) et enfin les endémiques Algériennes (A) avec seulement une espèce (*Calamintha candidissima* (Munby) Benth.), en attendant une confirmation de l'identité d'un taxon qui a reçu le même nom en Tunisia ! Le taux d'endémisme représente au total un pourcentage de

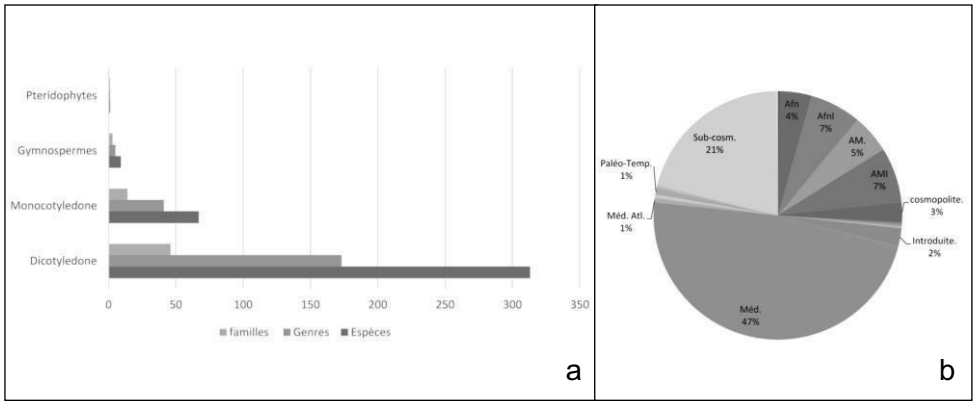


Fig. 2. a) Pourcentage de composition d'embranchement; b) Importance des éléments biogéographiques de la flore des pinèdes.

22,93% soit une espèce sur cinq représente un intérêt biogéographique. Les éléments à larges distributions et les autres éléments constituent les groupes les moins représentés.

Les représentations graphiques des pourcentages du nombre d'espèces exprimées en fonction de leur type biologique (Fig. 3a) donnent une idée de la structure de la végétation dans les stations étudiées. Les thérophytes occupent la part la plus importante, suivie de loin par les hémicryptophytes, les chaméphytes, les nanophanérophytes et les géophytes. Le spectre biologique de la flore vasculaire des pinèdes est typique de l'ambiance bioclimatique méditerranéenne semi-aride, avec un important pourcentage pour les thérophytes (45,10%) (Daget 1980; Olivier & al. 1995 ; Madon & Médial 1996). Il faut rappeler que la proportion des thérophytes en région méditerranéenne est généralement de l'ordre de 50 % selon les auteurs précités. Dans notre cas elle est un peu au-dessous. On relie cette relative baisse à la strate arboré (reboisement) qui limite les effets excessifs des températures et l'ensoleillement (Daget 1980; Barbero & al. 1990). Beaucoup d'auteurs (Négre 1960 ; Daget 1980; Barbero & al. 1990) s'accordent que la thérophytisation du milieu est liée soit au froid hivernal ou la sécheresse estivale de la région, soit aux perturbations du milieu (pâturage). Ce type biologique est une stratégie d'esquive des périodes défavorables (le froid et la sècheresse). En effet, en raison de la couverture forestière des reboisements la valeur des thérophytes est relativement basse par rapport à la normale. Le couvert forestier assure également, une forte production de litière et la protège d'où l'importance des hémicryptophytes (19,59 %). Barbero & al. (1989) confirme que l'importance de ce type biologique est liée à l'importance du taux de matières organiques dans le sol. Les chaméphytes, les géophytes et les nanophanérophytes et les phanérophytes représentent respectivement 13,66; 7,22; 7,21 et 5,15 % du total.

Le nombre de taxons rares (très rares et rares) en Algérie et inventorié dans les reboisements, est important (Fig. 3b). Il constitue 10,05 % du total, mais la plus grande partie de la liste floristique est dominée par les espèces communes (40 %) et très commune (25 %). Notre inventaire a compté aussi 28 taxons endémiques et/ou rares (tableau 1) dont 10 endémiques Ibéro-algéro-marocains (2 assez rares et 8 espèces rares), 8 endémiques algéro-

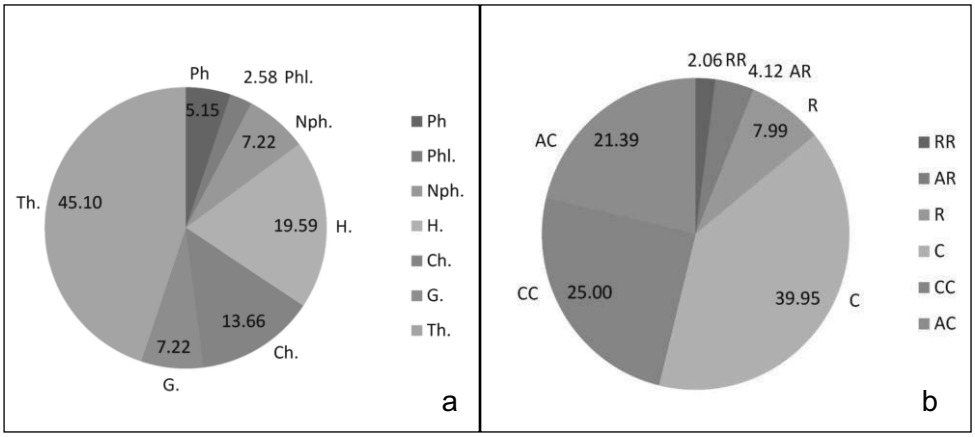


Fig. 3.a) Pourcentage des types biologiques; b) Pourcentage d'abondance des espèces.

Tableau 1. Liste des espèces rares et/ou endémiques. Degré de rareté (d'après Quézel & Santa 1962-1963).

Algériennes	Très rare	*Calamintha candidissima* (Munby) Benth.
Afn	Assez rare	*Oncostema elongata* (Parl.) Speta
Afn AfnI	Très rare	*Sonchus mauritanicus* Boiss. & Reut.
	Assez rare	*Bellis microcephala* Lange
AfnI AMI	Rare	*Arenaria emarginata* Brot.
	Rare Très rare	*Silene secundiflora* Otth. subsp. *secundiflora*
		Salvia jordanii J.B.Walker
		Daucus durieua Lange
	Très rare Assez rare	*Andryala arenaria* (DC.) Boiss. & Reut.
		Andryala laxiflora DC.
		Orobanche latisquama (F. W. Schultz) Batt.
AMI AM	Assez rare Rare	*Cytisus fontanesii* Spach ex Ball subsp. *fontanesii*
		Cistus umbellatus subsp. *viscosus* (Willk.) Demoly
	Rare Assez rare	*Centaurea eriophora* L.
		Convolvulus valentinus Cav.
		Linum tenue Desf.
		Lonicera biflora Desf.
		Nepeta tuberosa subsp. *reticulata* (Desf.) Maire
		Ononis euphrasiifolia Desf.
		Sinapis flexuosa Poir.
		Genista hirsuta subsp. *erioclada* (Spach) Raynaud
AM	Assez rare Rare	*Thymus munbyanus* Boiss. & Reut. subsp. *munbyanus*
		Linaria bordiana Santa & Simonn.
		Linum munbyanum Boiss. & Reut.
		Brassica maurorum Durieu.
	Rare Très rare	*Anthyllis vulneraria* subsp. *saharae* (Sagorski) Jahand. & Maire
		Genista quadriflora Munby
		Thymus saturejoides subsp. *commutatus* Batt.

marocains (4 assez rares et 3 rares et une très rare), 2 endémiques d'Afrique du Nord (1 assez rare et une autre très rare) et 7 endémiques ibéro-Nord Africains (une assez rare, 3 rare et 3 très rares) et une seule endémique algérienne. Les endémiques Ibéro-algéro-marocains occupent une place très importante dans la région suivie par les endémiques algéro-marocaines (certaines de ces espèces sont illustrées ci-après dans les figures 1S et 2S en

annexe). La richesse de la région en taxons endémiques de la péninsule ibérique et du Maroc met en évidence l'appartenance de celle-ci au complexe bético-rifain. Ce complexe est considéré par Quézel & Médial (1995) comme le plus riche *hotspot* méditerranéen.

Discussions et conclusions

L'analyse de la diversité floristique des reboisements de pin d'Alep en Oranie, nous a permis de démontrer leurs importances dans la reconstitution des milieux dégradés et la restauration/protection de la flore native. Pour 80 relevés, nous avons inventorié 389 taxons. Cette richesse globale est comparable aux résultats observés pour les peuplements naturels de chêne-liège dans diverses régions du Maghreb. Il convient de rappeler que de nombreux auteurs considèrent les subéraies comme l'un des milieux naturels les plus diversifiés du bassin méditerranéen (Aronson & al. 2009; Quézel & Médail 2003). De plus, Barbero & al. (2001) soulignent que la richesse globale des formations sclérophylles et des forêts de conifères méditerranéennes est similaire à 95 %. En effet dans les monts de Tlemcen Medjahdi & al. (2018) pour 150 relevés ont recensé 450 taxons, alors qu'au Maroc, Aafi (2007), pour un effort d'échantillonnage beaucoup plus important (400 relevés), a dénombré une richesse similaire (408 taxons, réparties sur 62 familles et 261 genres). En fin dans les subéraies de la Numidie orientale pour 150 relevés, Bennadja et al. (2013) ont recensé 292 taxons. Pour les peuplements de thuya de Barbarie des monts de Trara (nord-ouest algérien), Benkhaldi (2011) a inventorie 370 taxons pour le même nombre de relevés. Il faut noter qu'en Algérie tellienne (du Nord) la richesse globalement des principales formations forestières avoisinent les 350-420 taxons pour une moyenne de 100 relevés (Medjahdi 2009). Il semble que les reboisements de pin d'Alep présentent une richesse globale assez similaire aux peuplements naturels de l'ensemble de l'Algérie du nord. Sur le plan qualitatif, la comparaison des données de l'analyse du spectre biologique montre une nette dominance des thérophytes. Cette tendance est générale pour l'ensemble des forêts méditerranéennes (Daget & Poissonet 1977; Cody & Mooney 1978). Elle se situe entre 25 et 50% pour les formations forestières (Barbéro 1989) et devient beaucoup plus importante suite à l'ouverture du milieu sous l'effet de la sécheresse et des perturbations (Grime 1977; Daget 1980). Cependant l'importance des hémicryptophytes par rapport aux autres formations forestières où nous avons enregistré un taux avoisinant les 20%, alors qu'elle ne dépasse guère les 15 % dans les autres formations. Cette richesse est due à l'abondante litière du pin d'Alep (Molinier & Tallon 1970; Trabaud 1987). Ce constat soutient l'idée que la plantation de pins, notamment *Pinus halepensis*, pourrait contribuer à l'amélioration de la qualité des sols. En effet, leur litière abondante peut jouer un rôle clé dans l'enrichissement du sol en matière organique et dans l'amélioration de sa structure physique. La litière des pins, riche en composés organiques, contribue à la formation d'humus, ce qui a un impact direct sur la fertilité et la structure des sols (Trabaud 1987). Cependant, il est important d'étudier les propriétés de cette litière, car certains composés peuvent aussi ralentir la décomposition et l'incorporation de matière organique dans le sol (García-Ruiz & al. 2007). Des études pédologiques seraient donc nécessaires pour évaluer l'effet de la litière de pin sur le cycle de la matière organique et sa capacité à améliorer la structure du sol dans nos région.

Les autres types biologiques représentent des taux équilibrés, avec une légère domination des chaméphytes suivis par les nanophanérophytes et les géophytes. Cette tendance est caractéristique des milieux forestiers plus ou moins préservés (Quézel & Médail 2003; Blondel & al. 2010). La flore vasculaire des reboisements de pin d'Alep compte 100 taxons endémiques et/ou rares. Parmi eux, on compte 22 taxons endémiques Ibéro-Algéro-Marocains, 19 taxons endémiques Algéro-Marocains, 8 taxons endémiques d'Afrique du nord et 23 taxons endémiques Ibéro-Nord Africains. En ce qui concerne la rareté, on dénombre 8 taxons très rares, 31 rares et 15 assez rares. Les taxons endémiques représentent 18 % du total, et une grande partie d'entre eux sont considérés comme assez rares (voire rarissimes !). En comparant ces taux avec les études mentionnées précédemment sur les formations forestières algériennes et avec la synthèse de Barbero & al. (2001) concernant l'ensemble des formations méditerranéennes, nous constatons qu'ils sont relativement similaires et très proches. On pense que les reboisements de pin d'Alep présentent une diversité floristique assez appréciable avec des valeurs assez similaires avec les autres formations végétales de l'Algérie Oranienne.

Les reboisements de *Pinus halepensis* ne semblent pas avoir d'effet inhibiteur majeur sur la diversité du sous-bois. Lors de l'examen des relevés floristiques individuels, nous avons constaté une grande variation dans le nombre d'espèces recensées, allant de 8 à 60 espèces par relevé. Cette variation pourrait être attribuée à plusieurs facteurs, notamment les différences climatiques entre les sous-secteurs biogéographiques (Barbero & al. 2001), ainsi que divers autres facteurs écologiques locaux. Les reboisements dans des régions méditerranéennes plus sèches ou semi-arides, par exemple, tendent à présenter une diversité réduite par rapport à ceux situés dans des zones subhumides, où les conditions d'humidité semblent favorisant une richesse floristique plus élevée (Ne'eman & Izhaki 1996). La densité des arbres semble également jouer un rôle clé dans la régulation de la lumière atteignant le sol, ce qui peut contribuer à affecter la diversité floristique du sous-bois. Les reboisements à densité élevée peuvent créer de l'ombre excessive et réduire l'affectation voire la mise en place de certaines espèces héliophiles (Barbéro & al. 1990). D'autre part, les reboisements moins denses peuvent favoriser une plus grande diversité, en particulier des hémicryptophytes et des géophytes. En ce qui concerne l'âge des reboisements, des études ont montré que les jeunes reboisements tendent à avoir une diversité végétale plus faible. En revanche, les forêts plus anciennes, ayant accumulé de la matière organique au fil du temps, permettent une colonisation plus diversifiée du sous-bois (Quézel & al. 2000). La dynamique de la végétation du sous-bois peut aussi être influencée par le régime des feux, les reboisements plus anciens ayant généralement un sous-bois plus résilient et riche en espèces (Trabaud 1987). Nous envisageons de mener une étude qui visera à évaluer l'impact spécifique de la densité des arbres et de l'âge des reboisements sur la variabilité de la diversité floristique du sous-bois. Cette étude sera concomitante à des analyses pédologiques et des relevés floristiques à travers plusieurs sites géographiquement distincts pour bien cantonner les facteurs qui régissent ce changement de diversité/richesse floristique.

Il est important de souligner que la poursuite des reboisements par le pin d'Alep ou par d'autres conifères/résineux dans la région exige une gestion sylvicole prudente et adaptée aux conditions locales. Il est nécessaire d'adopter des pratiques de gestion telles que les éclaircies et le dépressage. En effet, Pausas & al. (2004) précisent que les éclaircies pratiquées dans les pinèdes permettent une meilleure régénération des sols, en favorisant une

plus grande accumulation de matière organique, contribuant ainsi à l'amélioration de la structure du sol et de sa capacité de rétention d'eau. Prendre en compte la densité des plantations en fonction des conditions bioclimatiques et pédologiques spécifiques à chaque station s'avère également une des conditions indispensables. En effet, dans les zones les plus humides (bioclimat subhumide) une densité plus élevée peut être supportée alors que dans les régions semi-arides, une densité trop importante peut entraîner une compétition excessive pour l'eau et les nutriments, ce qui affaiblit les arbres et ralentit leur croissance radiaire (Rovira & al. 2010). En outre, le type de sol doit également être pris en compte; les sols calcaires, fréquemment rencontrés en Oranie, peuvent limiter la disponibilité en nutriments pour les arbres. Des études anciennes ont montré que des sols pauvres ou superficiels nécessitent des densités plus faibles pour éviter des problèmes liés à la carence en éléments nutritifs et à la compétition hydrique (Ne'eman & Trabaud 2000).

Références

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Article

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Addenda to the checklist of alien plants of Algeria

Abstract

Sakhraoui, N., Essl, F. & Verloove, F.: Addenda to the checklist of alien plants of Algeria. — Fl. Medit. 34: 307-323. 2024. — ISSN: 1120-4052 printed, 2240-4538 online.

A thorough knowledge of the alien flora is an important basis for science and management. In Algeria, a first checklist of the alien flora was published in 2020. Since then, several new taxa have been observed for the first time in this country. This study therefore presents additions to the alien flora of Algeria, based on bibliographic and field research carried out since 2021. For each taxon recorded, the botanical family, life form, geographical origin, invasion status, distribution in Algeria, type of colonized habitat and introduction pathways were indicated. In total, 74 additional alien vascular plant taxa, belonging to 30 families and 53 genera were recorded. Data on the occurrence of seven alien species are reported here for the first time from Algeria: *Chlorophytum comosum*, *Helianthus annuus*, *Salvia hispanica*, *Sapindus mukorossi*, *Tradescantia pallida*, *Triadica sebifera*, and *Zinnia elegans*, four of these species are also new to North Africa.
Most of the newly recorded taxa originate from America (55.4%), Africa (14.8%) and Asia (9.4%). The most represented life forms, are phanerophytes (31 taxa), followed by therophytes (18 taxa) and geophytes (12 taxa). In terms of habitats, 43.2% of the taxa were found in human-made habitats, 12.1% in semi-natural habitats and the same percentage in natural habitats. Most of the taxa were introduced for ornamental purposes (71.6%). More than half (55.4%) of the taxa are naturalized, 14.8% are in the process of naturalization, and 33.7% are considered potentially invasive in Algeria.
As a result of our study, the alien flora of Algeria increases from 211 to 285 taxa, the naturalized flora from 108 to 156 taxa, and the potentially invasive flora from 15 to 40 taxa.

Key words: alien flora, distribution, habitats, naturalization, origin, pathway of introduction.

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Introduction

Ecosystem management cannot be carried out properly without prior knowledge of the various threats. Invasive and potentially invasive alien species constitute one of the most significant threats that can have very serious negative effects on biodiversity and the natural environment (Pyšek & al. 2020a; Domina 2021). The recognition and correct identification of these species is therefore essential for conservation purposes.

In the northern part of the Mediterranean, national alien plants checklists have been published during the last decades for most countries and several major islands, such as for Spain (Capdevilla Argüelles & al. 2006), Italy (Celesti-Grapow & al. 2009), Montenegro (Stešević & Petrović 2010), Greece (Arianoutsou & al. 2010), Corsica (Jeanmonod & al. 2011), and Slovenia (Jogan & al. 2012), and updates are regularly carried out in certain countries such as Italy (see e.g. Galasso & al. 2018; Spampinato & al. 2022; Galasso & al. 2024). In the southern part of the Mediterranean, such lists have only recently been published for the most countries of North Africa, namely for Egypt where the first list was published in 2016 and an update in 2020 (Shaltout & al. 2016; El Beihery & al. 2020), Tunisia (Sayari & Mekki 2016), Libya (Alzerbi & al. 2020) and Algeria (Meddour & al. 2020).

The studies that we have published over the last five years (see e.g. Sakhraoui & al. 2019a, 2019b, 2019c; Sakhraoui & al. 2022a, 2022b, 2022c; Sakhraoui 2023) have shown that plant invasions continue in Algeria, as they do in different parts of the world, requiring continued field surveys. In addition, these studies as well as many others published by other researchers have resulted in reports of new records of alien plants in Algeria. Thus, compiling these records in checklists of alien plants is important for management and science alike, as they provide researchers with an important bibliographic tool that can greatly facilitate their work, and can also help neighboring countries to assess potential invasion threats (El Beihery & al. 2020).

Here we publish additions to the first checklist of the alien flora of Algeria published by Meddour & al. (2020), taking into consideration the latest publications relating to new recordings of alien plants. This addendum was therefore produced on the basis of extensive bibliographic research which allowed the addition of further alien species not yet reported by Meddour & al. (2020), (either because, according to these authors, they did not occur in the wild in Algeria (only cultivated), or because they were overlooked, or because the data were only published after the publication of the checklist of the alien flora of Algeria), as well as on the basis of recent field surveys which yielded records of alien species that had not previously been reported from Algeria.

In addition, we report the naturalization status of some species for which the status in Algeria was unknown according to Meddour & al. (2020); the status of these species was assessed based on field observations carried out by the first author of this article, but also based on scientific literature.

Material and methods

First, a bibliographic data search was carried out focusing on: i) articles relating to reports of alien plant taxa in Algeria (mentioned in the bibliographic list) using appropriate keywords such as: plant, alien, exotic, introduced, new record, Algeria, Euro-Med checklist, notulae; in total, 44 publications were identified of which 27 reported new Algerian records (24 published between 2020 and 2024, and single publications for 2013, 2016 and 2019); ii) the five volumes of the 'Index synonymique de la flore de l'Afrique du Nord' (Dobignard & Chatelain 2010-2013); iii) the two volumes of the 'Flore d'Algérie' (Quézel & Santa 1962-1963) and the 5th volume of the 'Flore de l'Afrique du Nord' (Maire 1958), where only naturalized taxa were taken into consideration. Taxa that were reported as being

merely cultivated in Algeria by Dobignard & Chatelain (2010-2013) were ignored, unless they were observed outside of cultivation during the field surveys; in this case, a status was assigned to them according to Richardson & al. (2000) and Pyšek & al. (2004). Additionally, a search on iNaturalist (2024) was carried out, where only records clearly showing plants that had escaped from cultivation (confirmed by comments on the observation) were taken into consideration.

This bibliographic research was supplemented by field surveys, conducted from 2021 to 2024 by the first author of this article, in different areas of northeastern Algeria (Skikda, Annaba, Constantine, Guelma and El Tarf) and in different types of habitats. During this field work, very valuable data relating to the introduced flora was collected, some alien species were recorded for the first time in Algeria, and the invasion status for various species could be determined more precisely.

The following invasion status categories were considered (based on Richardson & al. 2000; Pyšek & al. 2004): 'casual' (alien plants that may reproduce occasionally outside cultivation in an area, but do not form self-replacing populations, and rely on repeated introductions for their persistence), 'naturalized' (alien plants that sustain self-replacing populations for at least 10 years), 'in the process of naturalization' (alien plants that maintain self-replacing populations but have not yet reached 10 years of persistence). The residence status in Algeria (native *vs* introduced) was checked against Plants of the World Online (POWO 2024) and the Euro+Med PlantBase (2024). The taxon was not retained when considered introduced in one database but native or doubtfully native in the other (e.g. *Acanthus spinosus* L., *Cephalaria syriaca* (L.) Roem. & Schult., *Cymbalaria muralis* G. Gaertn. & al., *Erysimum cheiri* (L.) Crantz and *Galega officinalis* L.). For taxa that were considered to be introduced in one and to be absent from Algeria in the other, two additional sources were consulted, the African Plant Database (APD 2024) and eflora maghreb (https://efloramaghreb.org/specie/148007); the taxon was then taken into consideration when it was considered naturalized by these two databases (e.g. *Eschscholzia californica* Cham.*, Trifolium alexandrinum* L.).

The taxa were subsequently organized in alphabetical order and are presented by their accepted names according to IPNI (2024). To maintain comparability in the presentation of data relating to the alien flora of Algeria, we followed, as far as possible Meddour & al. (2020). For each taxon we mention the respective family (according to APG IV 2016), life form (extracted from various bibliographical sources and given according to the classification of Raunkiær (1934)), the biogeographic region of origin (according to POWO 2024), invasion status (see above), the distribution in the four main natural zones in Algeria [i.e. coastal, Tellian Atlas, steppe (including high plateaus) and Sahara], the type of habitat colonized (according to bibliographic data and field observations, notably for new records; habitats were classified into natural habitats (divided into riparian habitats/wetlands and maquis/forests/steppe pastures), semi-natural habitats (including coastal habitats) and human-made habitats (divided into urban/ruderal habitats and agricultural land)) and the introduction pathways (identified from the scientific literature, but also from other bibliographic sources dealing with the ornamental flora in Algeria, in particular Carra & Gueit (1952) and Sakhraoui (2021a)).

The list of potentially invasive species in Algeria was established based, on the invasion history of the taxon elsewhere in Mediterranean countries or countries with a Mediterranean climate, and on the invasive behavior (i.e. taxon with increasing local or

regional distribution and with ability to form large populations and to colonize natural habitats) observed during field work by the first author of this paper.

Results

Of the newly registered taxa, 67 come from bibliographic research and seven from field surveys; the latter are therefore reported for the first time in Algeria: *Chlorophytum comosum* (Thunb.) Jacques, *Helianthus annuus* L., *Salvia hispanica* L., *Sapindus mukorossi* Gaertn., *Tradescantia pallida* (Rose) D.R. Hunt, *Triadica sebifera* (L.) Small and *Zinnia elegans* Jacq., including one (*S. hispanica*) also reported on iNaturalist (2024). Additional data relating to these newly recorded species are given in supplementary material.

Number of alien plant taxa and their taxonomic affiliation

As a result of our study, 74 new taxa were added to the alien plant species checklist (70 species, one subspecies and three hybrids) (Electronic Supplementary File 1. Table 1S). These taxa – all Angiosperms – belong to 30 families and 53 genera (Fig. 1a). 22 families and 39 genera are dicots whereas eight families and 14 genera are monocots. The most species-rich families are Cactaceae (9 species), Amaranthaceae and Asteraceae (7 species each), and Crassulaceae (5 species). The most species-rich genera are *Amaranthus* and *Opuntia* (6 species each), *Prunus* and *Solanum* (3 species each), the others are represented by two species such as *Aeonium, Aloe, Allium, Cyperus* and *Kalanchoe* or by a single species.

Invasion status

More than half of the newly added taxa are considered to be naturalized (41 taxa, 55.4%), eleven taxa (14.8%) are in the process of naturalization and 22 taxa (29.7%) are casual.

The invasion status of six species (*Morus alba* L., *Prunus domestica* L., *P. persica* (L.) Batsch, *Solanum lycopersicum* L., *S. tuberosum* L. and *Zea mays* L.) that were reported so far as exclusively cultivated in Algeria changed (see Dobignard & Chatelain 2010-2013). Escaped specimens of *M. alba* have been observed in several different localities in the Skikda region (northeastern Algeria) where they most often grow next to streams, particularly in the coastal dune. This species is now locally naturalized, while it was still considered as cultivated/subspontaneous (= casual) in Algeria by Dobignard & Chatelain (2010-2013). The other species, in turn, are considered casuals, and have often been observed near homes, in landfills, on rubble or along roadsides.

Biogeographic origin

Seven different areas of origin could be identified (Fig. 1b) with 5 taxa originating from multiple regions. Most taxa come from America (55.4%), of which 21.6% (16 taxa) from South America, 13.5% (10 taxa) from North America, 5.4% (4 taxa) from Central America and 2.7% (2 taxa) from Tropical America; the rest (9 taxa, 12.1%) come from various parts of America. Next come taxa of African origin (14.8%, of which 10.8% (8 taxa) from South Africa), followed by taxa of Asian origin (9.4%).

Taxa of Eurasiatic, Macaronesian and Mediterranean origin are the least represented with respectively 4.0%, 4.0% and 2.7%. However, three hybrids were recorded, two of which (*Gazania ×splendens* Hend. & Andr. Hend. and *Kalanchoe ×houghtonii* D.B. Ward) cannot be assigned to any region as they are artificial hybrids (see Guillot Ortiz & al. 2014; Sakhraoui & al. 2023a), hence keeping them in the hybrid category, while the last one (*Nothoscordum ×borbonicum* Kunth) is a natural hybrid whose region of origin is known (see Ravenna 1991).

Life form

Phanerophytes are the most represented life form (31 taxa), followed by therophytes (18 taxa) and geophytes (12 taxa). Hemicryptophytes and chamaephytes are the least represented, with only seven and six taxa respectively (Fig. 1c). Succulents are not treated separately in figure 1c as they belong to multiple life forms. However, they are represented by no fewer than 18 taxa (24.3%). Most phanerophytes (15 taxa (including 8 succulents) representing 48.4% of all phanerophytes recorded), geophytes (9 taxa, representing 75% of all geophytes recorded) and therophytes (11 taxa, representing 61.1% of all therophytes recorded) are naturalized.

Distribution in Algeria

Most taxa (68 taxa or 91.8%) are found in the coastal zone of Algeria, of which 64 taxa occur exclusively in this part and four taxa also occur in other parts, especially in the Tellian Atlas (3 taxa). Four taxa for which data on their distribution in Algeria are lacking were placed under the 'coastal' category as this best matches their climatic requirements (the Mediterranean climate is favorable for their installation, in other areas the climate is harsher). Five taxa are found in the Tellian Atlas, including three with an exclusively tellian distribution and two that also occur in the steppe. Finally, one taxon is exclusively found in the steppe. No taxon has an exclusively Saharan distribution, the only one species recorded in the Sahara (*Oenothera stricta* Link) also occurs in coastal areas and in the Tellian Atlas.

Among the 34 taxa from northeastern Algeria, 27 taxa (79.4%) are exclusively present in the Skikda region, of which 16 taxa (21.9%) are recorded in a single locality.

Colonized habitats

Of the 74 taxa recorded in this study, 32 (43.2%) are exclusively established in human-made habitats, among which 33.7% colonize urban/ruderal habitats (balconies, roofs, sidewalks, gutters, roadsides, railways, rubble, landfills, ruins) and 9.4% colonize agricultural land (fields, crops, orchards, abandoned gardens), nine taxa (12.1%) are exclusively established in semi-natural habitats (beaches, degraded coastal dunes, relict of coastal scrubland, wasteland near houses on the coast, sea cliffs near houses), and also nine taxa (12.1%) exclusively colonize natural habitats, among which 6.7% colonize riparian habitats/wetlands (edges of wadis and lakes, wetland meadows) and 5.4% colonize maquis/forests/steppe pastures (Fig. 1d and Table 1). Four taxa are capable of colonizing the three types of habitat at the same time: *Austrocylindropuntia subulata* (Muehlenpf.) Backeb., *Opuntia monacanthos* (Willd.) Haw., *O. stricta* (Haw.) Haw. and *Phoenix canariensis* H. Wildpret.

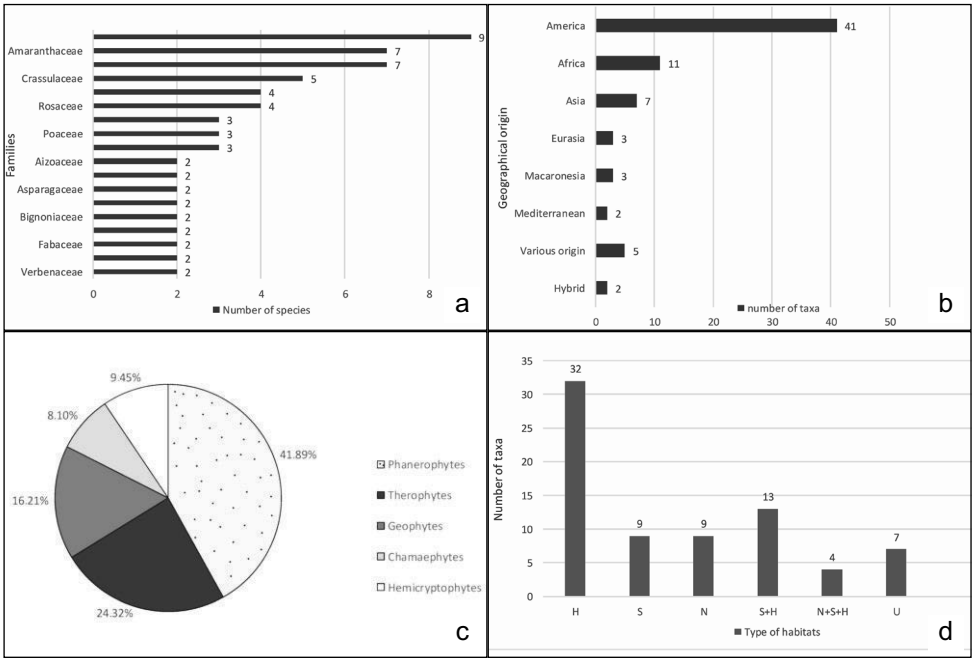


Fig. 1. a) The richest families ranked by the number of newly recorded alien plant taxa in Algeria; b) regions of origin of newly recorded alien plant taxa in Algeria; c) life forms of newly recorded alien plant taxa in Algeria; d) Number of newly recorded alien plant taxa in each colonized habitat. H: human- made, S: semi-natural, N: natural, U: unknown.

Table 1. Number of plant taxa and their invasion status in the various colonized habitats (C: casual, I/N: in the process of naturalization, N: naturalized).

Type of habitat	**Number of taxa per status**		
	C	I/N	N
Urban/ruderal habitats	17	2	6
Agricultural land	1		6
Coastal habitats	1	1	7
Riparian habitats/wetlands			5
Maquis/forests/steppe pastures		1	3
Coastal + Urban/ruderal habitats	1	7	5
Coastal+ Urban/ruderal + Maquis/forests/steppe pastures			4
Unknown	2		5
Total	**22**	**11**	**41**

Introduction pathways

Our results indicate that the majority of the newly reported taxa in Algeria were deliberately introduced (65 taxa, 87.8%). Of these, 53 taxa (71.6%) were introduced for ornamental purposes, 11 taxa (14.8%) for agriculture (food, fodder, pasture restoration) and one taxon (1.3%) for the sericultural industry. Accidental introductions only represent nine taxa (12.1%).

Potentially invasive taxa in Algeria

Potentially invasive taxa are fairly well represented among the newly registered taxa. In total, 25 taxa (33.7%) were classified as such. 19 are reportedly invasive in the Mediterranean region (15 naturalized, three in the process of naturalization and one casual) and two in regions with a Mediterranean climate type (one naturalized and one casual). For four taxa, invasive behavior has recently been observed in the field in Algeria by the first author of this article. The list of these taxa is shown in table 2.

Among the species in the first category, *Arctotheca calendula* (L.) Levyns, *Austrocylindropuntia subulata* (Muehlenpf.) Backeb. and *Opuntia stricta* (Haw.) Haw. already show invasive behavior in the field in Algeria (strongly increasing populations and an increasing number of new growing sites in natural habitats) (Sakhraoui, pers. obs.).

Taxa with unknown invasion status

For nine species reported by Meddour & al. (2020) as alien with unknown naturalization status in Algeria, the updated status is shown in table 3. Seven taxa are considered to be naturalized and two are casual. The observation sites either refer to data from the scientific literature or were obtained during field surveys by the first author of this article.

Discussion

As a result of our research, the list of alien plant species observed in Algeria increases by 35.0%, from 211 taxa recorded by Meddour & al. (2020) to 285 taxa. This also increases the ratio compared to the total Algerian flora, which is estimated at 4 449 taxa according to Dobignard & Chatelain (2010-2013), from 4.7% to 6.4%. Despite this increase, the rate of Algerian alien flora still remains far from that recorded in most countries in the northern part of the Mediterranean. For instance, in Italy, this proportion varies between 14% for Calabria and 21.6% for the whole country (see Spampinato & al. 2022; Galasso & al. 2024), while in Spain, the proportion for established plants in Catalonia, is 12% (see Aymerich & Sáez 2019). In comparison with countries from the southern part of the Mediterranean, the numbers recorded in Algeria are higher than those reported for Morocco and Tunisia, where the rates are 3.2% and 2.4% respectively (Dobignard & Chatelain 2010-2013; Sayari & Mekki 2016), but is substantially lower than the 11.7% reported for Egypt where 250 alien plant taxa were recorded (El Beihery & al. 2020) or the 17.7% reported for Libya where 361 alien plant taxa were recorded (Alzerbi & al. 2020).

North Africa is experiencing a considerable increase in the number of alien plants, particularly Tunisia where dozens of new reports have been recorded over the last ten years (see e.g. El Mokni & Verloove 2019; El Mokni 2023), which will undoubtedly increase the rate of alien flora in this country in future updates.

Table 2. List of alien plant taxa considered potentially invasive in Algeria.

Taxa reported as invasive in the Mediterranean region or in regions with a Mediterranean climate		
Taxon	**Region where invasive**	**Reference**
Amaranthus albus L.	Italy and Spain	Galasso & al. (2018), Aymerich & Sáez (2019)
Amaranthus cruentus L.	Italy and Spain	Galasso & al. (2018), Aymerich & Sáez (2019)
Amaranthus deflexus L.	Italy and Spain	Galasso & al. (2018), Aymerich & Sáez (2019)
Amaranthus powellii S. Watson	Italy and Spain	Galasso & al. (2018), Aymerich & Sáez (2019)
Amaranthus retroflexus L.	Italy, Libya and Spain	Galasso & al. (2018), Mahklouf (2019), Aymerich & Sáez (2019)
Anredera cordifolia (Ten.) Steenis	Italy	Galasso & al. (2018)
Arctotheca calendula (L.) Levyns	Italy and Tunisia	Stinca & al. (2021), Sakhraoui & al. (2024)
Austrocylindropuntia subulata (Muehlenpf.) Backeb.	Italy	Galasso & al. (2018)
Bidens aurea (Aiton) Sherff	Italy	Musarella & al. (2024)
Canna indica L.	South Africa	Rambuda & Johnson (2004)
Cyperus alternifolius subsp. *flabelliformis* Kük.	Italy	Galasso & al. (2018)
Cyperus eragrostis Lam.	Italy and Spain	Galasso & al. (2018), Aymerich & Sáez (2019)
Eclipta prostrata (L.) L.	Italy	Galasso & al. (2018)
Kalanchoe ×houghtonii D.B. Ward	Italy	Stinca & al. (2021)
Melia azedarach L.	South Africa, Libya and Italy	Henderson (2007), Mahklouf (2019), Musarella & al. (2024)
Opuntia stricta (Haw.) Haw.	Italy and Spain	Galasso & al. (2018), Aymerich & Sáez (2019)
Paspalum vaginatum Sw.	Spain	Aymerich & Sáez (2019)
Phoenix canariensis H. Wildpret	California	CALIPC (2024)
Solanum rostratum Dunal	Libya	Mahklouf (2019)
Tetragonia tetragonoides (Pall.) Kuntze	Libya	Mahklouf (2019)
Tradescantia fluminensis Vell.	Italy and Spain	Galasso & al. (2018), Aymerich & Sáez (2019)
Taxa with invasive behavior in Algeria based on field observations		
Taxon	**Ability to proliferate in natural habitats**	**Population size observed in the field**
Heliotropium amplexicaule Vahl	+	Very large populations over large areas
Opuntia monacanthos (Willd.) Haw.	+	Large populations
Opuntia robusta H.L. Wendl. ex Pfeiff.	+	Very large population over large area
Tecomaria capensis (Thunb.) Spach	+	Large populations

Table 3. Species reported by Meddour & al. (2020) as alien with unknown naturalization status in Algeria with their updated status (locations without bibliographic reference concern finds by the first author of this article). Status, N: naturalized, C: casual.

Species	Site of observation	Type of colonized habitat	Status
Agave sisalana (Engelm.) Perrine	Tipaza (Véla & al. 2013)	Roman ruins	N
Asparagus setaceus (Kunth) Jessop	Larbi Ben M'Hidi (Skikda)	Sidewalks near houses	C
Chasmanthe floribunda (Salisb.) N.E.Br.	Filfilla, Stora (Skikda), Algies (Zeddam 2012)	Maquis, roadsides, cliffs, fallow land near houses	N
Iris albicans Lange	Salah Chebel (Skikda), Constantine	Cemeteries, roadsides	C
Mirabilis jalapa L.	Stora, Larbi Ben M'Hidi (Skikda), El Chat (El Tarf)	Roadsides, rubble, landfills, coastal dunes, near houses	N
Podranea ricasoliana (Tanfani) Sprague	Stora (Skikda), Algies (Zeddam 2011)	Relict of maquis near houses	N
Senecio angulatus L.f.	Larbi Ben M'Hidi, Salah Chebel (Skikda), Bejaia (Miara & al. 2018)	Maquis, near houses	N
Tropaeolum majus L.	Stora, Filfilla, Larbi Ben M'Hidi, Salah Chebel, El Hadaeik (Skikda), Algies (Zeddam & Raus 2010)	Maquis, fields, wastelands, roadsides, near houses	N
Yucca gloriosa L.	Tipaza (Véla & al. 2013)	Roman ruins	N

However, although the alien flora in the southern part of the Mediterranean region, notably in North Africa, is poorer compared to the northern part, the situation in the field is more alarming, because actions to control invasive plants are very rarely undertaken in this part of the Mediterranean (Brunel & al. 2013).

Following our study, the number of naturalized taxa in Algeria is increasing, from 108 taxa mentioned by Meddour & al. (2020) to 156 taxa. The potentially invasive flora also increased from 15 to 40 taxa. This deserves special attention; regular monitoring makes early detection possible before a real invasion occurs. Particular attention should be paid to monitoring the populations of *Solanum rostratum* Dunal which remains the most worrying in Tellian and steppe zones, given its capacity to colonize varied environments and produce a large quantity of seeds ensuring strong dissemination (Chelghoum & al. 2020). This also applies to *Arctotheca calendula* (L.) Levyns in coastal areas (Sakhraoui & al. 2024a). Furthermore, these two species are considered invasive in neighboring countries (Libya (Mahklouf 2019), and Tunisia (Sakhraoui & al. 2024a) respectively and probably also Morocco, for the latter species), making them particularly threatening in Algeria.

Our study could therefore contribute to the development of monitoring lists that still do not exist in Algeria.

America is the main source area for the alien flora of Algeria with 107 taxa (66 already recorded by Meddour & al. (2020)). This dominance has also been recorded in other Mediterranean countries, such as Spain (Aymerich & Sáez 2019), Italy (Spampinato & al. 2022), Greece (Arianoutsou & al. 2010), Turkey (Uludağ & al. 2017), Egypt (El Beihery & al. 2020) and Tunisia (Sayari & Mekki 2016). Asia and Africa also contribute significantly to the alien flora in the Mediterranean region (Arianoutsou & al. 2010; Uludağ &

al. 2017; El Beihery & al. 2020; Spampinato & al. 2022). This undoubtedly explains the large number of naturalized taxa originating from these continents in the Mediterranean region (Arianoutsou & al. 2013), which was also observed in this study (24 American taxa and 7 African taxa are naturalized). Among the genera best represented and best adapted in Algeria, including species of American origin, are *Opuntia* (seven species of which only a single recorded by Meddour & al. (2020)) and *Amaranthus* (ten species of which four already reported by Meddour & al. (2020), eight of which are of American origin). The latter genus, which is usually introduced accidentally, is also most represented in Europe (Lambdon & al. 2008) and in other countries of North Africa, such as Egypt where 10 species were recorded (see El Beihery & al. 2020) and Tunisia where eight species were recorded (see Sayari & Mekki 2016). On the other hand, species of the genus *Opuntia* and other Cactaceae are prized in Algeria and are often used around fields and houses as fences, which has probably contributed to their spread (Sakhraoui & al. 2022b). *Opuntia ficus-indica* (L.) Mill. is one of the most common species in Algeria; it is cultivated throughout the country and has escaped from cultivation in many regions.

Taxa of South African origin are among the best represented in our study (10.8%). The native flora of South Africa includes many species of horticultural importance, which has led to their introduction to many parts of the world. South Africa is recognized worldwide as an important donor of naturalized or invasive plants (Pyšek & al. 2020b). South African plants are also among the most naturalized in Algeria (Vilà & al. 1999), probably due to the similarity of climate.

In our results, phanerophytes (including 13 succulents), therophytes and geophytes predominate. However, if the numbers reported by Meddour & al. (2020) are taken into account, the life form distribution for the Algerian alien flora is as follows: therophytes (108 taxa), phanerophytes (68 taxa), hemicryptophytes (41 taxa) and geophytes (33 taxa). Therophytes are also dominant in the Tunisian and Egyptian alien floras, but they are followed by geophytes and phanerophytes for Tunisia (see Sayari & Mekki 2016), and by phanerophytes and geophytes for Egypt (see El Beihery & al. 2020). According to our results, therophytes, succulents and geophytes have the highest naturalization rates (26.8%, 24.4% and 22.0% respectively). This may be due to their ability to adapt and their resistance characteristics allowing them to survive in unfavorable conditions. Therophytes are able to sustain themselves through the production of seeds during a short vegetative cycle, which allows them to avoid the stress of the summer season in the Mediterranean (Verlaque & al. 2001). Annuals are among the most commonly naturalized taxa throughout North Africa (Vilà & al. 1999). Succulents, on the other hand, are adapted to high temperatures and can easily cope with the hot summers in Algeria. Finally, geophytes are capable of accumulating significant nutritional reserves that allow them to survive in unfavorable conditions. They very easily adapt to environmental changes (e.g. low and high temperatures, drought, etc.) in climatic areas with marked seasons such as the Mediterranean basin (Steinfort & al. 2012). They have also shown high values of invasion success in European and Mediterranean coastal habitats (Giulio & al. 2021). These three biological types are therefore most likely to succeed in Algeria and future naturalization events are likely to emerge from these categories.

The distribution of taxa in Algeria clearly follows a decreasing north-south gradient, which was also found by Meddour & al. (2020). The climatic factor seems to be responsible for this spread. The northern part of the country has a milder climate, especially on the coast, where the Mediterranean climate is favorable for the cultivation of various alien species.

However, for some species, data concerning distribution and type of colonized habitats, are significantly outdated or nonexistent and require new research. These species have been reported as escapes from cultivation for a very long time in Algeria (see Battandier 1895; Battandier & al. 1914; Ducellier & Maire 1923). No monitoring of the dynamics of their populations has been carried out, leaving scientists with only very old information that does not reflect their current distribution. This type of research is therefore very important, because these essential data allow to correctly assess the risk of invasion of species. Algerian scientists are called upon to make more efforts in this research topic.

The high number of new records recorded exclusively in the wilaya of Skikda (representing 79.4% of the taxa recorded in northeastern Algeria) does not reflect any peculiarity of the region. Like all other wilayas on the Algerian coast, Skikda has a varied topography and is subject to the Mediterranean climate. However, the field surveys conducted by the first author of this article are mainly carried out in this region. It is very likely that plant invasions have also occurred in other regions of the Algerian coast, but have not been detected yet due to the lack of fieldwork.

The urban/ruderal habitats are home to a wide range of alien taxa, many of which are still in the early stages of their spread and have not yet succeeded in becoming permanently established. This habitat therefore has the highest percentage of casual taxa (23.0%); it includes: *Chlorophytum comosum* (Thunb.) Jacques, *Crassula ovata* (Mill.) Druce, *Helianthus annuus* L., *Kalanchoe laxiflora* Baker, *Salvia hispanica* L., *Tradescantia fluminensis* Vell., *T. pallida* (Rose) D.R. Hunt, *Triadica sebifera* (L.) Small and several fruit trees. Urban habitats are considered as secondary launching sites (McLean & al. 2017), which can largely enhance the adaptability of taxa and lead to invasive behavior, allowing their further spread into adjacent semi-natural or natural environments (Borden & Flory 2021). It will therefore not be surprising to note the change in the status of these species in the near future.

However, coastal habitats (beaches, rock cliffs, coastal dunes) have the highest naturalization rate (7 taxa, 9.6%) and share 17 taxa with other habitats, which represents 23.0% of all represented taxa. These habitats are known for their vulnerability to plant invasions, as they are subject to strong anthropogenic pressure that is causing increasing disturbance (Giulio & al. 2020). In recent years, the Algerian coast has experienced an increase in land development projects leading to the destruction of natural habitats (Ghodbani & Bougherira 2019), and many new alien ornamental species were introduced in public green spaces. Among the most threatening species in coastal dunes are: *Austrocylindropuntia subulata* (Muehlenpf.) Backeb. and *Opuntia stricta* (Haw.) Haw., but also *Acacia saligna* (Labill.) H.L. Wendl. and *Carpobrotus edulis* (L.) N.E. Br. In certain places, these species form very large populations that invade the natural environment and expand every year (Sakhraoui pers. obs.).

In Algeria, wetlands and the edges of wadis also provide favorable habitats for the establishment of alien species, as they provide the humidity necessary for their survival

(Sakhraoui 2023). Several species preferentially colonize these habitats, such as *Arctotheca calendula* (L.) Levyns, *Justicia adhatoda* L., *Tipuana tipu* (Benth.) Kuntze and many others. The prospection of these habitats, although often difficult due to their inaccessibility, therefore, remains useful in Algeria.

Conclusion

The present study demonstrates the dynamic nature of the alien flora in Algeria. No fewer than 74 taxa were added to the catalogue of Algeria's alien flora, i.e. an increase of 35.0%.

Further efforts such as field surveys in under-sampled parts of the country are needed to gain a truly complete picture of the alien flora of Algeria. In addition, management activities to halt the spread of invasive or potentially invasive taxa should be implemented, particularly for taxa established in natural areas. In this regard, the Algerian authorities are called upon to demonstrate greater commitment in defining and applying the most adaptable solutions to this growing problem, starting with the development of appropriate legislation.

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Article

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Ridha El Mokni

Four new alien lianas for Tunisia and new distributional records of *Anredera cordifolia* (*Basellaceae*), *Ipomoea indica* and *I. purpurea* (*Convolvulaceae*)

Abstract

El Mokni, R.: Four new alien lianas for Tunisia and new distributional records of *Anredera cordifolia* (*Basellaceae*), *Ipomoea indica* and *I. purpurea* (*Convolvulaceae*) — Fl. Medit. 34: 325-336. 2024. — ISSN: 1120-4052 printed, 2240-4538 online.

Aristolochia gigantea (*Aristolochiaceae*), *Distimake dissectus*, *Ipomoea batatas* (*Convolvulaceae*), and *Passiflora caerulea* (*Passifloraceae*) are newly reported from Tunisia and the distribution range of *Anredera cordifolia* (*Basellaceae*), *Ipomoea indica* and *I. purpurea* (*Convolvulaceae*) is extended as a result of botanical surveys during the last two decades. All the species are considered casual to naturalizing aliens and the horticultural trade is the most likely pathway for their introduction. General macromorphological characteristics together with original photographs are provided. Actual distribution, ecological notes (habitat, phenology) as well as the degree of naturalization are reported.

Key words: Floristics, climbing vines, new records, North Africa.

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Introduction

Tunisia, despite its restrictive area, is characterised by a high diversity of floristic communities from south to north. The country occupies a specific central-southern Mediterranean geographic position and is therefore under inter- and intra-continental movements of population, together with the development of transport networks between the surrounding countries. During the last decades, the extension of the practice of multiplication and sale of non-native ornamental plants (mainly in the north-west, Tabarka and its surroundings; the centre, Monastir and the north-eastern part, Ariana, Bizerta and Nabeul) make the country a suitable place for an active settlement of many plant species outside their native areas and led to the escape and even the well establishment of several aliens from all over the word, mainly during the last two decades (see e.g. El Mokni & Iamonico 2024; El Mokni & Verloove 2019; El Mokni & Domina 2020; El Mokni & al. 2019, 2022, 2024a, 2024b; El Mokni 2023, 2024).

In the course of floristic surveys throughout the Tunisian territory and as a result of iterate field investigations, four casual alien lianas not previously recorded for the vascular flora of the country were discovered in sub-nitrophilous/ruderal plant communities or as escaped ornamentals in the north-western and central-eastern part of Tunisia. In addition, new distributional records of *Anredera cordifolia* (Ten.) Steenis (*Basellaceae*), *Ipomoea indica* (Burm.) Merr. and *I. purpurea* (L.) Roth (*Convolvulaceae*) in the wild approve to enlarge the range of their distribution as naturalized aliens in Tunisia.

Material and methods

The present work is based on extensive field surveys, analysis of relevant literature with morphological features and distributive areas of different collected material besides examination of specimens for *Distimake dissectus* (Jacq.) A.R.Simões & Staples preserved at LY (sub *Convolvulus dissectus* Jacq.), for *Passiflora caerulea* L., preserved at AV, ANG, CHE, CLF, MHNM, MPU, P, REN and SLA, and for *Aristolochia gigantea* Mart. & Zucc., preserved at MPU and P (herbarium codes follow Thiers (2024) [continuously updated]), and in the personal collection of the author which is deposited in the Herbarium of the Faculty of Pharmacy of Monastir. The degree of naturalization is according to Pyšek & al. (2004). Reported taxa are presented alphabetically in two categories: first records of casual species and new distributional records of lianas that were already known from Tunisia. Each entry includes the currently accepted name of the taxon with one or more synonyms. Authorities of plant names usually follow POWO (2024).

Results

1. New records of casual to naturalizing species

Aristolochia gigantea Mart. & Zucc. **(***Aristolochiaceae***)**
≡ *Howardia gigantea* Klotzsch, = *Aristolochia mariquitensis* Mutis

Morphology – (Fig. 1. A-B). *Aristolochia gigantea* is a liana with one of the largest-flowers in the genus. It is distinguished mainly by its large, zygomorphic, velvety, burgundy with ivory-white veined flowers (Fig. 1. A) that consist of three congenitally united sepals that form a distinctive tube-shaped perianth that expands basally into a hollow trapping chamber (utricle). The fruits are papery capsules, ellipsoid, 8.9–13.6 × 2–2.6 cm, rostrate (Fig. 1. B), containing more than 20 seeds that are dispersed by the wind. A detailed description in provided by Abreu & Giulietti (2016).

Global distribution – *Aristolochia gigantea* is endemic to Brazil, occurring in the northeast (Bahia), Caatinga, southeast (Minas Gerais, Rio de Janeiro and São Paulo) and south (Paraná) regions (Capellari-Junior 1991; Costa & Hime 1981; Nascimento & al. 2010; Abreu & Giulietti 2016). Out of its native range, the plant was reported from North and Central America including Costa Rica, El Salvador, Honduras and Mexico and also from some European countries (sometimes only as cultivated, GBIF 2024a). In Africa, the species was reported only from Kenya, Seychelles, South Africa and Sudan with no



Fig. 1. A-B. *Aristolochia gigantea*, Tabarka, 02.08.2018 & 27.06.2020. C. *Ipomoea batatas*, Monastir, 07.10.2019. D. *Distimake dissectus*, Monastir, 02.07.2024. E. *Anredera cordifolia* with aerial stem tubers indicated by arrows, Tabarka, 01.05.2023. All Photographs by R. El Mokni.

report from North Africa (GBIF 2024a). It is here first reported as a casual alien from Tunisia.

Occurrence and habitat in Tunisia – (Fig. 2). The plant is rather a relic from cultivation. It was recorded only in one locality, climbing on the side of a road in a hedge of a field where many ornamentals were cultivated.

Phenology – In Tunisia, flowering and fruiting from July to January. Elsewhere, mainly in Brazil, it flowers and bears fruits throughout the year (Hipólito & al. 2012).

Specimens examined (new records) – TUNISIA. Jendouba: Tabarka, Houamdeya, 30 September 2015, *El Mokni s.n.* (Herb. El Mokni!); ibidem, 2 August 2018, *El Mokni s.n.* (Herb. El Mokni!); ibidem, 27 June 2020, *El Mokni s.n.* (Herb. El Mokni!); ibidem, 15 October 2021, *El Mokni s.n.* (Herb. El Mokni!); ibidem, 20 July 2024, *El Mokni s.n.* (Herb. El Mokni!).

Distimake dissectus (Jacq.) A.R.Simões & Staples (*Convolvulaceae*, *Merremieae*)

≡ *Convolvulus dissectus* Jacq., ≡ *Ipomoea dissecta* (Jacq.) Pursh, ≡ *Merremia dissecta* (Jacq.) Hallier f., ≡ *Operculina dissecta* (Jacq.) House

Morphology – (Fig. 1. D). An herbaceous climber with long slender, terete, striate stems. The species is characterized by its palmately dissected leaves with 5–9 segments, ovate to suborbicular in outline and its white to pale yellow corolla with dark purple throat. A detailed description (sub *Merremia dissecta*) is available e.g. in Ferreira & Miotto (2013), Al-Hawshabi (2016), Swamy & Venkatesham (2018) and Al-Anbari (2019).

Global distribution – Indigenous to Tropical and Subtropical America (Southern United States, Central America, West Indies, South America to Argentina and Uruguay), the species is cultivated and becoming naturalized in India, Indonesia, Pakistan, Sri Lanka, Thailand, Malaysia, Taiwan and Saudi Arabia as a garden escape (Austin & Ghazanfar 1979; Al-Farhan & Thomas 2001; Mujaffar & al. 2013). It was reported also for Yemen as a casual (Al-Hawshabi 2016) and in Iraq as well-established alien (Al-Anbari 2019). In Africa, the species was reported for several countries (merely cultivated in some) including Algeria, Benin, Cameroun, Congo, Côte d'Ivoire, Ghana, Madagascar and Seychelles, but no report from Tunisia (APD 2024a). This seems to be the first official report, as a casual alien, for the Tunisian non-native flora.

Occurrence and habitat in Tunisia – (Fig. 2). The plant was recorded only in one locality, climbing on a *Washingtonia robusta* H.Wendl. palm tree, in an abandoned field where waste of a nearby nursery was deposited.

Phenology – In Tunisia, flowering and fruiting from June to October. Elsewhere, it flowers and bears fruits all year round, more intensely during the summer, in Brazil (Ferreira & Miotto 2013); from May to December in Yemen (Al-Hawshabi 2016) and from August to January in India (Swamy & Venkatesham 2018).

Specimens examined (new records) – TUNISIA. Monastir: Monastir-city, ruderal plant communities not far away from a nursery of ornamentals, 10 November 2023, *El Mokni s.n.* (Herb. El Mokni!); ibidem, 20 July 2024, *El Mokni s.n.* (Herb. El Mokni!).

Ipomoea batatas (L.) Lam. (*Convolvulaceae*, *Ipomoeeae*)

≡ *Convolvulus batatas* L., ≡ *Solanum batatas* (L.) Aikman

Morphology – (Fig. 1. C). *Ipomoea batatas* is a perennial climbing herb with prostrate to

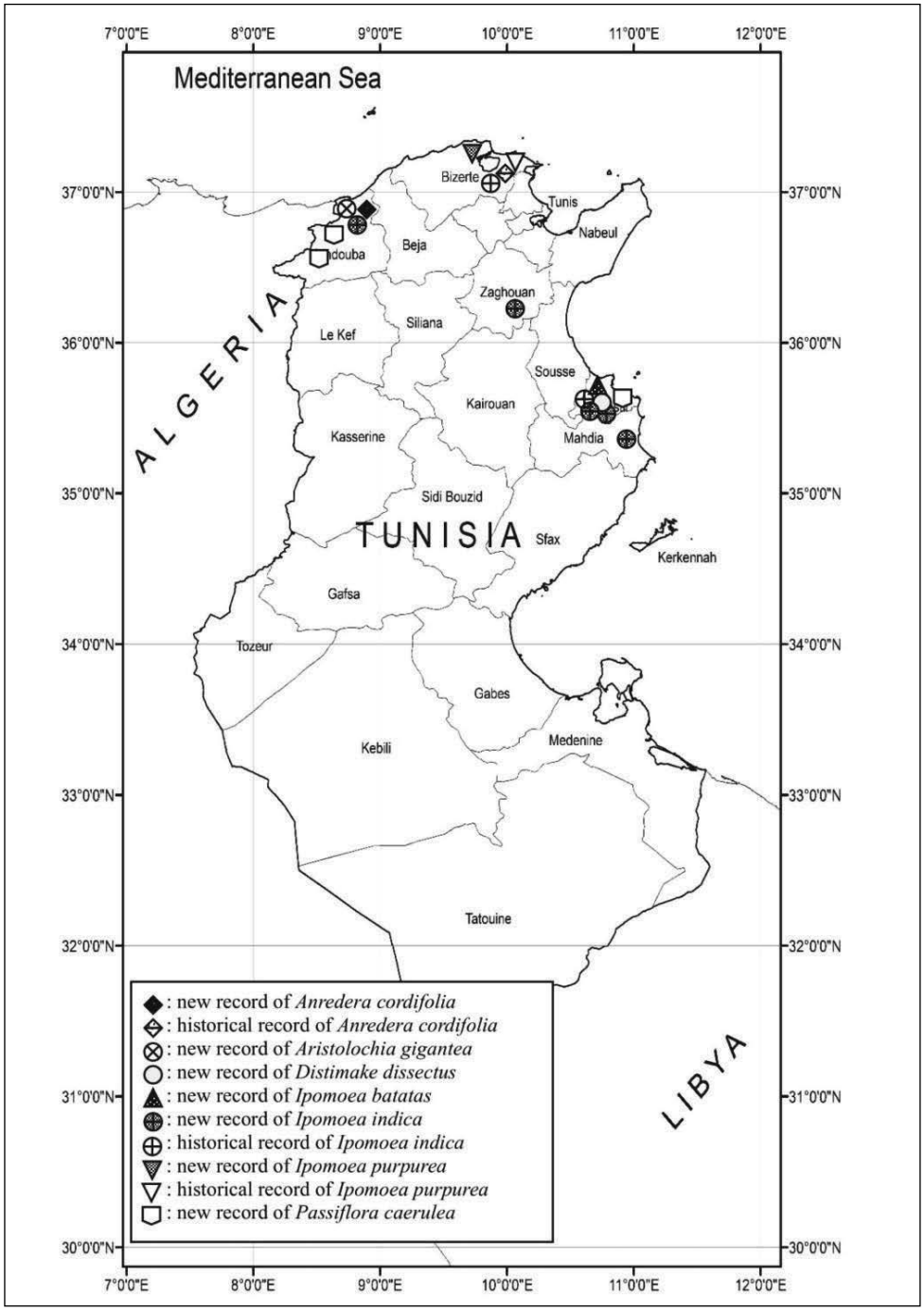


Fig. 2. Actual geographic distribution of *Anredera cordifolia*, *Aristolochia gigantea*, *Distimake dissectus*, *Ipomoea batatas*, *Ipomoea indica*, *Ipomoea purpurea*, and *Passiflora caerulea* in Tunisia.

ascending stems, distinguished mainly by its funnel-shaped completely glabrous corolla, 3–5 cm long. A detailed morphological description was provided in Austin (1978) and Williams & al. (2024).

Global distribution – *Ipomoea batatas* is native from Mexico to Venezuela and Ecuador (POWO 2024a). The plant seems introduced and naturalized in South America, in Europe (mainly Iberian Peninsula and Greece), in Canary Islands, in many countries of the African Continent including all the North African Mediterranean countries except Tunisia (POWO 2024a; Raab-Straube 2018+; APD 2024b). It is here first reported from Tunisia, as a casual alien.

Occurrence and habitat in Tunisia – (Fig. 2). The plant was recorded only in one locality, climbing on a stump of a dead *Ficus microcarpa* L.f. tree along the road.

Phenology – In Tunisia the plant was seen in flowers and fruits in November and December. Elsewhere, flowering starts around May through early September or October; from September to December in India and from April to June in Malta (Mifsud 2022).

Specimen examined (new record) – TUNISIA. Monastir: Monastir-city, within ruderal communities, 7 October 2019, *El Mokni s.n.* (Herb. El Mokni!); ibidem, 1 Decemebr 2024, *El Mokni s.n.* (Herb. El Mokni!).

Passiflora caerulea L. (*Passifloraceae*)

≡ *Granadilla caerulea* (L.) Medik.

Morphology – (Fig. 3 A). *Passiflora caerulea* is a glabrous vine, distinguished mainly by its 5-lobed leaves almost to base, membranous; its solitary, hermaphrodite flowers with sepals and petals 3–4.5 cm long, oblong, white inside; sepals greenish outside and with short dorsal horn towards apex; corona threads about 2 cm long, with base purple, middle white, and apex violet. A detailed morphological description was provided in Webb & al. (1988) and WFO (2024).

Global distribution – *Passiflora caerulea* is a perennial vine native to South America (southern Brazil, Argentina, Paraguay and Uruguay), which has been deliberately introduced as an attractive garden plant in North America, Europe (e.g. Canary Islands, Germany, Great Britain, Ireland, Italy and Spain), Asia and Australia where it has become well established along riverbanks and in hedgerows and waste areas (Weeds of Australia 2012; Invasive Species South Africa 2014). On the African continent, the species was reported only in Kenya and South Africa, with no report from Mediterranean African countries (POWO 2024b; APD 2024c). It is here first reported as a casual alien from Tunisia and continental North Africa.

Occurrence and habitat in Tunisia – (Fig. 2). The plant was recorded in several localities:

First record was from the northwestern part of Tunisia (Jendouba, Ghar-Dimaou, 9.7.2020), many flowering-fruiting individuals in hedgerows;

Second record was in the northwestern part of Tunisia (Jendouba, Ain Draham surroundings, 06.07.2022), one huge blooming-fruiting individual on a riverbank;

Third record was in the northwestern part of Tunisia (Jendouba, Ain Draham-city, 12.6.2023), one flowering individual climbing in roadside from an ancient abandoned building;



Fig. 3. A. *Passiflora caerulea*, Monastir, 9.4.2024. B-C. *Ipomoea indica*, climbing on metallic hedges and creeping on the ground; Mahdia, 16.6.2021. D-F. *Ipomoea purpurea*, Habit with typical leaves and chartaceous, oblong lanceolate sepals covering capsules, Bizerta, 18.11.2018. All Photographs by R. El Mokni.

Fourth locality was in the central eastern part (Monastir, Monastir-city, 9.4.2024), few flowering-fruiting individuals of almost 50-80 cm high in ruderal habitats.

Phenology – In Tunisia, flowering and fruiting from April to October. Elsewhere, it flowers and bears fruits from August to March in South Africa (WFO 2024) and from May to July in China (WFO 2024).

Specimens examined (new records) – TUNISIA: Jendouba, Ghar-Dimaou, 9 July 2020, *El Mokni s.n.* (Herb. El Mokni!); Ain Draham surroundings, 6 July 2022, *El Mokni s.n.* (Herb. El Mokni!); Ain Draham-city, 12 June 2023, *El Mokni s.n.* (Herb. El Mokni!); Monastir, Monastir-city, 9 April 2024, *El Mokni s.n.* (Herb. El Mokni!); ibidem, 4 October 2024, *El Mokni s.n.* (Herb. El Mokni!).

2. New distributional records for lianas already known from Tunisia

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

≡ *Boussingaultia cordifolia* Ten., = *B. gracilis* Miers

New record – TUNISIA. Jendouba: Tabarka, Ouechteta, 1.5.2023, climbing on hedges of *Opuntia ficus-indica* (L.) Mill., with a lot of aerial stem tubers.

Identification – (Fig. 1 E). *Anredera cordifolia* is a perennial, evergreen, vigorous climbing vine with branched inflorescences consisting of masses of showy, pedicellate, fragrant whitish-yellow flowers. The plant shows usually typical aerial stem tubers (vegetative reproductive structures). A detailed description was provided by Sperling (1987), Eggli (2002) and Eriksson (2007).

Previous national distribution, habitat and actual degree of naturalization – (Fig. 2). Native to the southern and central parts of South America (South Brazil, Paraguay and northern Argentina) (Wagner & al. 1999), the species was known in Tunisia only from Bizerta governorate (Jarzouna and Bizerta-city) in the northeastern part of the country (El Mokni & al. 2019). It is reported here for the second time in Tunisia, where it was recently collected in an abandoned area full of wastes within several cultivated huge individuals of *Opuntia ficus-indica* (L.) Mill., in the northwestern part of the country within Jendouba governorate (Tabarka, Ouechtata). The plant produces a high number of aerial stem tubers that easily detach from the parent plant enhancing its vegetatively spreads in the surroundings. We here propose a new degree of naturalization for this taxon in Tunisia, from casual to naturalized.

Ipomoea indica (Burm.) Merr. (*Convolvulaceae*)

≡ *Convolvulus indicus* Burm.

New records – TUNISIA. Mahdia: Rejiche, 16.06.2021; Hiboun, 30.10.2022; Monastir: Teboulba, 15.10.2020; Bembla, 18.10.2019; Moknine, 14.8.2024; Zaghouan: El Fahs, 6.5.2024 ; Jendouba: Tabarka, 12.12.2024.

Identification – (Fig. 3 B-C). A perennial herb with twining or prostrate stems and entire or 3-lobed leaves, ovate in outline, 5–12 cm long, 3–15 cm wide, cordate at the base, acuminate at the apex, lobes acuminate; corolla blue or mauve-purple, often red-tinged, tube whitish at the base. A detailed morphological description was provided in Williams & al. (2024).

Previous national distribution, habitats and actual degree of naturalization – (Fig. 2). Native to tropical and subtropical America, the species was known from Tunisia only from two localities, one in Bizerta (northeastern part) and the other from Monastir (cen-

tral eastern part, El Mokni 2018a). Additional records are here presented from Monastir governorate (Teboulba, Bembla and Moknine), first records from Mahdia governorate (Rejiche and Hiboun in the central eastern part) and also a first record from Zaghouan governorate (El Fahs, northeastern part) and more recently many localities with well established individuals within Tabarka in the governorate of Jendouba. In all cases, the plant was observed climbing on metallic hedges of buildings and/or creeping on the ground along or near railways and rivers. The status as naturalized in previous reports is here confirmed.

Ipomoea purpurea (L.) Roth (*Convolvulaceae*)
≡ *Convolvulus purpureus* L., ≡ *Pharbitis purpurea* (L.) Voigt
New records – TUNISIA. Bizerta: Jarzouna, 23.10.2001; Nadhour, 18.11.2018.
Identification – (Fig. 3 D-F). An herbaceous twining annual, distinguished from related species mainly by its 3-fid styles (*vs*. 2-fid in *I. tricolor* Cav.) and the length of hairs on leaves which are usually ca. 0.4-0.6 mm long, (*vs*. 1-2 mm long in *I. hederacea* Jacq.) (Grøstad & al. 2002; Verloove 2024).
Previous distribution, habitat and degree of naturalization – (Fig. 2). Native to Tropical and Subtropical America, the species was first seen in Tunisia in the surroundings of Tunis region since 1990 but reported without clear status (Le Floc'h & al. 2010). The first record far from Tunis was in Bizerta (Jarzouna, northeastern part of the country) since 2001 (unpubl. records by the author). In 2018, the plant was seen again in Bizerta (Nadhour) in ruderal places climbing on dried herbs and creeping on rocky soils. We here confirm the status of naturalization for this alien taxon in Tunisia, as given by Raab-Straube (2018+).

Conclusion

All new records here reported are regarded as casual to naturalizing aliens for which the horticultural trade is considered to be the most likely pathway for their introduction. Dissemination is presumably facilitated by the production of seeds and pruning waste that is discharged in ruderal habitats (in the case of the major genera of the *Convolvulaceae* family, the genus *Aristolochia* and the genus *Passiflora*) and by the production of aerial stem tubers in the case of the genus *Anredera*. Regarding the Convolvulaceae family in Tunisia, based on previous recent publications (see e.g. El Mokni 2018a, 2018b; El Mokni & al. 2016, 2024c) and the records here reported, the family is now represented by 6 genera, 31 species and 8 subspecies (with only one species among them endemic to Algeria and Tunisia), 5 tribes (*Convolvuleae*, *Cresseae, Cuscuteae*, *Ipomoeeae* and *Merremieae*) and 2 subfamilies (*Convolvuloideae* and *Cuscutoideae*). The taxa here reported for the first time from Tunisia belong to subfamily *Convolvuloideae*, to two tribes (where *Merremieae* is here its first report), to two genera (where *Distimake* is here its first report) and to four species.

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Article

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Updates on the vascular flora of Castellón and Valencia (Valencian Community, Spain)

Abstract

Verloove, F., Laguna, E., Ferrer-Gallego, P. P., Fabado, J., Guillot Ortiz, D. & Leliaert, F.: Updates on the vascular flora of Castellón and Valencia (Valencian Community, Spain). — Fl. Medit. 34: 337-355. 2024. — ISSN: 1120-4052 printed, 2240-4538 online.

Fieldwork in the autumn of 2023 in the Spanish provinces of Castellón and Valencia yielded some interesting plant records, mainly (but not exclusively) of non-native taxa. Their degree of naturalization varies from ephemeral garden escapes (such as *Clerodendrum trichotomum* or *Erythrina crista-galli*) to well-established, fast-spreading weeds (such as *Chloris truncata*). *Arthraxon hispidus* is reported for the first time in Spain.

Key words: Chorology, Iberian Peninsula, casual, invasive.

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Introduction

The flora and vegetation of the Valencian Community are particularly well studied, both in terms of native and non-native species. Moreover, the available information is up-to-date: the fifth and penultimate part of the Flora Valentina (Mateo & al. 2011-2015, 2022-2024) was only recently published (Mateo & al. 2024). The data regarding the local non-native flora are also recent: a very detailed overview of the alien flora, including identification keys and distribution maps (and not only for the Valencian area but for the whole of Catalonia) was recently published as a doctoral thesis (Gómez-Bellver 2023).

Notwithstanding this, interesting plant discoveries can still be made even in well-studied areas. Especially in regions with high anthropogenic pressure (densely populated, subject to intense economic activities or tourism), the flora is permanently changing: new alien species are constantly being introduced, whether intentionally or not. It is also interesting to monitor the behavior of species that are already present: their status (ephemeral to naturalizing to naturalized to invasive) can change quickly. Ornamental plants that were deliberately introduced in the past may begin to escape from cultivation, which could be

the first step toward an incipient future naturalization or even invasion. Also, increased knowledge regarding difficult species groups (including the application of genetic research) may shed new light on the identity of some taxa.

It is with this approach that intensive fieldwork was carried out in the autumn of 2023 in the provinces of Castellón and Valencia. This article discusses the findings made as a result. Although the initial focus was on non-native species, some observations of native species are also discussed. The status of some taxa (native *vs* non-native) is very uncertain.

Materials and methods

The records here presented are the result of fieldwork by the first author conducted between 29 August and 11 September 2023. On that occasion, numerous localities were explored throughout the provinces of Castellón and Valencia, especially along the coast and in the lowland areas. The focus was on riparian and anthropogenic, often urban habitats (such as port and industrial areas, railway infrastructure, roadsides, parks, etc.), agricultural fields (including the numerous fruit growing areas and rice fields), etc. The other authors contributed with recent and/or unpublished personal records and/or provided further information useful to this study.

Herbarium specimens were collected for most records and these are preserved in the herbaria of the Meise Botanic Garden, Belgium (BR) and/or of the University of Valencia, Spain (VAL). Specimens deposited in BR will be soon be made available online at https://www.botanicalcollections.be/. Records for which no herbarium material was collected are supported by photographs. All records, including the photographs, were also registered on the observation.org online platform (https://observation.org/), an EU-based platform for biodiversity citizen science and monitoring. These data are available as Electronic Supplementary File 1 of this article and were subsequently also loaded into GBIF (Global Biodiversity Information Facility; https://www.gbif.org/).

The nomenclature in this paper follows Plants of the World Online (POWO 2024), except for *Gamochaeta*.

The presence or absence of each taxon and its rarity were verified by consulting the Biodiversity Database of the Valencian Community (Banco de Datos de Biodiversidad de la Comunidad Valenciana, https://bdb.gva.es).

For two taxonomically challenging taxa, a putative *Commelina* species (here identified as *Arthraxon hispidus*) and a species of *Eleocharis*, molecular phylogenetic analyses were employed to aid species identification and assess possible geographical origins. For *Arthraxon,* we analyzed the plastid encoded *trnL-F* spacer (Skendzic & al. 2007, Arthan & al. 2017, Lee & al. 2022). For *Eleocharis*, we analyzed the nuclear rDNA internal transcribed spacer (ITS) region following Roalson & Friar (2000) and Roalson & al. (2010), as well as the plastid encoded *matK* gene. Total genomic DNA was extracted from silica-dried leaf material using a modified CTAB protocol. The ITS region was amplified using primers ITS4 (5'-TCCTCCGCTTATTGATATGC-3') and ITS5 (5'-GAAG-TAAAAGTCGTAACAAGG-3') (White & al. 1990); *matK* was amplified using primers matK-MALPR1 (5'-ACAAGAAAGTCGAAGTAT-3') and *matK-xF* (5'-TAATTTAC-

GATCAATTCATTC-3') (Ford & al. 2009; Dunning & Savolainen 2010); *trnL-F* was amplified using primers *trnL-c* (5'-CGAAATCGGTAGACGCTACG-3') and *trnL-f* (5'-ATTTGAACTGGTGACACGAG-3') (Taberlet & al. 1991). PCR conditions are described in detail on the open-access repository Zenodo (10.5281/zenodo.12731814). PCR quality control was performed with a BioAnalyzer (Agilent Inc.). After purification using ExoSAP-IT (ThermoFisher Scientific), PCR products were sequenced by Macrogen (Seoul, South Korea). Forward and reverse sequences were assembled using Geneious Prime v2023.2.1. (Biomatters, Auckland, New Zealand). Sequences have been deposited in the European Nucleotide Archive (ENA) under project number PRJEB77568 (https://www.ebi.ac.uk/ena/browser/view/PRJEB77568) and accession numbers OZ119296 (*Arthraxon hispidus*, *trnL-trnF* IGS), OZ174342-OZ174346 (*Eleocharis* sp. pl., *matK* and ITS). Sequence datasets were constructed, including the sequences generated in this study and publicly available sequences obtained from ENA/GenBank, including the sequences from the abovementioned publications and closest BLAST hits. Sequences were aligned using MUSCLE (Edgar 2004). Phylogenetic relationships were reconstructed using maximum likelihood and 1000 ultrafast bootstrap replicates in IQ-TREE 2.2.2.7 (Nguyen & al. 2015) on the CIPRES Science Gateway portal (Miller & al. 2010). Sequence alignments are available from Zenodo (10.5281/zenodo.12731814).

Results

Arthraxon hispidus (Thunb.) Makino (*Poaceae*) (Fig. 1a)
New to Spain.
Local status: casual alien weed.
Origin: Tropical Africa, Indian Ocean islands and from western Asia to Australia.
Herbarium specimens: Castellón de la Plana, Paseo Rio Nilo, weed in ornamental plantation, a single individual, 3.9.2023, *F. Verloove 14917* (BR0000027060391V).

Arthraxon hispidus is distinctive in its lanceolate to oblong leaves with auriculate-clasping bases and its creeping habit, with stems rooting at lower nodes (see illustrations in Nesom 2011). Vegetatively, it superficially resembles a species of *Commelina*, for which the Castellón individual was initially erroneously taken. However, the presence of a ligule excluded *Commelina*. Moreover, *trnL-trnF* spacer sequences were identical to those of *A. hispidus* plants from Korea, China, Thailand and Mexico published in previous studies (Skendzic & al. 2007; Arthan & al. 2017; Lee & al. 2022) (Fig. 2) confirming the species identity. This species is weedy throughout its distribution range and locally invasive in areas where it was introduced, in particular in parts of North America (Kiger 1971; Nesom 2011).

According to GBIF, the species has only been found a few times in Europe so far and has not (yet) been able to establish itself permanently. Seed of the species commonly occurs as a contaminant in Niger seed (*Guizotia abyssinica*) from East Africa (Hanson 2019), and the species has indeed also been found as a birdseed alien in London (Ryves & al. 1996). In the 1950s, *Arthraxon hispidus* was also found in the Netherlands at a storage of Korean mats. In 1997 it was also seen in the port of Bamberg in Germany where it was probably introduced with granite from China. Finally, the species is also known as a weed



Fig. 1. a) *Arthraxon hispidus* as a plantation weed in Castellón de la Plana in September 2023 (F. Verloove); b) *Bauhinia variegata*, self-sown on the verge of an urban canal in Albal in May 2021 (E. Laguna). These escaped plants are flowering and fruiting, which indicated an incipient local naturalization. c) *Catalpa bignonioides* in Castellón de la Plana (Riu Sec) in September 2023 (F. Verloove). In this dried-out riverbed escaped individuals are not rare and some of them reach the fruiting stage, indicating an incipient naturalization process. d) The Australian *Chloris truncata* in Nules in September 2023 (F. Verloove). In this area, this species has become a common and fast-spreading roadside weed. e) Escaped individuals of *Clerodendrum trichotomum* in Burriana in September 2023 (F. Verloove). f) *Eleocharis caduca* in Ribesalbes in September 2023 (F. Verloove).

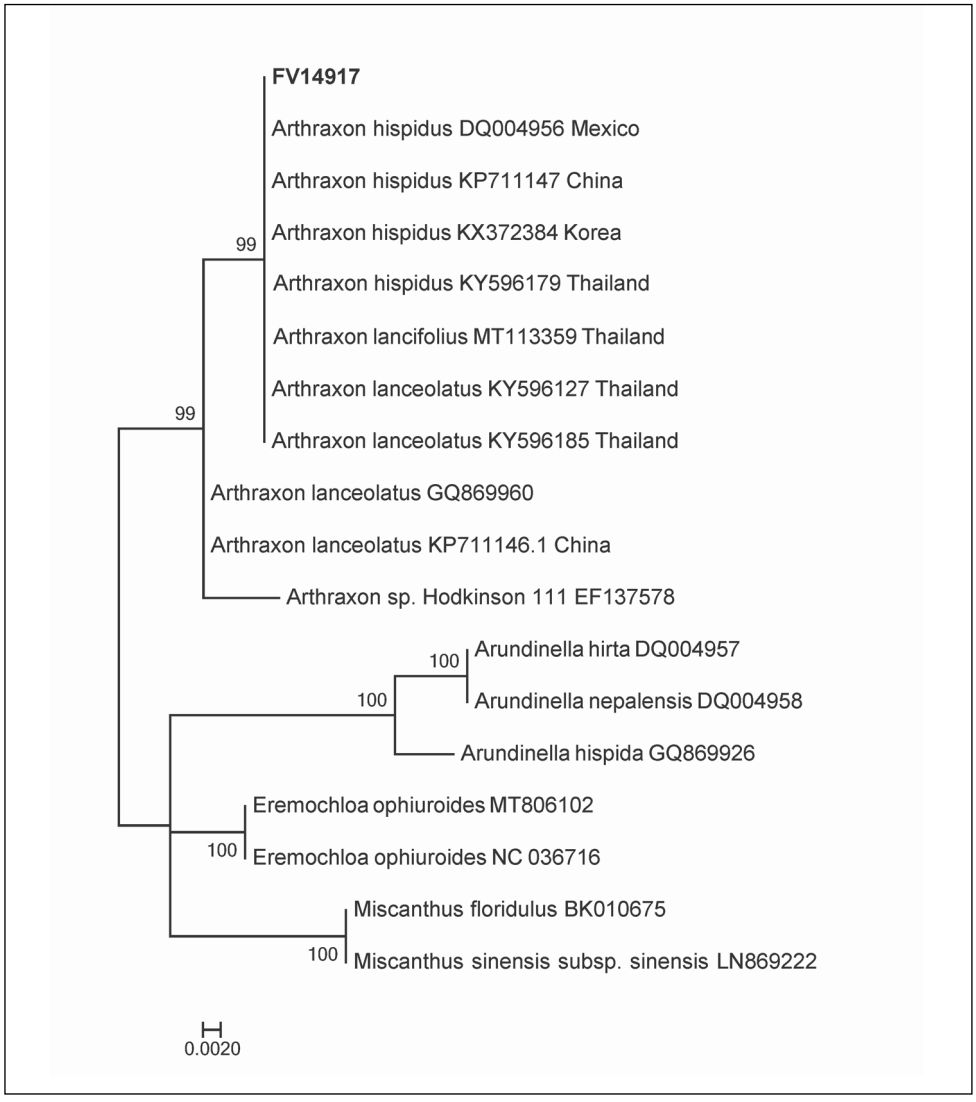


Fig. 2. Phylogenetic tree (trnL-trnF spacer sequences) showing the position of *Arthraxon hispidus* from Castellón de la Plana (coll. FV14917) and from various other provenances (GenBank).

in bamboo tubs (comm. R. Otto, June 2024). Based on these earlier European finds, two possibilities seem most obvious: either the species germinated from birdseed (although no other typical birdseed plants were seen), or (and therefore most likely) *Arthraxon hispidus* was inadvertently introduced with the ornamental plants, including as a stowaway in the complementary substrate that is often used by local plant nurseries; see also Verloove & al. (2014). In the latter case, the species appears to be present in local plant nurseries and

garden centers and thus can be expected in ornamental plantations elsewhere in the region.

In the locality where it was found in Castellón de la Plana in 2023, the species was weeded a few weeks after our observation.

Bauhinia variegata L. (*Fabaceae*) (Fig. 1b)
New to the provinces of Castellón and Valencia.
Local status: casual escaped ornamental (both provinces) and naturalizing (Valencia).
Origin: Indian subcontinent, China.
Observations:
Castellón province:
Benicasim, Barranc de Farja, vacant lot in residential area, 1.9.2023, *F. Verloove*.
Valencia province:
-Albal, urban plot at Avenida Padre Carlos Ferris and margins of ravine 'Rambleta del Sord', both naturalizing specimens that flower and bear fruit, and new seedlings that germinated from nearby planted trees, 6.5.2021 *E. Laguna*, 39º 23' 55" N, 0º 24' 18" W
-Albal, Calle Doctor Fleming, seedlings and young plants escaped from nearby planted trees in urban semi-abandoned garden, 15.7.2018, *E. Laguna*, 39º 23' 44" N, 0º 24' 34" W
-Valencia, parking lot in front of Hospital San Juan de Dios, seedlings and young plants in semi-abandoned urban tree pits with different tree species, close to planted trees of *Bauhinia variegata*, 8.10.2011, *E. Laguna*, 39º 28' 39" N, 0º 19' 50" W

This ornamental species is much planted in urban areas in Spain. It flowers and fruits abundantly and increasingly reproduces from seed. In eastern Spain, however, it was only known from the Alicante province (Gómez-Bellver 2023). It is here first reported from Benicasim in the Castellón province. Scattered self-sown individuals were observed on rough ground, close to planted individuals. It is also reported for the first time for Valencia, including older, unpublished data of seedlings and young plants emerging from nearby planted trees in Valencia and Albal, as well as more recent observations of specimens already producing flowers and fruits in Albal. At least in this last locality *Bauhinia variegata* appears to be in the process of naturalization.

Catalpa bignonioides Walter (*Bignoniaceae*) (Fig. 1c)
New to the province of Castellón.
Local status: naturalizing escaped ornamental.
Origin: southeastern U.S.A.
Observations: Castellón de la Plana, Riu Sec, dried-out riverbed, 1.9.2023, *F. Verloove*; La Vall d'Uixó, Riu de la Font de San Josep, dried-out riverbed, 10.9.2023, *F. Verloove*.

This ornamental tree is regularly recorded as an escape from cultivation in northeastern Spain but it is generally considered to be an ephemeral species (Gómez-Bellver 2023). In the Castellón province, from where it was not yet known, it locally seems to be in the process of naturalization, especially in dried-out riverbeds. In Castellón de la Plana, self-sown flowering and fruiting individuals were observed in the Riu Sec valley, suggesting that the species is able to build up a self-sustaining population. Interestingly, the escape of this species in the Riu Sec riverbed in Castellón was already observed in 2019 by one of the authors (DGO). A similar incipient naturalization process was observed in the Barranc de Sant Josep in La Vall d'Uixó.

Chloris truncata R.Br. (*Poaceae*) (Fig. 1d)
New to the provinces of Castellón and Valencia.
Local status: naturalized weed.
Origin: Australia.
Herbarium specimens: Nules, L'Estany, roadsides, very common in this area, 31.8.2023, *F. Verloove* 14870 (BR0000027060575V); Villareal, N-340 near Camí de Sant Jordi, gravelly roadside, under crash barrier, very common, 11.9.2023, *F. Verloove 14889* (BR0000027058534V, dupl. VAL).
Observations: Nules, Cami del Cabeçol, in chicken run, ca. 100 individuals, 31.8.2023, *F. Verloove* ; Nules, Camí de la Serratella, roadside, 31.8.2023, *F. Verloove*; Nules, Carretera de la Segona Andana del Rajolí, roadside, omnipresent, 31.8.2023, *F. Verloove*; Nules, Camí de la Mar, roadside, 4.9.2023, *F. Verloove*; Nules, Camí de Nules a Moncofa, roadside, 4.9.2023, *F. Verloove*; Nules, CV-2262 SW of the village, roadside, 4.9.2023, *F. Verloove*; Nules, Avinguda de València × Camí de Nules a Moncofa, roadside, 6.9.2023, *F. Verloove* ; Nules, Avinguda de València, roadside, omnipresent, 6.9.2023, *F. Verloove*; Valencia, V-30 motorway alongside Riu Túria, under crash barrier, very common, 8.9.2023, *F. Verloove*; Nules, CV-2262 roundabout SW of the village, roadside, 10.9.2023, *F. Verloove*; Villarreal, N-340 road, under crash barrier, very common, 11.9.2023, *F. Verloove*.

This Australian grass species is a recent newcomer in Spain. It was probably first recorded in Cambrils (Tarragona) in 2003 (Verloove 2005). Subsequently, it was also found near Barcelona (Sánchez Gullón & Verloove 2015, Verloove & Aymerich 2020), Cáceres (Vázquez 2008), again in Tarragona (Verloove & al. 2019) and in Sevilla (Sánchez Gullón & al. 2020). At present, it is still considered to be ephemeral in the Iberian Peninsula (Velayos 2020). However, in reality, it is a fast-spreading naturalized alien. Since it is usually found along roadsides, often under crash barriers, it is probably often overlooked. Given the species' actual presence in the surroundings of Nules, Valencia and Villareal, it either must have been overlooked for quite a long time, or must have spread very prolifically. Google Streetview images were verified in some locations where the species is very abundant. Although it cannot be assessed with absolute certainty (images are not always available for every relevant time of year, sometimes mowing has just taken place or the images are simply not sharp enough), the species seems to have only been visible since 2021, which suggests a very rapid expansion indeed. Like the following species, *C. truncata* is very easily wind-dispersed.

Chloris truncata is a well-known troublesome weed and it has been shown that Spain falls within the areas that are climatologically very suitable to this species (Michael & al. 2012). During our recent field work the species was also observed on the verge of agricultural fields, especially in the Nules area. Tolerance mechanisms to glyphosate in a *C. truncata* population from Extremadura are currently being investigated (comm. Joel Torra Farré, Lleida).

Chloris virgata Sw. (*Poaceae*)
New to the province of Castellón.
Local status: naturalized weed.
Origin: Central and South America, southern U.S.A.
Herbarium specimens: Benicasim, former railway track (now Via Verde) at Barranc de

Farja, roadside, scattered small populations, 11.9.2023, *F. Verloove 14864* (BR0000027060544V); Oropesa del Mar, Avenida Central, roadsides, 11.9.2023, *F. Verloove 14868* (BR0000027060568V).

Chloris virgata was probably first recorded from Spain by Mateo & Pyke (1998) and Vallverdú (2000), from the Zaragoza and Tarragona provinces respectively. Its persistence and spread in Cambrils (Tarragona) was subsequently reported by Verloove & Sánchez-Gullón (2008). At present, it is still considered to be ephemeral in the Iberian Peninsula (Velayos 2020). However, it is at least locally naturalized in northeastern Spain (Gómez-Bellver 2023); the recent records in Benicasim and – particularly Oropesa – seem to confirm this.

In the two aforementioned nearby coastal cities in Castellón, *C. virgata* occurs along roadsides. With its lemmas of the fertile floret that are crowned with a hairy pappus, it is very easily wind-dispersed. A future local expansion is therefore likely.

Previous observations of the genus *Chloris* in Valencia and Castellón were consistently attributed to the only known taxon of the local flora (see Mateo & Crespo, 2014), *C. gayana* Kunth. Because this species superficially resembles *C. virgata*, the two may have been confused with each other in some cases.

Clerodendrum trichotomum Thunb. (*Lamiaceae*) (Fig. 1e)

New to the province of Castellón.

Local status: casual escaped ornamental.

Origin: East Asia.

Herbarium specimens: Burriana, Cami del Rajoli, border of concrete canal, escaped but planted nearby, 10.9.2023, *F. Verloove 14874* (BR0000027060490V).

This ornamental shrub is only exceptionally recorded as an escape from cultivation in Spain, perhaps so far only from Sallent in the province of Barcelona (Aymerich 2016).

In Burriana three young individuals were observed in the joints of concrete of a small canal. A flowering and fruiting parental shrub was observed nearby.

Cyperus brevifolius (Rottb.) Hassk. (*Cyperaceae*)

New to the province of Valencia.

Local status: casual alien weed.

Origin: tropics and subtropics.

Herbarium specimens: Valencia, enclosed garden on the side of the school Jesús y María, in Literat Gabriel miró street, 30S 729201 4376825, 15 m, 3.9.2023, *J. Fabado* (VAL 252804).

This pantropical species is known from a few provinces in the Iberian Peninsula (Castroviejo, 2007), all in the south and west of the Peninsula. In the locality where it was found in Valencia in 2023, it is a weed in an ornamental plantation, with hundreds of individuals. In 2024 its presence was confirmed in early July. The lawn is mowed periodically, but the plant grows back vigorously.

Digitaria ciliaris (Retz.) Koeler (*Poaceae*)

New to/confirmed from the province of Castellón.

Local status: naturalized weed.

Origin: Old World tropics and subtropics.

Herbarium specimens: Castellón de la Plana, El Grau, Parc El Pinar, lawn weed, 1.9.2023, *F. Verloove 14916* (BR0000027060520V); Castellón de la Plana, Parque Manuel Babiloni, lawn weed, leaves unusually wide and hairy, 2.9.2023, *F. Verloove 14942* (BR0000027060506V, dupl. VAL); Castellón de la Plana, Parque Manuel Babiloni, plantation weed, 2.9.2023, *F. Verloove 14943* (BR0000027060513V, dupl. VAL).

Digitaria ciliaris is a poorly known species that is still frequently confused with *D. sanguinalis* (L.) Scop. It is distinguished by its spikelets with the lower lemma with smooth veins (in *D. sanguinalis* the lateral veins of the lower lemma are scabrous). Gómez-Bellver (2023) did not report it from Castellón, contrary to Alonso & Crespo (2020). Its presence in that province is here confirmed. In the Castellón de la Plana area, *D. ciliaris* was recorded on several occasions, not only as an urban weed in parks but also as a roadside weed in the port area. It is clearly naturalized but apparently widely overlooked.

Digitaria violascens Link (*Poaceae*)

New to the province of Castellón.

Local status: naturalized weed.

Origin: Tropical & Subtropical Asia, Australia.

Herbarium specimens: Castellón de la Plana, Parque Manuel Babiloni, weed in flowerbeds, etc., 2.9.2023, *F. Verloove 14881* (BR0000027058510V); Castellón de la Plana, Calle del Rio Jucar, irrigated lawns, very common, 3.9.2023, *F. Verloove 14890* (BR0000027058541V, dupl. VAL).

Digitaria violascens is a recent but increasing weed in Spain. Since the first observations in 2007 (Verloove & Sánchez-Gullón 2008), it has been recorded from the provinces of Barcelona, Cádiz, Huelva, Lérida, León, Pontevedra, Tarragona and Zaragoza (Alonso & Crespo 2020).

It is here reported for the first time from the province of Castellón where it is found in similar circumstances as elsewhere in southern Europe, i.e. as a weed of irrigated lawns and flower beds.

Diplachne fusca subsp. ***uninervia*** (J.Presl) P.M.Peterson & N.Snow (*Poaceae*)

New to the province of Castellón.

Local status: naturalized (?) weed.

Origin: Central and South America, southern U.S.A.

Herbarium specimens: Castellón, El Grau, Platja del Pinar, beach, mouth of small stream, not rare but only locally, 1.9.2023, *F. Verloove 14883* (BR0000027058527V, dupl. VAL).

Several dozen individuals were recorded on both sides of the mouth of a small stream and along a nearby track in coastal dunes in El Grau de Castellón. In this locality, this taxon looks well-established but it was not seen in other localities in the surroundings.

Diplachne fusca is represented by two subspecies in the Iberian Peninsula: in addition to subsp. *uninervia* (usually with the inflorescence completely exserted from the uppermost leaf sheaths), also subsp. *fascicularis* (Lam.) P.M.Peterson & N.Snow is found (with panicles usually partially enclosed) (Aedo 2020). Both are relatively recent

newcomers and in the process of spreading, particularly as weeds in rice fields (del Monte & Cortés 2000).

Eleocharis caduca (Delile) Schult. (*Cyperaceae*) (Fig. 1f)
New to the province of Castellón.
Local status: naturalized weed (or native?).
Origin: Mediterranean area, Africa.
Herbarium specimens: Ribesalbes, embassament de Sitjar, exposed pond margin, very common, 7.9.2023, *F. Verloove 14912* (BR0000027059579V, dupl. VAL).

Eleocharis caduca is a poorly known species with main distribution in tropical Africa, but with some isolated occurrences further north, especially in the Mediterranean, e.g. in Crete (Greuter & al. 2002). In the Iberian Peninsula it has been confused with the New World species *E. flavescens* (Poir.) Urb. for quite a long time (Verloove & Sánchez Gullón 2010). It is in fact less rare than the latter but most records are from Portugal. *E. caduca* was collected once, in 1971, in Ibiza and it is unknown what status should be assigned to this record (native *vs* alien).

In Ribesalbes, on the exposed banks of the Sitjar water reservoir, *E. caduca* was found in large numbers, along with – among others – *Bolboschoenus maritimus* (L.) Palla and *Cyperus flavidus* Retz. In contrast with *E. flavescens* nutlets in this species are shiny black. In addition, the leaf sheath apex is not prominently hyaline and wrinkled, a characteristic feature of *E. flavescens*.

Due to the complexity of the group, the plants found in Ribesalbes underwent molecular phylogenetic analyses using ITS and *matK* sequences. These sequences were compared with previously collected samples of *Eleocharis caduca* and *E. flavescens* from the Iberian Peninsula, as well as with samples of *E. flavescens* from America and other regions (accessions from GenBank). The ITS and *matK* markers (Fig. 3) support the hypothesis, previously suggested by Verloove & Sánchez Gullón (2010) based on morphological data, that two closely related but distinct taxa are present in Spain and Portugal.

Eragrostis virescens J.Presl (*Poaceae*)
New to/confirmed from the province of Valencia.
Local status: casual (?) weed.
Origin: New World.
Herbarium specimens: Alboraya, camí de les Vinyes, roadsides, 22.10.2023, *P.P. Ferrer-Gallego s.n.* (VAL 252816, dupl. BR).

Eragrostis virescens is a poorly known species that is still frequently overlooked. Gómez-Bellver (2023; sub *E. mexicana* (Hornem.) Link) did not report it from Valencia, contrary to Sánchez Gullón & al. (2020). Its presence in that province is here confirmed, although its status remains uncertain. In Alboraya only a few individuals were observed in a dried-out concrete canal bordering a rice field. However, given its weedy nature, it may well be more widely dispersed in that area.

Erythrina crista-galli L. (*Fabaceae*) (Fig. 4a)
New to the province of Valencia (and probably to Spain as well).
Local status: casual escaped ornamental.

Origin: South America.

Herbarium specimens: Alboraya, Barranc de Carraixet, near its estuary, concrete slope next to river, a single self-sown individual, 6.9.2023, *F. Verloove 14863* (BR0000027060537V).

A single self-sown, non-flowering individual was found on the fortified bank of the Carraixet river, close to its estuary. No putative parent trees were observed in the vicinity but this species is widely grown as an ornamental in Spain (Sánchez de Lorenzo Cáceres 2003). To our knowledge, *Erythrina crista-galli* had not been recorded before as an escape in Spain. It was recently recorded for the first time in the wild in Madeira (Verloove & Silva Gonçalves 2022). In riparian habitats, *E. crista-galli* is often invasive, for instance in New South Wales, Australia (Smith 1996). In Alboraya, it is an ephemeral species, unless yet undiscovered specimens are occurring nearby.

Species of *Erythrina* are not easily identified, especially if flowers and fruits are missing. The plant was identified using the keys in McClintock (1953), Sánchez de Lorenzo Cáceres (2003) and Nesom (2015).

Euphorbia davidii Subils (*Euphorbiaceae*)

New to the province of Castellón.

Local status: naturalized (?) weed.

Origin: disjunct in Southwestern U.S.A. and Argentina.

Herbarium specimens: Villareal, AP-7 motorway at Cami de Betxi, dried-out ditch, a small population, ca. 100 individuals, 2.9.2023, *F. Verloove 14879* (BR0000027058497V).

a, A small population was detected in a dried-out ditch bordering the AP-7 motorway near Villareal. *Euphorbia davidii* is a recent newcomer in Spain that was probably first recorded from the province of Barcelona (Pyke 2008; early records were erroneously ascribed to *E. dentata* L.). Since then, it has been recorded on a few other occasions from the same province (Aymerich & Sáez 2015, Gómez-Bellver & al. 2016, Gómez-Bellver 2023). These are probably the only records in Spain to date, although the species is an upcoming weed in several parts of southern Europe (see e.g. Barina & al. 2012).

Euphorbia hypericifolia L. (*Euphorbiaceae*) (Fig. 4b)

New to the province of Castellón.

Local status: naturalized (?) weed.

Origin: Central and South America, southern U.S.A.

Herbarium specimens: Castellón de la Plana, Ronda Norte, weed in flowerbed, several dozens, 1.9.2023, *F. Verloove 14915* (BR0000027059678V).

Three ‘chamaesyces’ with erect stems are currently found in the northeastern Iberian Peninsula (Gómez-Bellver 2023) and they all look similar in gross morphology. *Euphorbia nutans* Lag. is the oldest introduction; it used to be more or less widespread but might be declining lately, in favor of the other two species. Its stems and leaves are hairy and its capsules exceed 2 mm in diameter. The other species, *E. hypericifolia* and *E. hyssopifolia* L., are recent introductions but they are increasing in recent years (see Laguna & al. 2017). Both are much less hairy (*E. hyssopifolia*) to glabrous (*E. hypericifolia*) and have distinctly smaller capsules. *E. hyssopifolia* is characterized by slender, few-flowered inflorescences, while in *E. hypericifolia* the flowers are densely clustered.

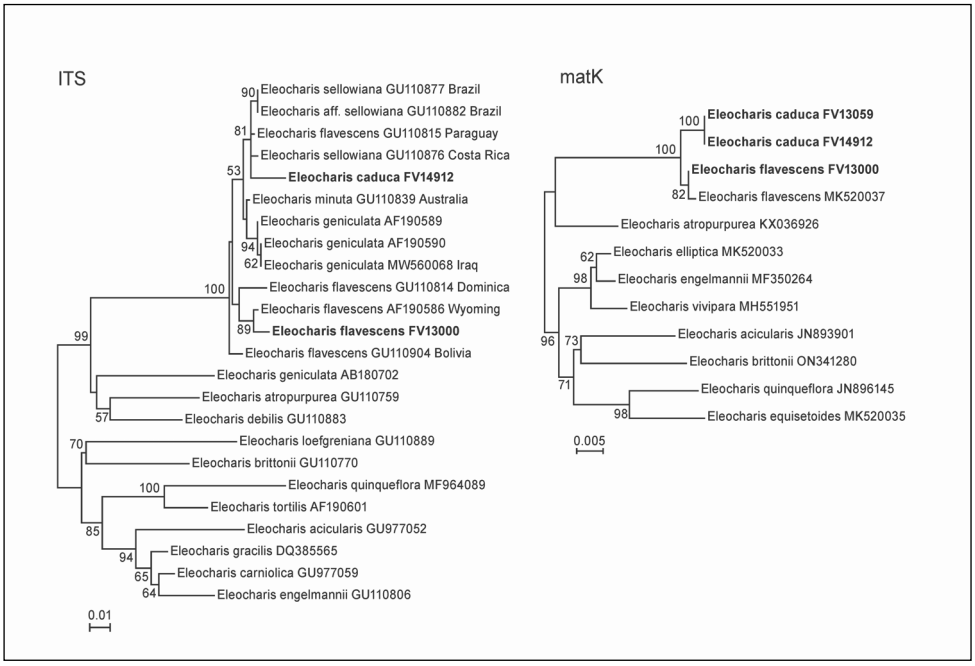


Fig. 3. Phylogenetic tree (ITS and *matK* spacer sequences) showing the position of *Eleocharis caduca* from Ribesalbes (coll. FV14912) and from various other provenances (GenBank), incl. previous collections from the Iberian Peninsula of that species (FV13059) and of the closely related *E. flavescens* (FV13000).

Plants that were recently found as weeds in a flowerbed in Castellón de la Plana are completely glabrous, have distinct stipules that are longer than 1,5 mm and very small capsules; these characteristics refer to *E. hypericifolia* (e.g. Chen 2004), a species that was not yet known from the Castellón province (Gómez-Bellver 2023).

Gamochaeta coarctata (Willd.) Kerguélen (*Asteraceae*) (Fig. 4c)
New to the province of Castellón.
Local status: naturalized (?) weed.
Origin: Central and South America, southern U.S.A.
Herbarium specimens: Castellón de la Plana, Parque de Don Ramón James Boera, in gravel, ca. 200 individuals, 3.9.2023, *F. Verloove* 14898 (BR0000027058466V, dupl. VAL).

In northeastern Spain *Gamochaeta coarctata* was only known from the provinces of Barcelona and Gerona, where it is a recent introduction (Gómez-Bellver 2023). In Castellón de la Plana, it is an urban weed in a park; it should be looked for elsewhere in the area.

Gamochaeta coarctata belongs to a complex of closely related species that is probably best treated as a single, variable species, *G. americana* (Mill.) Wedd. (Freire & al. 2021). It also includes the recently described *G. impatiens* Nesom (Nesom 2022).

Malvastrum coromandelianum (L.) Garcke (*Malvaceae*) (Fig. 4d)
New to the provinces of Castellón and Valencia.
Local status: naturalized (?) weed.
Origin: Central and South America, southern U.S.A.
Herbarium specimens: Oropesa del Mar, Barranc de la Rampuda, dried out, gravelly riverbed, common, many dozens over a distance of ca. 300 m, 11.0.2023, *F. Verloove 14871* (BR0000027060582V, dupl. VAL); Valencia, Valencia city, Enguera street, urban garden tree pits, 10.10.2023, *P.P. Ferrer-Gallego* s.n., VAL 255201 (dupl. BR); idem, 18.10.2023, *J. Fabado s.n.*, VAL 252817.

Malvastrum coromandelianum was recorded for the first time in Spain in 2007 in Huelva, as an ephemeral alien (Verloove & Sánchez-Gullón 2008). More recently it was also observed, for several years, in a garden in Vilablareix in Girona (Gómez-Bellver 2023). During our recent field work, apparently stable populations of this species were observed in two localities. In Oropesa del Mar, many dozen individuals were observed in a dried-out river bed, over a distance of ca. 300 m. Specimens were found in flowering and fruiting, abundantly reproducing from seed. It looks as if this species is naturalized in this particular area. It was found along with, among others, *Cardiospermum halicacabum* L. and other species that are regularly observed from sewage sludge. In Valencia, this species has been collected in several tree basins in garden areas on Enguera street, where the plants produce numerous seeds.

Interestingly, some morphological variation has been observed in the area under study. While the plants from Oropesa del Mar belong to the nominal subspecies, those from Valencia are atypical in having unusually large leaves with 4-rayed hairs on the upper surface (*vs* most or all hairs simple) and flowers in dense, interrupted clusters (*vs* most flowers solitary and axillary). Such plants are distinguished as *M. coromandelianum* subsp. *capitatospicatum* (Kuntze) S.R.Hill. This taxon was recently also recorded from La Palma in the Canary Islands (Otto & Verloove 2016) and from Saudi Arabia and the United Arab Emirates (Thomas & al. 2014, Sakkir & al. 2022).

Tipuana tipu (Benth.) Kuntze (*Fabaceae*) (Fig. 4e)
New to the province of Castellón.
Local status: naturalizing escaped ornamental.
Origin: South America.
Observations: Burriana, Avinguda de Londres, vacant lot in residential area, 30.8.2023, *F. Verloove*; Villarreal, rough ground near to the railway station, 30.08.2023, *F. Verloove*; Castellón de la Plana, Riu Sec, dried-out riverbed, 1.9.2023, *F. Verloove*; Benicasim, Barranc de Farja, dried-out riverbed, 1.9.2023, *F. Verloove*; Castellón de la Plana, Carrer del Riu Sena and Carrer del Riu Nerbion, vacant lots in residential area, several dozens, 2.9.2023, *F. Verloove*; La Vall d'Uixó, Riu de la Font de San Josep, dried-out riverbed, 10.9.2023, *F. Verloove*.

This ornamental tree is much planted in urban settings in the study area. It abundantly reproduces from seeds and is escaping wherever planted. In northeastern Spain, it was not yet known from the Castellón province (Gómez-Bellver 2023). It is, however, like in the surrounding provinces, in the process of naturalization. During our recent fieldwork escaped individuals were recorded in, among others, Benicasim, Burriana, Castellón de la

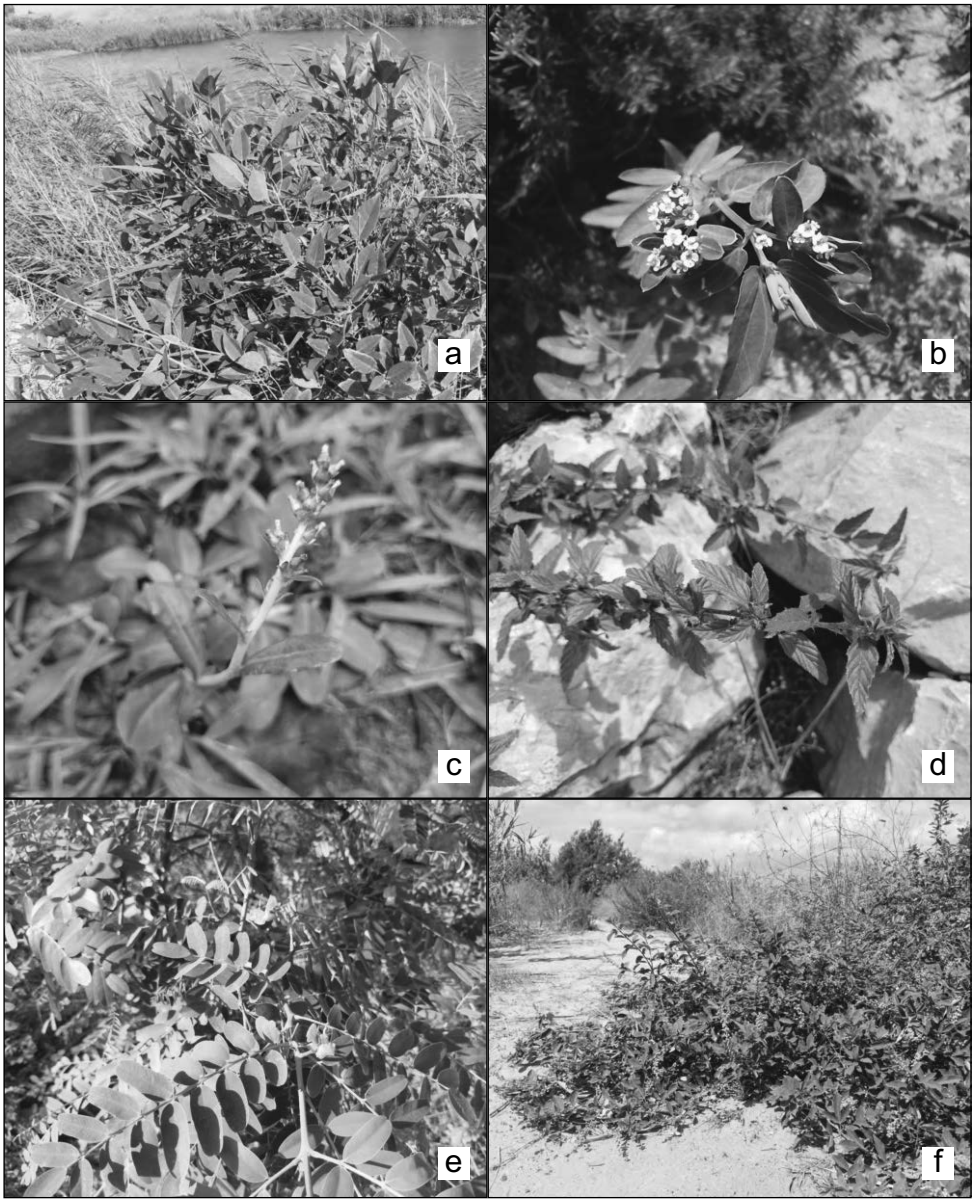


Fig. 4. a) *Erythrina crista-galli*, escaped on the banks of the Carraixet river in Alboraya in September 2023 (F. Verloove); b) *Euphorbia hypericifolia* in Castellón de la Plana in September 2023 (F. Verloove); c) *Gamochaeta coarctata* in Castellón de la Plana in September 2023 (F. Verloove); d) *Malvastrum coromandelianum* in Oropesa del Mar in September 2023 (F. Verloove); e) *Tipuana tipu* in Castellón de la Plana (Riu Sec) in September 2023 (F. Verloove). In this dried-out riverbed escaped individuals are not rare and some of them reached the flowering and fruiting stage, indicating an incipient naturalization process; f) Escaped flowering and fruiting individual of *Vitex trifolia* near the beach in Castellón de la Plana in September 2023 (F. Verloove).

Plana, La Vall d'Uixó and Villareal. It was most often observed on rough ground (vacant lots) in residential areas and in dried-out riverbeds. In the latter type of habitat, for instance in the Riu Sec in Castellón de la Plana, seemingly naturalized populations with flowering and fruit-bearing individuals were seen. Interestingly, the escape of this species in the Riu Sec riverbed in Castellón was already observed in 2019 by one of the authors (DGO).

Verbena officinalis var. ***africana*** (R.Fern. & Verdc.) Munir (*Verbenaceae*)
New to the provinces of Castellón and Valencia (and probably Spain as well).
Local status: naturalized weed (or native?).
Origin of variety: western Mediterranean area (Morocco), East Africa, Australia.
Herbarium specimens: Villareal, Riu Millars at N-340, dried out riverbed, 02.09.2023, *F. Verloove 14891* (BR0000027058558V).
Observations (for details, also see the herbarium label): Villareal, Riu Millars, dried-out riverbed, 2 and 3.9.2023, *F. Verloove*; Valencia, Tavernes Blanques, Barranc de Carraixet, dried-out riverbed, 6.9.2023, *F. Verloove*.

The infraspecific variability of *Verbena officinalis* in the Iberian Peninsula was not discussed by Pujadas & Plaza (2010). Nonetheless, on the basis of leaf morphology two more or less distinct varieties can be distinguished. Plants with deeply divided leaves with acute to serrate lobes and floral bracts that are usually at least half as long as the calyx are referable to *V. officinalis* var. *africana*. In the nominal variety leaves are merely lobed with obtuse lobes and floral bracts tend to be shorter (Fernandes & Verdcourt 1989, Munir 2002, O'Leary & al. 2010). According to Michael (1997) such plants are best treated as a distinct species, *V. africana* (R. Fern. & Verdc.) P.W. Michael.

In dried-out gravelly riverbeds in Villareal and Valencia populations of *Verbena officinalis* were observed that correspond in all details with var. *africana*. It is unclear, however, whether this is an overlooked native variety or a naturalized alien taxon.

Vitex trifolia L. (*Lamiaceae*) (Fig. 4f)
New to the province of Castellón.
Local status: casual escaped ornamental.
Origin: East Africa (southern Somalia to Mozambique), South Asia and Pacific.
Herbarium specimens: Castellón de la Plana, Riu Sec near the beach, sandy ruderal riverbank, a single shrub, 2.9.2023, *F. Verloove 14880* (BR0000027058503V).

This species is rarely grown as an ornamental shrub in Spain (it is not mentioned for instance by Sánchez de Lorenzo Cáceres 2023). Yet, it was reported as an escape from cultivation in 2013 and 2015 in Alboraya, at the estuary of the Carraixet river (Ferrer-Gallego & al. 2016). In 2024 it turned out that the growing area had recently been destroyed after major works (obs. PPFG).

In similar circumstances, a single flowering and fruiting shrub was recorded in Castellón de la Plana. Like in Alboraya, it belongs to a cultivar called 'Purpurea' with lower leaf surfaces tinged pinkish-purple. No putative parent shrubs were observed in the vicinity.

In the Mediterranean area, *Vitex trifolia* is probably only known from Tunisia where a naturalized population was reported by Hadj Khalifa & El Mokni (2020).

The incipient escape of *Vitex trifolia* should be monitored as the species is an emerging environmental weed in some warm-temperate and subtropical regions (e.g. Cousins & al.

2010, Anderson 2020). However, this usually concerns *V. trifolia* subsp. *litoralis* Steenis, with unifoliolate leaves, which is perhaps better treated as a separate species, *V. rotundifolia* L.f. (Sengun 2017). The latter taxon has recently been recorded as a local invader of beaches in Georgia in the Caucasus (https://observation.org/observation/256889157/).

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Mediterranean plant karyological data – 34

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Mediterranean plant karyological data – 34/1

Contribution to the karyological knowledge of some representatives of the family *Asteraceae* in the Pyrenean flora, II

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: *Adenostyles*, *Carpesium*, *Centaurea*, chromosome number, distribution, *Lapsana*, *Leucanthemopsis*, *Pentanema*, ploidy level, *Senecio*, *Tanacetum*.

Introduction

When studying, as is the case in several current projects, the plants of the Alpine system, with particular emphasis on the Pyrenees, and one of the world's largest plant families, the *Asteraceae* or *Compositae*, acquiring information on chromosome numbers and ploidy levels is crucial. These data are fundamental for understanding the processes undergone by the species constituting the flora in these areas.

Following a paper published in this section last year (Garnatje & al. 2023), the aim of this study is to increase 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 or, in one case, of all the Iberian Peninsula.

To verify previous or complementary counts, we have consulted the Chromosome counts database (https://taux.evolseq.net/CCDB_web/about, 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), and the Chromosome database of the flora of the Catalan Countries (https://sites.google.com/view/cromocat/home?authuser=0, Simon & al. 2023). We checked all these databases on 22 November 2024.

All plants studied have been collected in the Catalan Pyrenees (Iberian Peninsula). Vouchers have been deposited in the herbarium BC, of the Botànical Institute of Barcelona. The information provided about their taxonomic status and general distribution area has been obtained in all cases from Plants of the World Online (POWO, https://powo.science.kew.org, accessed November 22, 2024) and Flora iberica (Devesa & al. 2014; Talavera & al. 2016; Benedí & al. 2019).

2032. ***Adenostyles alliariae*** (Gouan) Kern subsp. ***allariae*** — 2*n* = 2x = 38+1B (Fig. 1A).

Hs: Catalonia, Setcases, camí del refugi d'Ulldeter, alt. 2196 m, 42° 25' 11" N, 2° 15' 31" E, 19 Jul 2023, leg. *T. Garnatje (GR 823), P. Fernández & C. Atienza* (BC).

It is a perennial plant growing in Europe. In the Pyrenees, it grows between 800 and 2.300(-2.500) m a.s.l. This chromosome number found in a population on the south face of the mountain is in agreement with that of another Pyrenean Catalan population, located on the north face, and for which the presence of a B-chromosome was not reported (Garcia & al. 2013). It is also coincidental with all the other numerous counts performed in this taxon, two of which, from outside the Pyrenees, also indicate one B- chromosome (https://taux.evolseq.net/CCDB_web/home). This represents a diploid level based on a basic number, x = 19, which should be of polyploid origin. Contandriopoulos (1964) reported the same chromosome number for another mountain plant of the genus, *A. alpina* (L.) Bluff & Fingerh.

2033. ***Carpesium cernuum*** L. — 2*n* = 4x = 40 (Fig. 1B).

Hs: Catalonia, Rocabruna, Font de la Vila, alt. 947 m, 42° 20' 07.7" N, 2° 27' 08.5" E., 31 Aug 2023, leg. *T. Garnatje (GR 921b) & O. Hidalgo* (BC).

The range of this species extends from Europe to Japan and Borneo. It grows in the Pyrenees at altitudes of up to 1.000 m a.s.l.

All the counts reported for this species agree with the one here presented, and the number is the same, with very scarce deviations (2*n* = 36, 50, in addition to 40, in *C. abrotanoides* L., in practically all the genus (https://taux.evolseq.net/CCDB_web/ home). Only a putative record of the diploid level has been published for *C. nepalense* Less. (*n* = 10, Hsu 1970). According to the data consulted, this is the first report of the chromosome number of this species in the Pyrenees and in all the Iberian area.

2034. ***Centaurea nigra*** L. subsp. ***nigra*** — 2*n* = 2x = 22 (Fig. 1C).

Hs: Catalonia, Espinavell, pista de Setcases, alt. 1.547 m, 42° 23' 10.0" N, 2° 22' 02.0" E, 31 Aug 2023, leg. *T. Garnatje (GR 920d), O. Hidalgo & J. de Montaigne de Poncins* (BC).

It is a perennial species native from Europe, growing in the Pyrenees between 800 and 1.750(-2.225) m a.s.l.

The discoid capitula, bract morphology, and corolla size confirm the subspecies' status, ruling out a hybrid origin despite frequent crossbreeding with *C. jacea* L., a cohabiting species (Arnelas & al. 2018). Both 2*n* = 22 and 2*n* = 44 have been recorded as the chromosome number of *C. nigra* subsp. *nigra*, in some cases in the same area (Elkington &

Mitlefell 1972; Gardou 1972). This taxon had not received any chromosome count in the studied area to date (https://sites.google.com/view/ cromocat/home).

2035. ***Lapsana communis*** L. subsp. ***communis*** — 2*n* = 2x = 14 (Fig. 1D).

Hs: Catalonia, Llanars. La Bona Font, alt. 1.148 m, 42° 18' 30.3" N, 2° 20' 14.0" E, 17 Aug 2023, leg. *T. Garnatje (GR 884), O. Hidalgo, J. de Montaigne de Poncins & I. Pérez-Lorenzo* (BC).

It is an annual species native to Macaronesia, and to Europe, to Siberia and Iran. Only the typical subspecies is present in the Pyrenees up to 2.170 m a.s.l.

Three chromosome numbers have been reported for this taxon. In only one case, 2*n* = 12 (Pak & Bremer 1995), and in much more numerous cases, 2*n* = 14 and 2*n* = 16 (https://taux.evolseq.net/CCDB_web/home). The counts on Iberian material are divergent, with 2*n* = 16 (Luque & Díaz Lifante 1991), and *n* = 7 (Mejías 1986) and 2*n* = 14 (Fernandes & Queirós 1971), which could be added to 2*n* = 14 recorded in Southern France (Van Loon & al. 1971), all the latter ones agreeing with the present record. No reports from the studied area were available to date (https://sites.google.com/view/cromocat/home).

2036. ***Leucanthemopsis alpina*** (L.) Heywood subsp. ***alpina*** — 2*n* = 4x = 36 (Fig. 1E).

Hs: Catalonia, Setcases, camí del Costabona, alt. 2.215 m, 42° 24' 44.4" N, 2° 20' 31.3" E, 24 Aug 2023, leg. *T. Garnatje (GR 911) & J. Luque* (BC).

It is a perennial species growing in the alpine meadows of European's mountains. In the Pyrenees, it reaches 3.300 m a.s.l.

The material studied closely resembles the subspecies *alpina* (Tomasello & Oberprieler 2017), as the leaves exceed 20 mm and the green part of the involucre bracts shows some hairiness. However, the number of leaf segments range from 4 to 7, with noticeable hirsute leaves. A detailed analysis using nuclear markers is needed to determine if this accession represents a transition between *alpina* and *minima* subspecies, given the population's location in their contact zone.

Diploid, tetraploid and exaploidy levels (2*n* = 18, 36 and 54, respectively) have been detected in this taxon, (https://taux.evolseq.net/CCDB_web/home). According to Tomasello & Oberprieler (2017), diploid representatives of *L. alpina* are found in the western Alps, Corsica, the Carpathians, and the area surrounding the Dolomites. Tetraploids are present throughout the species range, except in Corsica and the Carpathians. In the western Alps, where the species is restricted to the Pennine and Cottian Alps, the tetraploid cytotype is almost entirely replaced by diploids. Hexaploids, meanwhile, are exclusively found in two populations within the Maladeta massif in the central Pyrenees.

2037. ***Pentanema squarrosum*** (L.) D.Gut.Larr., Santos-Vicente, Anderb., E.Rico & M.M.Mart.Ort. (syn.: *Inula conyza* DC.) — 2*n* = 4x = 32 (Fig. 1F).

Hs: Setcases, camí de Tregurà, alt. 1.298 m, 42° 22’ 18.7” N, 2° 17’ 48.8” E, 31 Aug 2023, leg. *T. Garnatje (GR 920b) & O. Hidalgo* (BC).

It is a biennial or perennial species. The native range of this species is Europe to Iran. In the Pyrenees it can be found up to 1.650 m a.s.l.

The present count, the first one in a Pyrenean population (https://sites.google.com/view/cromocat/home). agrees with all those recorded for this taxon, in many areas including the Iberian Peninsula (https://taux.evolseq.net/CCDB_web/home). This indicates a tetraploid level, with an x = 8-based chromosome number, as *Inula montana* L. (2*n* = 16, Löve & Kjellqvist 1974), as an example among others in the genus from which *Pentanema* was segregated and also present in the Pyrenees. Conversely, other *Pentanema* species, such as *P. indicum* (L.) Ling and *P. vestitum* (Wall.) Ling, exhibit x = 9-based chromosome numbers (Gupta & Gill 1989; Rajalakshmi & Jose 2002).

2038. *Senecio pyrenaicus* L. — 2*n* = 4x = 40 (Fig. 1G).

Hs: Setcases, Coll de la Marrana, alt. 2.375 m, 42° 25’ 12.8” N, 2°14’58.4” E, 18 Aug 2023, leg. *T. Garnatje (GR 891), O. Hidalgo, J. de Montaigne de Poncins & I. Pérez-Lorenzo* (BC).

It is a perennial species. The native range of this species is restricted to the Pyrenees and other mountain systems of the Iberian Peninsula, between 1.000 and 3.200 m a.s.l.

This count agrees with all those available for this species (https://taux.evolseq.net/CCDB_web/home). Favarger & Küpfer (1968) studied a population located in the Northern Pyrenean face (quoted as *Senecio tournefortii* Lap.), and the present one is the first report from the studied area, in the Southern face (https://sites.google.com/view/cromocat/home).

2039. *Tanacetum parthenium* (L.) Sch.Bip. — 2*n* = 2x = 18 (Fig. 1H).

Hs: Catalonia, Llanars, Espinalba, alt. 1134 m, 42° 18’ 34.9” N, 2° 20’ 14.7” E, 16 Jul 2023, leg. *T. Garnatje (GR 822), O. Hidalgo, J. de Montaigne de Poncins & L. Palazzesi* (BC).

It is a biennial or perennial species. The native range of this species is South Eastern Europe to Western Himalayas. In the Pyrenees it can be found exceptionally up to 2600 m a.s.l.

Most previous counts on this species coincide with the present count, the first one in the Pyrenean area, indicating a diploid level (https://sites.google.com/view/cromocat/home; https://taux.evolseq.net/ CCDB_web/home), whereas a few records suggest an also x = 9-based tetraploid one (2*n* = 36, Zhmyleva & Kondo 2006). It is worth mentioning that one report of a putative x = 8-based triploid level has been published (2*n* = 24, Davlianidze 1985).

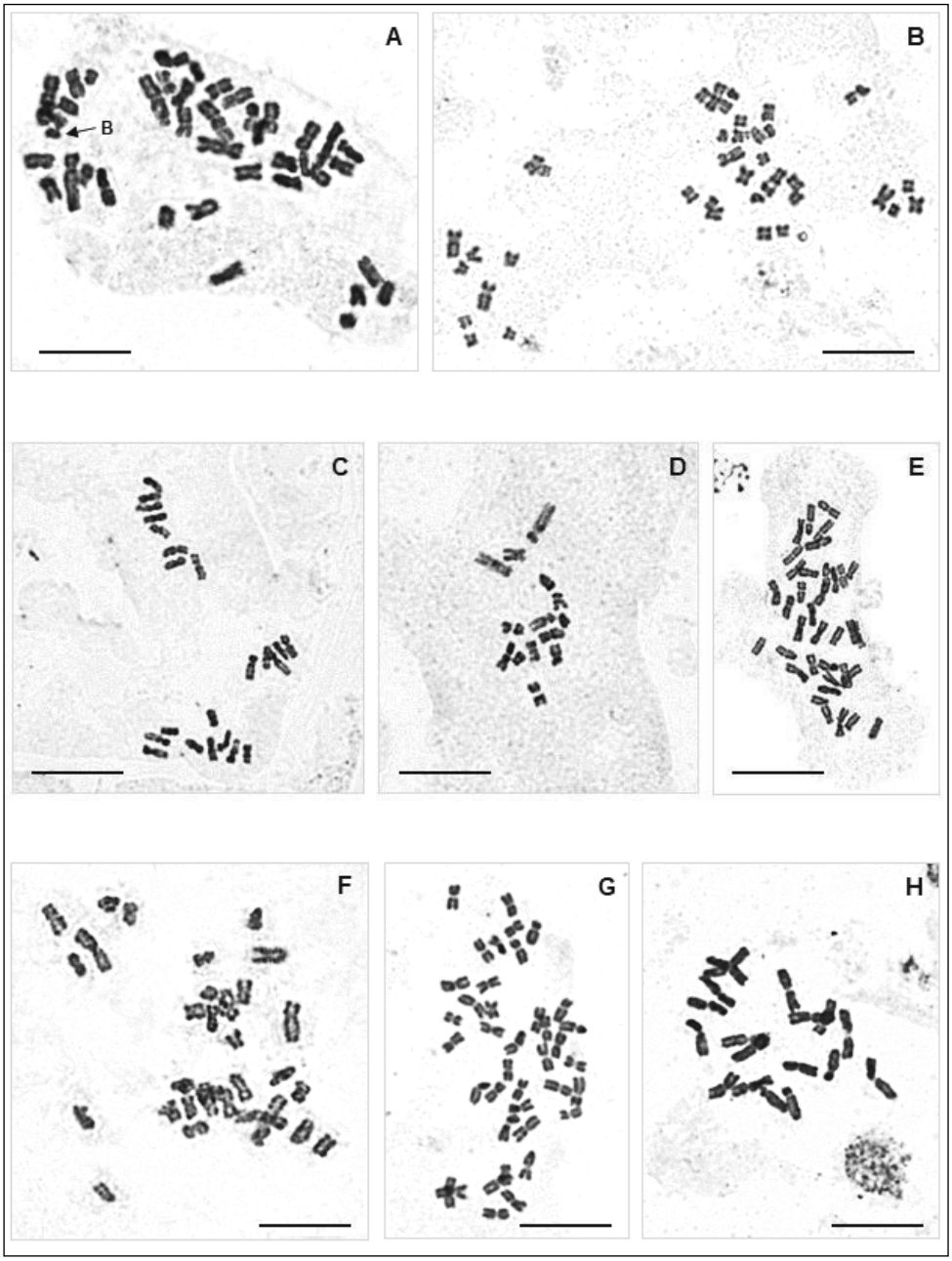


Fig. 1. Mitotic metaphase chromosome plates: **A,** *Adenostyles alliariae*, 2*n* = 38+1B; **B**, *Carpesium cernuum*, 2*n* = 40; **C,** *Centaurea nigra* subsp. *nigra*, 2*n* = 22; **D,** *Lapsana communis* subsp. *communis*, 2*n* = 14; **E,** *Leucanthemopsis alpina* subsp. *alpina* 2*n* = 36; **F,** *Pentanema squarrosum*, 2*n* = 32; **G,** *Senecio pyrenaicus*, 2*n* = 40; **H,** *Tanacetum parthenium*, 2*n* = 18. – Arrow indicates the B-chromosome; Scale bars = 10 μm.

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Mediterranean plant karyological data – 34/2

Contribution to the karyological knowledge of some geophytes from Sicily

G. Barone, E. Di Gristina & G. Domina

Abstract
Chromosome numbers, ploidy level, distribution, localities, and selected prior chromosome counts are detailed for six taxa collected in Sicily belonging to the *Amaryllidaceae*, *Asparagaceae* and *Liliaceae*.

Keywords: Chromosome number, *Muscari*, *Narcissus*, *Oncostema*, *Tulipa*, distribution, ploidy level.

Introduction

In the context of ongoing floristic and taxonomic investigations in Sicily, obtaining data on chromosome numbers and ploidy levels is essential for understanding the processes influencing the region's flora. Often, information on geophytes is derived from plants of unknown origin cultivated in botanical gardens. This study aims to enhance existing cytogenetic datasets by providing new data on chromosome numbers and ploidy levels, from plants collected in the wild with verified provenance and cultivated in the greenhouses of the Faculty of Agriculture, Food and Forest Sciences of the University of Palermo. All specimens analysed were collected in Sicily, Italy. Distribution data for these species were obtained from Plants of the World Online (POWO 2024).

2040. *Muscari commutatum* Guss. **—** 2*n* = 2x = 18 (Fig. 1a).

Si: Baia del Corallo, Sferracavallo (PA), 38°12'6.55" N 13°16'3.75" E, 20 m a.s.l., 14 March 2022, *G. Domina s.n.* (SAF100150).

Muscari commutatum Guss. (*Asparagaceae*) is a bulbous geophyte whose native distribution includes Italy, Sicily, the Balkans, the E-Aegean islands and Kriti (POWO 2024).

Comprehensive reports on the chromosome numbers known in *M. commutatum* are in Garbari (1968) and Karlén (1985). The basal chromosome number of *Muscari* is x = 9 (Karlén 1985) and the main chromosome number for *M. commutatum* is 2*n* = 2x = 18 (Garbari 1968; Karlén 1985). However, Karlén (1985) reports for two Greek populations from the Samos island also the triploid number 2*n* = 27, specifying that those triploids were unusually large with flowers 1-1/2 times the normal size. The number 2*n* = 45 counted by Delaunay (1927) must be regarded as dubious since this has not been confirmed by later authors (Karlén 1985).

The chromosome number 2*n* = 2x = 18 (Fig. 1a), found here on material from Segesta (Trapani Province, NW-Sicily) coincides with the diploid number of the species.

2041. ***Narcissus obsoletus*** (Haw.) Steud. — 2*n* = 2x = 20 and 2*n* = 3x = 30 (Fig. 1b, 1c).

Si: Mt. Cofano, 38° 6' 23" N, 12° 41' 12" E, 15 m a.s.l., 15 October 2023, *G. Domina & E. Di Gristina s.n.* (SAF100151).

Narcissus obsoletus (Haw.) Steud. (*Amaryllidaceae*) is a bulbous geophyte with a native range extending from Spain and Baleares, N-Africa, to Turkey and Israel and (POWO 2024, Euro+Med PlantBase 2024). It belongs to the subgenus *Hermione* (Haw.) Spach. and is an example of speciation by allopolyploidy, a frequent process in perennial herbs and which is particularly common in the Mediterranean area (Thompson 2005). According to Diaz Lifante & al. (2009) *N. obsoletus* represents an evolutionary link between *Narcissus* sect. *Hermione* and *Narcissus* sect. *Serotini* Parl.

The basal chromosome number of *Narcissus* subgenus *Hermione* is x = 10, 11 (Brandham & Kirton 1987). Two chromosome numbers were found in the same site of Mt. Cofano (Trapani Province, NW-Sicily) from bulbs of morphologically identical plants: 2*n* = 2x = 20 and 2*n* = 3x = 30 (Fig. 1b, 1c). Diaz Lifante & al. (2009) report for *N. serotinus* L. s.l. the counts of 2*n* =10, 20 and 30 published by different authors (e.g. Fernandes 1968; Garbari & al. 1973; Phitos & Kamari 1974) and distinguishes *N. obsoletus* (2*n* = 30) from *N. elegans* (2*n* = 20). On this basis Troìa & al. (2013) attribute 2*n* = 20 to *N. elegans* and 2*n* = 30 to *N. obsoletus* both collected in C.da Critazzo (Mazara del Vallo, TP).

2042. ***Narcissus tazetta*** subsp. ***italicus*** (Ker Gawl.) Baker — 2*n* = 2x = 22 (Fig. 1d).

Si: Lipari southern part of the island, 38° 26' 57" N, 14° 57' 2" E, 185 m a.s.l.,19 April 2022, *G. Domina & G. Barone s.n.* (PAL).

Narcissus tazetta subsp. *italicus* (Ker Gawl.) Baker (*Amaryllidaceae*) is a bulbous geophyte native to France, Corse, Italy, Sicily, Balkan Peninsula and Kriti (POWO 2024). In the past this taxon was considered as a hybrid between *N. tazetta* L. and *N. papyraceus* Ker. or *N. bertolonii* Parl. or *N. broussonetii* Lag. (Maugini 1953; Park & al. 2023). This taxon is known to us from meadows near the sea and presents much higher plants than *N. tazetta* subsp. *tazetta* which grows in the pastures of the interior.

This material was collected in Lipari (Aeolian Islands, Messina Province, NE-Sicily) in 2022 during the excursion of the group for Floristics, Systematics and Evolution of the Italian Botanical Society but the identification remained at the species level (Barone & al. 2023) because the individuals were in fruit at the time of collection. The bulbs were cultivated and the plants in flower were identified, the next year, as *N. tazetta* susbp. *italicus***.**

The chromosome number 2*n* = 2x = 22 (Fig. 1d) found here) agrees with the chromosome counts reported by Maugini (1953) from plants grown in pots in the Botanical Garden of Florence.

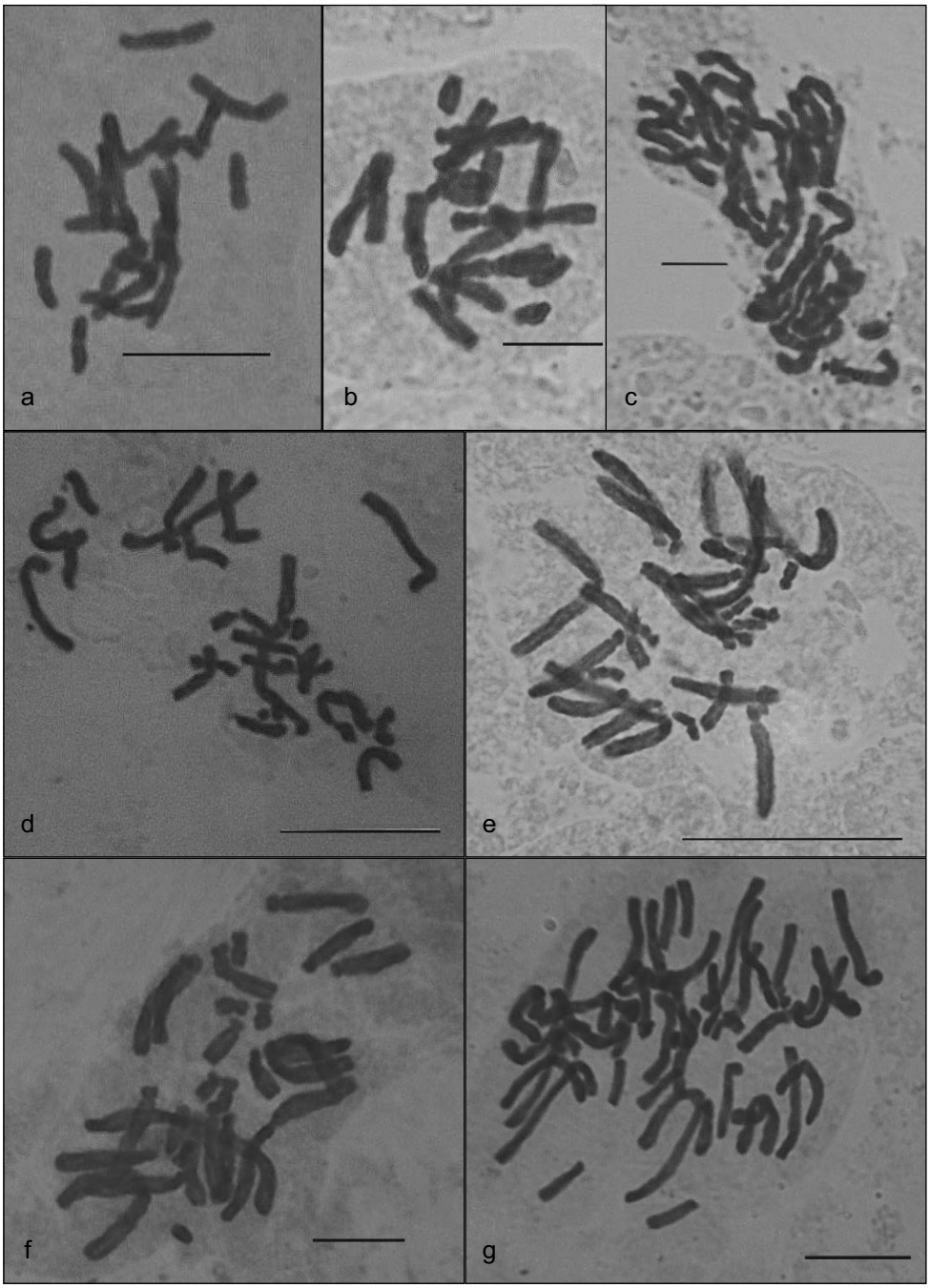


Fig. 1. Microphotographs of mitotic metaphase plates of: **a**, *Muscari commutatum*, 2*n* = 18; **b**, *Narcissus obsoletus*, 2*n* = 20; **c**, *N. obsoletus*, 2*n* = 30; **d**, *N. tazzetta* subsp. *italicus*, 2*n* = 22; **e**, *Oncostema dimartinoi*, 2*n* = 28; **f**, *O. siculum*, 2*n* = 28; **g**, *Tulipa raddii*, 2*n* = 36. – Scale bars = 10 μm.

2043. *Oncostema dimartinoi* (Brullo & Pavone) F. Conti & Soldano — $2n = 4x = 28$ (Fig. 1e).

Si: Lampedusa, Vallone dell'Acqua, 20 April 2017, *G. Domina s.n.* (SAF100152).

Oncostema dimartinoi (Brullo & Pavone) F. Conti & Soldano (*Asparagaceae*) is a bulbous geophyte endemic to Lampedusa (Pelagie Islands, Sicily) (POWO 2024). At present, its conservation status is Endagered (EN) but the increase in tourism over the years is a serious threat to the protection of the species (Di Gristina & al. 2022).

The basal chromosome number in the genus *Oncostema* is x = 7, 8, with diploid and tetraploid populations (Brullo & al. 2007). The chromosome number $2n = 4x = 28$ (Fig. 1e) found here on material from Vallone dell'Acqua (West side of Lampedusa, Agrigento Province) coincides with the number reported by Brullo & al. (1987) from Capo Grecale (East side of Lampedusa), the *locus classicus* of the species.

2044. *Oncostema siculum* (Tineo) Speta — $2n = 4x = 28$ (Fig. 1f).

Si: Mt. Formaggio (CL), 38° 26' 57" N, 14° 57' 3" E, 370 m a.s.l., 4 May 2023, *G. Domina & B. Di Gregorio s.n.* (SAF100153)

Oncostema siculum (Tineo) Speta (*Asparagaceae*) is a subendemic bulbous geophyte occurring in Sicily, Calabria, Basilicata and Malta (POWO 2024; Bartolucci & al. 2024). In Sicily the species grows in several scattered localities of NW and SE of the island (Mazzola & al. 2012).

The karyological data known in literature for this species concern material usually cultivated in Botanical Gardens and of not always documented origin (Bartolo & al. 1979; Ferrarella 1988).

The chromosome number $2n = 4x = 28$ (Fig. 1f) found here on material from Mt. Formaggio (Caltanissetta Province, C-Sicily) is included in the variability ($2n = 28$, $2n = 29$) reported for this species (Bartolo & al. 1979; Ferrarella 1988) and confirms the taxonomic independence of this taxon from the other *Oncostema* species belonging to this group which, instead, present $2n = 16$ (see e.g. Barone & al. 2021; Nassar & al. 2024)

2045. *Tulipa raddii* Reboul — $2n = 3x = 36$ (Fig. 1g).

Si: Castronovo di Sicilia (PA), 37°42'12.9" N 13°36'29.3" E, 735 m a.s.l., 14 April 2022, *G. Barone s.n.* (SAF100154).

Tulipa raddii Reboul (*Liliaceae*) is a bulbous geophyte whose native range extends from the E-Mediterranean to Jordan (POWO 2024). Due to its beauty and the precocity of the flowering (hence the common name 'Early Tulip'), the species has been introduced in much of southern Europe, including Italy, where it has also become naturalized (Spadaro & Raimondo 2001; Galasso & al. 2024).

The basal chromosome number in *Tulipa* is x = 12 and diploid, tetraploid, and hexaploid varieties and species occur (Newton 1926). The chromosome number $2n = 3x = 36$ (Fig. 1g) found here on material from Castronovo di Sicilia (Palermo Province, C-Sicily) agrees with the triploid number reported by Blakey & Vosa (1982) on cultivated material (sub *T. praecox* Ten.), but does not agree with the diploid number ($2n = 2x = 24$) reported by Bambacioni Mezzetti from Montughi (Florence Province, NC-Italy).

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Mediterranean plant karyological data – 34/3

Karyological study of selected Iridaceae taxa from Greece

P. Bareka, A. Tiniakou, E. Kriemadi, D. Phitos & G. Kamari

Abstract

The karyological diversity of the *Iridaceae* family provides critical insights into its systematics and evolutionary patterns, encompassing variations in chromosome numbers, ploidy levels, and karyotype morphology. This study documents the chromosomal data of five taxa within the Iridaceae, focusing on populations in Greece. The chromosome numbers and karyotypes are presented with accompanying microphotographs of metaphase plates, contributing to the ongoing updates of the PhytoKaryon database.

Keywords: Chromosome number, distribution, *Iris*, karyomorphology, *Moraea*, PhytoKaryon.

Introduction

The karyology of the *Iridaceae* exhibits remarkable diversity, playing a crucial role in understanding its systematics and evolutionary patterns. Basic chromosome numbers, ploidy levels, and karyotype morphology vary widely across the family (Goldblatt 1990, 1991). Ancestral chromosome numbers have been identified for many genera and significant chromosomal variations, including polyploidy and Robertsonian translocations, are revealed. Chromosomal variation patterns within and among closely related genera are becoming increasingly well-defined and understood (Goldblatt & Takei 2013).

In the process of updating the PhytoKaryon database (Kamari & al. 2017-onwards), focused on documenting the chromosomal diversity of Greek flora, populations of five *Iridaceae* taxa were studied providing chromosome numbers and karyotypes, complemented by microphotographs of metaphase plates.

2046. *Iris attica* Boiss. & Heldr. — $2n = 2x = 16$ (Fig. 1A).

Gr: Evvia island (WAe), Mount Prasino, northern slopes, south of the village of Prasino, 38° 20’ 45” N, 24° 05’ 35” E, leg. *Bareka & Kriemadi E54* (AUA).

Iris attica is a species native to Greece, North Macedonia and Turkey (POWO 2024), usually found on rocky limestones. The flowers of this species exhibit a variety of colours, ranging from yellow to bluish-purple, with both colours frequently appearing within the same population. Previously referred to as *Iris pumila* subsp. *attica* (Boiss. & Heldr.)

K.Richt., the name *Iris attica* has been reinstated following the recent typification of certain *Iris* species (Boltenkov & al. 2021).

The chromosome number of $2n = 16$, has already been given in previous studies by Simonet (1932), Mitra (1956), Randolph & Mitra (1959), Lovka & al. (1971), Sauer & Leep (1979), Sauer & Stegmeier (1979), van Loon & Oudemans (1981) and Kriemadi & Bareka (2022). At least two chromosome pairs bear small spherical satellites. The karyotype formula is given as $2n = 2x = 2m/sm + 10st/t + 4st/t\text{-}SAT= 16$ chromosomes, in accordance with the karyotype morphology given by Kriemadi & Bareka (2022). Chromosome size varies from 9.17 to 5.01 μm.

2047. *Moraea sisyrinchium* (L.) Ker Gawl. — $2n = 4x = 24$ (Fig. 1B).

Gr: Kriti island (KK), Nomos Hanion, Prov. Kissamos, Falasarna village, 35° 30’ 00” N, 23° 34’ 46” E, alt. 15 m, 18 Apr 2022, leg. *E. Kriemadi & S. Athanasiou E36* (AUA).

The genus *Moraea* Mill., primarily native to South Africa, comprises of approximately 220 species, and has been extensively studied due to its remarkable variation in chromosome numbers and karyotype morphology, which closely correlate with its morphological diversity. Several related genera, including *Barnardiella* Goldblatt, *Galaxia* Thunb., *Gynandriris* Parl., *Hexaglottis* Vent., *Homeria* Vent., and *Roggeveldia* Goldblatt were synonymized with *Moraea* based on inferred morphological and, in some cases, cytological synapomorphies within specific species groups (Goldblatt 1998; Goldblatt & Manning 2013).

Moraea sisyrinchium is a common tuberous geophyte found in the Mediterranean region, extending eastwards to the Arabian Peninsula and the western Himalayas (POWO 2024). It grows in mediterranean phrygana and olive groves at altitudes ranging from 0 to 600 m.

Polyploidy is common in *Moraea* and contributes to both disploidy and recent speciation (Goldblatt & Manning 2013). Goldblatt (1980) reported tetraploid karyotypes of the two *Moraea* species found in Greece (*M. sisyrinchium* and *M. mediterranea*) with $2n = 4x = 24$ chromosomes in populations from Attiki, based on a basic chromosome number of $x = 6$. The same chromosome number was reported for *M. mediterranea* by Bareka & al. (2018) in material from the Ionian Islands. This chromosome number has also been reported for *M. sisyrinchium* by Ruiz-Rejon (1974) (under *Iris sisyrinvhium* L.) and by Goldblatt (1980), Queiros (1980), Perez & Pastor (1994) and Snogerup (1995) (under *Gynandriris sisyrinchium* (L.) Parl.). Additionally, for *Gynandriris sisyrinchium*, Montmollin (1986) reported an octaploid population with $2n = 8x = 48$ chromosomes from Kriti (Greece), while Vogt & Aparicio (1991) reported a decaploid population with $2n = 10x = 60$ chromosomes from Cyprus.

The karyotype described here is tetraploid ($2n = 4x = 24$) consisting of four metacentric (m) chromosomes which are the largest in size, while the remaining chromosomes are submetacentric (sm) and acrocentric (st). The chromosome size ranges from 11.46 to 4.58 μm.

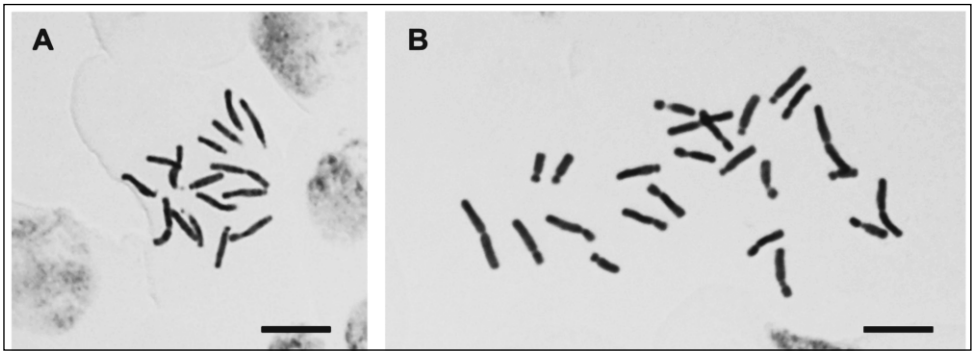


Fig. 1. Microphotographs of mitotic metaphase plates of: **A,** *Iris attica*, 2*n* = 2x = 16; **B,** *Moraea sisyrinchium* 2*n* = 4x = 24. – Scale bars = 10 μm.

Iris unguicularis Poir.

Iris unguicularis is a Mediterranean species found in rocky areas, riverbanks, hillsides, dry scrublands, or open coniferous woodlands. It is divided into five subspecies (POWO 2024). The typical subspecies is found in Northwest Africa (Morocco, Algeria, Tunisia), while the remaining subspecies are distributed across the eastern Mediterranean. *I. unguicularis* subsp. *carica* (Wern. Schulze) A. P. Davis & Jury is distributed in the East Aegen Islands and Turkey. *I. unguicularis* subsp. *syriaca* (Wern. Schulze) Güner it is occurred in Lebanon-Syria and Turkey, while the remaining two, e.g. subsp. *angustifolia* (Boiss. & Heldr.) Greuter and subsp. *cretensis* (Janka) A. P. Davis & Jury, are endemic to Greece.

Flowering from December to April (and sometimes later), all three taxa found in Greece grow in both phrygana and maquis vegetation and occupy a wide range of habitat types. They show a preference for limestone and neogene substrates (calcarenite, sand, silt, and marl), but can also grow on other rock types, such as flysch and schist, and occasionally on serpentine or acidic volcanic rocks. Despite their ability to grow on relatively poor soils, they are most commonly found in habitats with significant deposits of mixed clayey, silty, and sandy materials formed from the weathering of limestone and neogene geological formations.

Variation of chromosome number within *I. unguicularis* is known (Simonet 1928a & b, 1932, 1934, 1952; Sakai 1952; Schulze 1965; Sharma 1970) and previous counts from various authors are summarized by Davis & Jury (1990), most from unknown localities. The chromosome number 2*n* = 32 for *I. lazica* has also been found by the above authors who also reported 2*n* = 50 for *I. unguicularis* plants from Algeria and 2*n* = 40 from Parnassos and from Kriti. Older records for *I. unguicularis* variants with 2*n* = 38, 40 and 48/50, suggest the basic number for this group is x = 8 or 10 (Davis & Jury 1990).

2048. *Iris unguicularis* subsp. ***angustifolia*** (Boiss. & Heldr.) Greuter — 2*n* = 38 (Fig. 2A).

Gr: Peloponnisos (Pe), Nomos Arkadias, propre pagum Toubitsi, 37° 42’ 25” N, 21° 52’ 28.7” E, 29 Mar 1992, *leg. A. Tiniakou 1566* (UPA).

The material from Peloponnisos analyzed in this study exhibited a chromosome number of 2*n* = 38. Most chromosomes are submetacentric (sm), with some acrocentric (st) and metacentric (m) ones, and their sizes range from 1.30 to 3.65 μm. A different chromosome number, 2*n* = 40, has been reported for this taxon from Mt. Parnassos (Davis & Jury 1990).

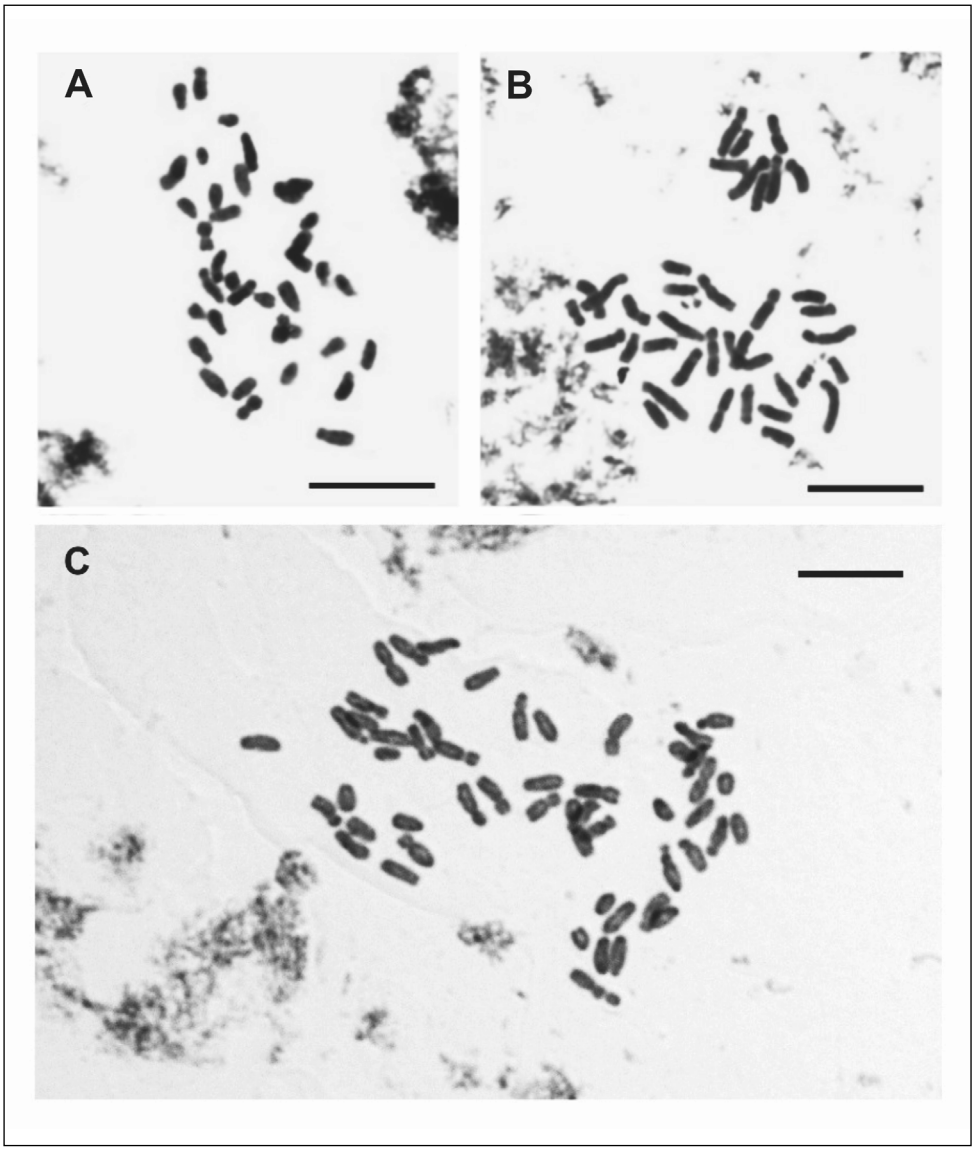


Fig. 2. Microphotographs of mitotic metaphase plates of *Iris unguicularis*: **A,** subsp. *angustifolia*, 2*n* = 38; **B.** subsp. *carica*, 2*n* = 38; **C,** subsp. *cretensis*, 2*n* = 52. – Scale bars = 10 μm.

2049. *Iris unguicularis* subsp. ***carica*** (Wern. Schulze) A. P. Davis & Jury — 2*n* = 38 (Fig. 2B).

Gr: Nomos Dodekanisou (EAe), Rodos island, city of Rodos, at a place called Rodini, 36° 25' 36,8" N, 28° 13' 15.8" E, alt. 1.100 m, 24 Mar 1991, *leg. A. Tiniakou 2184* (UPA).

Iris unguicularis subsp. *carica* is primarily distributed in Turkey, with its presence in Greece limited to the islands of Rodos and Kos (and possibly Kastellorizo). The population of subsp. *carica* studied from Rodos island exhibited a chromosome number of 2*n* = 38. Most chromosomes are submetacentric (sm), ranging in size from 2.43 to 4.87 μm, with one pair showing a satellite on the short arm. The heterochromatin regions observed in these karyotypes, along with secondary bands, render the chromosomes fragile. This fragility may partly explain the varying chromosome numbers reported for this group.

2050. *Iris unguicularis* subsp. ***cretensis*** (Janka) A. P. Davis & Jury — 2*n* = 52 (Fig. 2C).

Gr: Kriti (KK), Nomos Lasithiou, municipality of Agios Nikolaos, (municipal division of Kritsa), Katharo platau, 35° 09' 04.8" N, 25° 32' 57.0" E, alt. 1.100 m, 18 Apr 2022, *leg. E. Kriemadi & G. Afordakos E39* (AUA).

The population studied for this Greek endemic subspecies revealed the chromosome number 2*n* = 52. Other known counts for this taxon are 2*n* = 40 (Davis & Jury 1990) from two populations of Mt. Dikti (Kriti island), and 2*n* = 24 (Sz.-Borsos 1971) from an unknown location.

The karyotype is symmetrical consisting mostly of submetacentric (sm) and acrocentric (st) chromosomes. Two chromosome pairs bear distinct large satellites on their short arms, which are often detached due to the squashing technique, occasionally creating the impression that the chromosome number is 54 instead of 52. The size of the chromosomes ranges from 5.02 to 2.19 μm.

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Obituary

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Benito Valdés & Werner Greuter

To the memory of Vernon Hilton Heywood

The texts of the two lectures given at the beginning of Symposium 10 of the XVII OPTIMA Meeting (Palermo-Erice, September 20-24, 2023), dedicated to the memory of V. H. Heywwod, are included below.

Benito Valdés

Professor Vernon Hilton Heywood. The scientist, the teacher, the person. The influences of Spain

Abstract

Valdés, B.: Professor Vernon Hilton Heywood. The scientist, the teacher, the person. The influences of Spain. — Fl. Medit. 34: 379-394. 2024. — ISSN: 1120-4052 printed, 2240-4538 online.

Vernon Hilton Heywood was an eminent botanist who had been active for many years on several fields of plant sciences. He was born on the 24 December 1927 at Edinburgh and died on 17 September 2022 at Reading, shortly before reaching the age of 94. This memoir is dedicated to remember his activity as scientist and teacher and highlight his personality. Special attention is paid to the first decade of his professional and personal activity, little known to conservationists and even to most botanists.

Key words: Heywood, Flora of Spain, Cazorla, Flora Europaea.

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Introduction

In September 19, 2022, all OPTIMA members received a communication from our President, Prof. Francesco Maria Raimondo with the sad news of the death of Prof. Vernon

Hilton Heywood, a member of the International and Executive Councils of our Organization. In fact, the Secretary of OPTIMA, Prof. Gianniantonio Domina had already sent this new the previous day by an e-mail. Prof. Raimondo communication was translated to French by Dr. Audrey Tocco, the Operational Project Manager of Tela Botanica, and this translation was sent by this network of French-speaking botanists (c. 47,000 in 2020) three days later. Almost simultaneously, in September 29th, Botanic Garden Conservation International (BGCI), of which Prof. Heywood had been the founder and first Director, sent this bad new to all its members, over 800 botanic gardens spread along the five continents.

This is why a few days after its happening, the death of Prof. Heywood was known all around the World, as all around the World his figure as a botanist particularly involved in promoting plant conservation was equally known, as well as his marked personality, his deep knowledge in all aspects of plant sciences, his ability as lecturer, his generosity in the transmission of his knowledge and his easy-going treatment to others, regardless their importance and category.

Prof. Heywood had been defined as "… a life dedicated to plant conservation" (BGCI communication, 20 September 2022), "… the most important botanist for conservation worldwide and a brave defender of the Mediterranean flora (Baccheta & al. 1922), "… the most important and prominent botanist at global level on conservation of endangered wild plants" (CIEF, 29.09.2022), "… the most important of the specialists on plant conservation and one of the taxonomists and popularizers of botanical sciences more actives in the last decades" (Laguna & al. 2023a: 42), etc. And in the modern online encyclopedia, Wikipedia, Prof. Heywood is referred as "British botanist. He specialized in medicinal and aromatic plants".

It is true that for almost half a century Prof. Heywood devoted his activity mainly to those aspects of plant sciences, but we must not forget that from the beginning of his professional career he spent more than three decades practicing and contributing to the development of plant taxonomy and evolution through his research activity and the training on Botany and Taxonomy of hundreds of students. This is why it is more accurate the definition given by Planta Europa (a network of nongovernment and government organization based in Paris) when in 2007, presented Prof. Heywood the Linnaeus Award during the celebration in Cluj-Napoca (Romania) of the V Conference on Conservation of Wild Plants: "Prof. Vernon H. Heywood is an eminent scientist who has been active for many years in the fields of plant classification and evolution and whose efforts are currently focused in the development of strategies for the conservation of plants".

The content of this memoire is dedicated mainly to the first decade of his professional activity, little known to conservationists and even to most botanists, and particularly to his implications in the study of the flora of Spain.

The beginnings

Origins

Vernon Hilton Heywood was borne in Edinburgh on December 24, 1927. His original family name was not Heywood, with the birth certificate showing his registered name as Hilton Vernon Nathan. However, the family name was changed by Deed Poll[1] from Nathan

to Heywood in 1938 on account of the increasingly ominous political situation in Europe at the time (Prof. P. Heywood, pers. comm.).

From 1937 to 1945 he did his secondary studies at George Heriot School, Edinburgh. His vocation was not defined yet, as he initially lined towards Agronomy, as he says himself: "… in fact, I wanted to be a farmer … However, during my studies I stood out in Zoology, and if it hadn´t be for my teachers, that insisted on telling me that I would have to be a botanist …" (Heywood 2000). Following their advice, in 1945 he registered in Edinburgh University to study Botany, to get his title of Bachelor of Sciences in 1949 (Laguna & al. 2023a).

The first expedition to Spain

In 1947 he traveled to Spain for the first time. The circumstances of this travel are given by Heywood in the following terms: "I was studying Botany at the University of Edinburgh with Prof. Sir Williams Wright Smith … at that time I had no particular interest for Spain, but when in 1947 Dr. Paul Giuseppi, a surgeon of Felixstove and renowned specialist in alpine plants contact Sir Williams searching a young student to accompany him on a trip to Spain to collect some rare plants, I was the designated student and I did not lose the opportunity … On June 24, 1947 we left by car to Spain crossing France, together with Herbert Cowley, a known editor of gardening magazines … I was by then 19 years old" (Heywood 2004). This is why, by chance, Heywood visited several Spanish mountain systems, including Cazorla, for the first time (Fig. 1).

Dr. Giuseppi (1881-1947) was an amateur botanist expert on alpine plants, member of the Royal Horticultural Society and from 1945 President of the Alpine Garden Society. He had visited the mountains of Iran (Persia), Russia, Crete, the Balkans and the Iberian Peninsula, particularly the Cantabrian Mountains and Cazorla[2]. "All these excursions were planned in the greatest detail and nothing was left to chance" (Roger-Smith 1948). Besides to be editor of several botanical magazines, Cowley was an amateur botanist who had traveled to the Alps and the Balkan Peninsula in search of plants, was honorary life member of the Alpine Garden Society (Anonymous 2014: 931) and an expert photographer. Most surely the costs of the expedition were covered by Dr. Giuseppi and the destination of the plants, seeds and bulbs collected was his own rocky garden and glasshouse and the gardens of the Royal Horticultural Society at Wisley (Surrey), trying to increase the presence of the Spanish mountain plants in the British gardens, as it is the case of *Viola cazorlensis* Gand., cultivated in England from seeds collected by Dr. Giuseppi in his previous travel to Cazorla and of which "Seed from this year´s collection has now been distributed and we hope to see more of *Viola* in the near future" (Heywood 1948: 262). They failed, though, to introduce *Pinguicula vallisnerifolia* Webb for cultivation, as "A search made for seed later was fruitless, for any seed set must have been dislodged by a hail-storm which broke nearly every window pane in Cazorla. The problem of introducing this giant Butterwort is rather formidable, for the carefully packed sticky ribbons we sent back by air shrivelled into powder." (Heywood, 1948: 261).

[1] A Deed Poll is a type of legal document. Nowadays, the most common use of a Deed Poll is to officially change your name.

[2] By instance, Heywood (1950a: 448) writes: "This is the form [of *Hypericum ericoides*] in general cultivation in Britain – collected by Dr. P.L. Giuseppi in the Sierra de Cazorla"



Fig. 1. Vernon Hilton Heywood in Sierra de Cazorla, during his first expedition to Spain. 1947. Behind, *Pinguicula vallisnerifolia* Webb, endemic to provinces of Jaén, Granada and Albacete, Spain.

There is no doubt that for Heywood, as a beginner, it was a great advantage to benefit from the experience of the two other members of the expedition, particularly of Dr. Giuseppi, and once back to England he prepared a report of the travel which was published in the Journal of the Royal Horticultural Society (Heywood 1948). This is his first publication, which includes an excellent description of the travel, the mountains they visited and the plants which more particularly attracted his attention. It should be the starting point of some of his future botanical publications, including his first taxonomic revision on *Tanacetum* Subsect. *Leucanthemopsis* Giroux (Heywood 1954c), a group he raised later to the category of genus (Heywood 1975), a proposal adopted by botanists since[3]. One of the results of this expedition was the publication by Heywood of a study on *Iris serotimum* Willk., endemic of SE Spain, based on the plants collected (Heywood 1950c)[4].

The feelings this expedition moved in the young Heywood are described by him many years later in the following terms: "My first visit to Spain had ended. Left me an indelible effect and would have incalculable consequences for my life and subsequent professional career" (Heywood 2004). He was strongly attracted by the mountains of Spain, by the country, the Spaniards and the plants and vegetation; and some time later he felt in love with Conchita (María de la Concepción), a girl from Cazorla that he married in 1952.

[3] Subsequently, Heywood´s contribution to volume 4 of Flora Europaea was the treatment of all genera of *Compositae* belonging to subtribes *Anthemidinae* (Cass.) Dumort., *Leucantheminae* Bremer & Humphries and *Leucanthemopsidinae* Oberpr. & Vogt (Heywood 1976: 168-177).

[4] This species is currently considered a part of genus *Xiphion* Mill. (see, by instance, Crespo & Martínez 2013: 439).

The second expedition to Spain

In 1948 Vernon Heywood made his second botanical travel to Spain, this time sponsored by the Royal Horticultural Society, together with Peter Hadland Davis, a well-known botanist for his Flora of Turkey (Davis 1966-1985). Davis was nine years older than Heywood and one of his classmates. In 1938 he began botanizing as an amateur in Middle East, including Turkey, but his botanizing work was interrupted by the second world war as he had to serve the British Armed Forces from 1936 to 1945 (Waterson & Shearer 2006: 243). Once the war finished he began his training in Botany in 1945, to get his title of Bachelor of Sciences in 1959, this is at the same time than Heywood. Both were responsible for the organization of the travel, and this time they did not use a car, but public transportation: trains and buses.

The expedition was practically confined to Andalusia, as it was in this region where they collected for almost three months, particularly in Sierra de Cazorla mountains (Fig. 2) "because of their paramount horticultural and botanical interest" (Heywood 1950a: 446). Intense collections were also made in Sierra Nevada, (Granada), Sierra de Grazalema (Cádiz), Serranía de Ronda and Sierra de Tolox (Málaga), and visits to different zones of Murcia and Alicante provinces at the end of the expedition and to the gypsum areas near Aranjuez at the beginning, while waiting in Madrid for the arrival of the presses and field materials.

The expedition was highly productive. As Heywood says: "Seeds were collected of over 180 different species as well as bulbs and corms of 15; these are in the main grown at the Society´s Gardens at Wisley and at the Royal Botanic Gardens of Kew. We also made about 1,000 herbarium gatherings that are being divided between the herbaria of the British Museum (Natural History), Kew and Edinburgh." (Heywood 1950a: 444).



Fig. 2. General view of Cazorla and the Sierra. 1948. (Photo V. H. Heywood).

Among the species of which bulbs were collected was *Narcissus hedraeanthus* (Webb & Berth.) Colmeiro, "Which flowered in Sussex on Christmas day, at Wisley a few days later and at Edinburgh in mid-February. These were identified as *Narcissus hedrianthus* [sic]" (Heywood 1950a: 449), introduced this way into cultivation in the British gardens in 1948 (Mayer 1966: 74). Heywood prepared this species for The Curtis´s Botanical Magazine some years later (Heywood 1955, plate 248), as he previously announced[5]

The main difference between this second and the first journey is that although they made a good collection of seeds, bulbs and corms to fulfill the interests of the Royal Horticultural Society, they also collected herbarium material for future taxonomic studies, because Heywood and Davis were being trained as botanists, while Dr. Giuseppi and Cowley were rather "plant hunters", more interested in the introduction into cultivation of new or rare plants.

In October 4, 1949, Heywood gave a lecture on the expedition to the Society, which was the basis for the preparation of a publication which was not claimed to be a report of the expedition but a discussion of some of the plants they collected. It was divided into two parts, one devoted to Sierra de Cazorla (Heywood 1950a), and a second to plants of the rest of the travel (Heywood 1950b). In this publication Heywood pointed out numerous species which attracted his attention. This time, there was not Dr. Giuseppi (in fact he died a few months after coming back to England from Spain) neither Mr. Cowley to orientate him, and Peter Davis was not familiar with the Spanish flora. So, the feeling we can get from reading his publication is that Heywood had identified at least the greatest amount of the plant material collected, and that he had acquired in a short time (less than two years) a good skill in the knowledge of the Spanish flora.

But he was unable to identify some of the plants, as he writes, by instance: "On climbing out the *Pinetum* to the limestone slopes of the Cabeza del Tejo we found … and a variety of *Arenaria armerina* … it resembles *A. tetraqueta* in general habit …" (Heywood 1950a: 447), or: "Below the peak [Pico Cabañas] a dwarf *Geranium* with white flowers veined with violet … and a blue-flowered *Aquilegia* 6 inches high …" (Heywood 1950a: 451). The reason was that they were undescribed species. Heywood named the new *Arenaria,* in herb., *A. lithops*, a name which was validated later by John McNeill (McNeill 1962: 113)[6] and the *Geranium* and *Aquilegia* were named and described by Heywood four years later as new species with the names of *Geranium cazorlanum* and *Aquilegia cazorlense* (Heywood 1954a: 112, 84)[7].

Further expeditions to Spain

In 1949 Heywood got his title of Bachelor of Sciences at the University of Edinburgh, and began the preparation of a doctoral thesis at the University of Cambridge (Penbroke College) under the supervision of Prof. Edred John Henry Corner.

[5] "In horticultural circles it has attracted considerable attention [*N. hedraeanthus*] and a paper giving fuller information is in preparation (Heywood, 1950a: 449).

[6] The correct name of this species is *Arenaria alfacarensis* Pamp. (López González 1985: 258, 1990: 183).

[7] Although the latter is considered today as a subespecies of *Aquilegia pyrenaica* DC. (see by instance Díaz González, 1986: 385), its identity as a distinct taxon is out of any doubt.



Fig. 3. Vernon in Cazorla. 1951. Left, in the festivities of the city, with Conchita (Mª de la Concepción Salcedo). Right, resting in the village after one of his excursions to the Sierra.

Attracted by the Sierra de Cazorla, Heywood made new expeditions to collect plants and to study the vegetation, as he himself writes: "… a further expedition [following those of 1947 and 1948] was arranged in 1951 when extensive gatherings were made together with copious notes on the vegetation. Most of the period between September, 1951 and July, 1955 was spent in Spain and further visits were made to the Sierra de Cazorla at all seasons of the year. Many tours were made to the Sierra to study the vegetation. Short additional trips were made in 1956, 1958 and 1959 during expeditions to the neighboring Sierra de Segura" (Heywood 1961:36).

The most important of those expeditions was that of 1951, according to the herbarium material collected by Heywood which is kept at different British herbaria, particularly in those of The Natural History Museum (London), Royal Botanic Gardens of Kew, Royal Botanic Garden of Edinburgh and his personal herbarium, that he kept at least until 1967. These expeditions gave him a clear idea of the flora and vegetation of Sierra de Cazorla and allowed him to describe as new several taxa, such as *Aquilegia cazorlense*, *Alyssum fastigiatum*, *Erysimun linifolium* subsp. *baeticum* and *E. linifolium* subsp. *cazorlense*, *Geranium cazorlense* and *Erodium cazorlanum* (Heywood 1954a) and *Fumana paradoxa* (Heywood 1954b: 174).

The Spanish period

During this period, particularly between 1951 and 1954 in which he elaborated his doctoral thesis at the University of Cambridge, he was also staying at the "Instituto "Antonio

José Cavanilles" of the Consejo Superior de Investigaciones Científicas, Madrid" and "In addition shorter periods in the herbaria of … Facultad de Farmacia, Ciudad Universitaria, Madrid, Instituto Forestal de Investigaciones y Experiencias, Madrid, Instituto Botánico, Barcelona and Facultad de Farmacia, Universidad de Granada" (Heywood 1961a: 36).

This period, and particularly between 1951, when he undertook his third expedition to Sierra de Cazorla and October 1955, when he moved to the University of Liverpool, as it will be indicated below, was particularly important for his personal and professional life.

On the personal and affective side, he married María de la Concepción Salcedo Manrique de Lara (1924-2012), born in Cazorla, daughter of José Salcedo Cano, a much appreciated and respected medical doctor, by then the Major of the city, and María Manrique Manrique, a lady connected to the Spanish nobility through the lineage of Lara. The wedding took place in Valladolid and was administered by the Archbishop of that city (Prof. P. Heywood, pers. comm., Fig. 4).

On the professional side, he connected the Spanish Council of Scientific Research (C.S.I.C., Consejo Superior de Investigaciones Científicas), from which he got some funding through a scholarship, and this gave him the opportunity to contact with several Spanish botanists, such as Salvador Rivas Goday, Elena Paunero Ruiz, Emilio Fernández-Galiano, Emilio Guinea and Pedro Montserrat in Madrid, and Oriol de Bolòs and Pio Font Quer in Barcelona, with some of which, particularly with Emilio Guinea and Emilio Fernández-Galiano, he established bonds of friendship.



Fig. 4. Vernon Hilton Heywood and María de la Concepción Salcedo Manrique de Lara got married in Valladolid on June 7th, 1952. The wedding service was administered by the Archbishop of Valladolid.

In 1952, after the wedding, Conchita and Vernon established their residence in Madrid (Fig. 5), where they owned a flat which is now the property of their son Paul (Prof. P. Heywood, 2023, pers. comm.). In January, 1954 Heywood got his PhD title by the University of Cambridge. In 1954 he published the first, and unique, number of his "Notulae criticae ad floram Hispaniae pertinentes". As he indicates, this note was projected as "The first of a series of papers on the taxonomy of the Spanish flora. It is primarily concerned with the Montes del Estado de la Sierra de Cazorla, province of Jaen, of which the author is writing a flora; but it contains notes on species outside that area and other matters of interest concerning the Spanish floristic that have come to his notice during this work …" (Heywood 1954a: 83). This is an excellent study based on his own collections and observations and on the plants kept in the herbarium of the Botany School, University of Cambridge, but also in the plants of the herbaria of the Natural History Museum, London, Royal Botanic Gardens of Kew and Edinburgh, where Heywood had spent short periods of time. This first number covers the families *Ranunculaceae*, *Papaveraceae*, *Fumariaceae*, *Cruciferae* and *Geraniaceae* and includes the description of six new taxa endemic of Sierra de Cazorla or of the Betic mountains. But for several reasons it was not continued, what has to be considered a pity, because in addition to comments and updated nomenclature of many species, it would probably include the description of new taxa.

Heywood remained in Madrid until October 1955. He felt happy and confortable, and totally identified with the country and particularly with Cazorla, to the point to express his feelings in the following terms: "We who have the great luck to be able to claim the lands



Fig. 5. Vernon and Conchita in Madrid. 1954.

of Jaén as our homeland ("patria chica"), especially those of us who were born under the shadow of the Peña de los Halcones[8] (or, as myself, claim it as a marriage right) we have in our mountains, in the meadows, in the valleys, a Nature heritage that do not deserves that disregard with which we treat it. In every corner of our argentean mountain range we have, if we want to look for it, a treasure" (Heywood 1954b: 28). Besides, he was appreciated and admired by his colleagues and friends, that much recognized his knowledge and new inputs to botanical studies in Spain, as expressed, by instance, by Emilio Guinea: "… this efficient botanist that so much has done and continue doing for the knowledge of the Spanish flora and for raising the scientific level of our country" (Guinea 1954: 6). To leave Spain was not part of his expectations. But at the beginning of 1954 the funding he received from the Spanish Council was not renewed, owed most probably to a foul play, as was his feeling, what is in line with the gossip I heard in Madrid in the decade of the 60s. This forced him to return to England against his will. He tried hard to avoid this problem without success. By sure complained the Spanish Council, and asked for help to the British Embassy on February 27, 1954. The British Consul contact the Spanish Council without success and also the director of the British Institute in Madrid, Prof. Walter Starkie who had close relations with the powerful Secretary General of the Spanish Council, the soil scientist and priest Dr. José María Albareda. The later confirmed that "the scholarship awarded to Mr. Heywood was done exceptionally, and it is natural that there are difficulties to extend a situation with that character" (letter from José María Albareda to Prof. Walter Starkie, 30 April 1954; Heywood family archive). But Heywood had also a funding from the Carnegie Trust for The Universities of Scotland, which purposes include to encourage the development of research skills in undergraduates and postgraduates, which was extended to allow him to remain in Spain a further year (Prof. Paul Heywood, 2023, pers. comm.).

The Liverpool period

In 1955 Heywood changed his residence from Madrid to Liverpool. If he had continued in Spain, most surely he would have been incorporate to the Spanish Council of Scientific Research as a member its staff. But most probably he would have not reached the important role he played at the worldwide developing of botanical science.

Meanwhile, two events who took place in 1954 and 1955 favored his transfer to Liverpool: his election as the Secretary of *Flora Europaea* in 1954 and his appointment as Lecturer of Botany in the University of Liverpool in 1955.

In July, 1954, he attended the VIIIth International Botanical Congress in Paris. It was an opportunity to contact other British botanist who were in attendance in the Congress. May be Heywood already knew some of them, particularly Stuart Max Walters (1920-2005), Professor of Botany at Cambridge University, where he had prepared and submitted his doctoral thesis. It was in this Congress when the project of a flora of Europe originated. As described by A.D. Bradshaw in the obituary of Prof. Thomas Gaskell Tutin (1908-1987): "At the VIIIth Botanical Congress at Paris in July 1954, there was a Symposium on "Progress of work on the European flora". In his introductory talk D.H. Valentine, referring

[8] Peña de los Halcones is an enormous Cliff rock which dominates the city of Cazorla.

to the several new national floras, added that "a new European Flora, although an immense undertaking, must be regarded as one of the aims of the future". This idea was followed up in a café near the Sorbone, under the influence of a little Calvados. It took off when Tom, with his inimitable energy not long freed from the British Flora[9], induced David Valentine, N.A. Burges, V.H. Heywood, S.M. Walters and D.A. Webb to joint an informal committee for a proposed *Flora Europaea*, which met first in Leicester on 4 January, 1946" (Bradshaw 1992: 369). Prof. T.G. Tutin took the chair of the Editorial Committee (previous Editorial Board); Vernon Heywood was designated as Secretary.

In October, 1955, Heywood was appointed lecturer of Botany at the University of Liverpool, maybe proposed by Aland Burges, Professor of Botany at that University, and the Heywood family (already with the first of the four sons born) moved to Liverpool. In 1946 Heywood organized in Liverpool the Secretariat of *Flora Europaea*.

So, he acquired two new commitments to add to his research activity: to ensure the development and success of *Flora Europaea* and to lecture at the University. All this should have been too much for many, but not for Heywood, gifted with a great intelligence and an extraordinary working capacity.

To be the secretary of the Editorial Committee of *Flora Europaea* was really hard, at least along the first period, until the first volume was published in 1964 (Tutin & al. 1964). During this period his duties were not only to organize the periodical meetings of the Committee, to coordinate the work of an international group of advisory editors and regional advisers, to receive and distribute the drafts of the authors, etc., but also to prepare and distribute the guidelines to the authors (Heywood 1957a, 1958, 1960b), to edit the series *Notulae Systematicae ad Floram Europaeam spectantes*, four issues in this period (Heywood 1961-1964), to prepare the volumes of the *Flora* for publication, to coordinate the celebration of the periodical Symposia of Flora Europaea (four in this period, from the first in 1959 to the fourth in 1963), and to edit an write as author the treatments of families and genera of its competence, which for the first volume meant to edit 13 plant families, including *Cruciferae*, and the authorship of 34 genera, including *Biscutella* (together with E. Guinea) and *Brassica*.

At the University of Liverpool he was appointed successively Lecturer (1955), Senior Lecturer (1960), Reader (1963) and professor (1964) of Botany. He lectured Botany, and also Plant Taxonomy and Plant Evolution since 1963 when he opened the first Master on this topic established in England. His lectures were particularly clear, perfectly structured and absolutely up to date. He published, together with his old classmate and friend, and by then Professor of Botany at the University of Edinburgh, Peter Hadland Davis, the most complete textbook on Taxonomy so far published (Davis & Heywood 1963), an endless source of taxonomic information.

But he also managed to find time to submit a new thesis at the University of Edinburgh to get the doctorate in Sciences (DSc), of which he was particularly proud, and to attend his family (Fig. 6).

But so many new duties separated Prof. Heywood from his direct interest in the Spanish flora, of which he was by them considered an expert, as he himself declared ("I had become an expert on Spain", Heywood 2004) or as many of his colleagues admitted (by

[9] A reference to Clapham, A.R., Tutin, T. G. & Warburg, E. F. 1952: *Flora of the British Isles*. Cambridge, at the University Press.



Fig. 6. Heywood´s family in Paris, early 1970. From left to wright: Christopher, Nicholas, Vernon, Conchita and Francis (Photo Paul Heywood).

instance Sventenius and Bramwell (1971: 5), who described the compositae genus *Heywoodiella* "in honorem cl. Prof. Dr. V. H. Heywood, florae hispanicae meritissimi investigatoris"). Between 1948 and 1955, when he left for England, he had published 10 papers (Heywood 1948-1955). From this date to 1963 he published 16 more (Heywood 1956-1964; Ball & Heywood 1962; Brummitt & Heywood 1964; Heywood & Ball 1962, 1963), prepared during his stay in Spain or based on his field experience of this country, three of them in relation to his implications as author for vol. 1 of *Flora Europaea*. These included a first part of the never completed Flora of Cazorla (Heywood 1961a) and the first part of a catalogue of the Spanish vascular plants (Heywood 1961b), for which he had the ability to get the collaboration of Peter W. Ball (Liverpool), Oriol de Bolòs (Barcelona), Emilio Fernández-Galiano (Madrid), Pío Font Quer (Barcelona) Emilio Guinea (Madrid), Manuel Laínz (Gijón), Pedro Montserrat (Madrid), Salvador Rivas Goday (Madrid) and Werner Rothmaler, by them at Leipzig, but had been working as botanist in Barcelona and Lisbon between 1933 and 1940. This catalogue was "an attempt to provide a summary of the content of the Spanish flora" (Heywood 1961b: XIV), and it could have been the origin of a flora of Spain. But as with the series of Notulae Criticae (Heywood, 1954a) and his Flora of the Sierra de Cazorla (Heywood 1961a) was never completed. Owing to the impossibility to complete his Flora of Cazorla, he disinterestedly offered the still unpublished manuscript to Emilio Fernández-Galiano, then at Madrid and latter at Sevilla, which resulted in the joint publication of a checklist of the plants of the eastern half of province of Jaén (Fernández-Galiano & Heywood 1960).

Heywood never lost his interest for Spain, a country for which he was probably nostalgic, neither his links with Spanish botanists, not only with its contemporary but also those of news generations, that always had his help and advice. For many years he brought his University students of Liverpool and later of Reading for their field practices to Seville, Murcia or Valencia, and was always ready to participate in symposia, meetings, courses or conferences in any Spanish town and to help in the improving or establishment of the Spanish botanic gardens.

Reading and the Botanic Garden Conservation International

In 1968 Heywood was appointed professor of Botany of the University of Reading, a post he maintained till his retirement in 1987, and named Emeritus Professor from 1990 to 2020. He divorced from María de la Concepción Salcedo in 1981, and later that year married Christine Anne Brighton (Fig. 7).

It is in this period, and more particularly once the fifth and last volume of *Flora Europaea* was published, when Heywood gradually changes from taxonomy to plant conservation. From 1987 to 1990 was Secretary of the Botanic Garden Conservation Secretary of the International Union for Conservation of Nature (IUCN), a Secretariat that segregated from IUCN in 1990 to become the Botanic Garden Conservation International based at Kew, of which Vernon H. Heywood was the founder and Director from 1990 to 2015.

His death in 17 September 2022 was not a surprise for many of us, since we were aware he was diagnosed of an inoperable cancer in April, 2020.



Fig. 7. Heywood and Christine Anne Brighton. 2013. (Photo S. Jury).

Epilogue

Vernon Hilton Heywood was author or co-author and editor or co-editor of more than 40 books, of which perhaps the most relevant was *Flowering Plants of the World* (Heywood 1978) translated to several languages including Chinese, and its much enlarged second edition, *Flowering Plant Families of the World* (Heywood & al. 2007). He was also author or co-author of over 400 papers. His contribution to Botany and Plant Sciences in general has been widely recognized and has earned him numerous awards. The fist was his appointment in 1972 as Honorary Counselor of the Spanish Council of Scientific Research, the same Institution that denied his funding in 1954. It was not until 15 years later when a British institution recognized his merits: The Linnean Society of London which awarded him the Linnean Medal for Botany in 1987. Then he received new honors: Honorary Research Professor of the Botanic Garden and Botanic Institute of Nanjin (1988), Medal Can de Plata of the Cabildo Insular de Gran Canaria (1989), Hutchinson Medal of the Chicago Horticultural Society (1990), Storer Lectureship of the University of California in Davis (1990), Honorary Fellow of the Royal Botanic Garden of Edinburgh (1990), Honorary Fellow of the Linnean Society of London (1996), Honorary Professor of the University of Mendoza, Argentina (1997), Regent´s Lecturer of the University of California in Riverside (1998), Insignia de Oro of the Botanical Garden Viera y Clavijo, Gran Canaria (2002), Medal of the Chicago Horticultural Society (2002), Linnaeus Award of Planta Europa (2007), Gold Medal of OPTIMA (2007) and Theophrasthos Prize of the Fondazione pro Herbarium Mediterraneum.

He left many friends in Spain, some of which have published extensive and felt obituaries (Marrero 2023; Laguna & al. 2023a, 2023b), from which some of the data for this memoir have been taken.

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Werner Greuter

Vernon Heywood and OPTIMA's four Musketeers

Abstract

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The circunstamces that led to the creation of OPTIMA (Organisation for the Phyto-Taxonomic Investigation of the Mediterranean Area), the efforts of the four botanists that promoted its creation (the four Mosketeers: V. V. Heywood, H. Runemark, G. Moggi and W. Greuter) and the fundamental role played by V. H. Heywood in its origings and development are emphasized.

Key words: Moggi, Runemark, Sauvage, Guinochet, Ozenda, Quézel, Hainard, Charpin, Burdet, Montpellier, Goulandris, Girardin, Miège, Aymonin, Kamari, Phitos, Iraklion, Leningrad, Palermo.

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Introduction

Benito Valdés has just shown to us the deep Mediterranean roots of Heywood's scientific interests and, indeed, of his whole personality. I will continue his story, while focusing on Heywood's role in the setup and early history of OPTIMA.

Let me start in the year 1973, a crucial date in this respect. Heywood was then deeply involved in the publication of Flora Europaea, being the secretary of the editorial committee of that gigantic undertaking, the largest cooperative enterprise in European botany so far. Leading French botanists were notoriously jealous of that success story, and sour that it was an exclusively British feat. They decided that it was the turn of France to match Flora Europaea by launching their own project, centred in France: a new Flora Mediterranea.

When the intent to launch that project became known, Heywood was genuinely alarmed: not so much for being fearful of the competition as for the predictable failure of the new project which, same as the demise of the first version of the Flora of North America project in the U.S.A., was bound to compromise the burgeoning sympathy of European funding agencies toward taxonomic biology triggered by Flora Europaea. In France of those days, systematic botany was notoriously languishing or even facing extinction, and expert human resources, such as would be required for the new project, were scant or non-existent.

Heywood then prompted Hans Runemark in Lund, Sweden, to invite for and host a brainstorming meeting where these dangers and possible remedies could be discussed. The

meeting took place in early 1974; in addition to Heywood (1927-2022) and Runemark (1927-2014), those invited were Guido Moggi of Florence, Italy (*1927), and myself (*1938) who was then sharing my time between Geneva (Switzerland) and Kifisiá in Greece. We were the four Musketeers mentioned in the heading, and indeed the number four played an all but magical role in the events here related. Apart from the Lund group, the figureheads of the French initiative also were four, to name: Charles Sauvage, Montpellier (1909-1980), Marcel Guinochet of Orsay (1909-1997), Paul Ozenda of Grenoble (1920-2019), and Pierre Quézel of Marseille (1926-2015). Last not least, there were the four "young wolves" at Geneva: Pierre Hainard, André Charpin, Hervé Burdet, and myself, who were my faithful support during those early days.

The Lund meeting led to the inception of OPTIMA, including the invention of its name. A sleepless night following some heavy aquavit drinking (an unavoidable custom in Lund, as we soon found out) brought about the invention of the "Organisation for the Phyto-Taxonomic Investigation of the Mediterranean Area", enthusiastically adopted, among other things, because it resulted in a catchy acronym. (We did not go public with the matching designation I had coined for the French group, in allusion to the "systématique synthétique", the catchword of the Guinochet school: Projet d'Etude Syn-Systématique Intégrale de la Méditerranée Autonome".) The real break-through of the Lund meeting was not, however, the new acronym: it was the consensual recognition that writing a Mediterranean Flora was not only a premature idea doomed to failure, but that as a preliminary step, it was highly desirable to bring Mediterranean botanists together and getting them to establish transnational contacts and a lively exchange of information. The Mediterranean being an incredibly fragmented and multiform area, not only geographically and politically (with its ca. 30 independent states and major islands), but also linguistically and culturally, with its countless languages using seven different scripts. This was the message the four Musketeers were going to bring to the French Symposium.

At the said symposium, "La Flore du Bassin méditerranéen. Essai de systématique synthétique", in Montpellier in June 1974, we were not however allowed to present the idea ourselves. Being part of the series "Colloques Internationaux du C.N.R.S." and abiding by its rules, half of the participants had to be French and the other half invited by the French organisers; so that the meeting was strongly manipulated by the latter, who during a very stormy concluding session came up with their own idea of a Mediterranean botanical association, and asked for the symposium's mandate to implement it. Heywood's resolute and brilliantly presented protest prevented any such a decision. Meanwhile I had prepared a draft constitution for OPTIMA, which the four of us edited and agreed upon while sitting at a sunny table in front of a Montpellier coffee shop. We decided to move immediately, and shortly afterward a written invitation was widely distributed, to join OPTIMA by approving its constitution and the proposed first International Board and Council (consisting of 22 botanists of as many different countries, who had agreed to support our idea).

In spite of an outspoken written protest by the French group, in which they claimed we were pirating their idea (when in actual fact just the reverse had happened), OPTIMA met with instant success, having obviously hit a gap in the market: by the deadline indicated, October 1st of 1974, which is OPTIMA's foundation date, exactly 100 persons from all around the Mediterranean (and indeed the World) had signed up, thus becoming our founding membership.

OPTIMA's success didn't stop there. By the end of 1975 we had 341 members (including 9 member institutions), and one year later, 422 members (18 institutions). The OPTIMA Secretariat, initially hosted in Reading by Heywood, then soon transferred to Kifisiá under my care, was a busy place in those early years. The Goulandris Natural History Museum deserves our thanks for sponsoring those activities, as does Mrs. Lise Girardin and the City Council of Geneva who in March 1975 formally offered to the OPTIMA Secretariat a stable home at the Conservatoire botanique, which implied bearing the production and mailing cost of our publications. As my then boss in Geneva, Jacques Miège (1914-1993), had dropped his initial, luke-warm support of OPTIMA out of solidarity with his French compatriots, the City of Geneva's political decision was of utmost importance for the Organisation.

This may be the place to note that the leaders of French botany, all university chairholders who fully exerted their powers in matters of tenure and funding (a power that they had been quick to recover, in the aftermath of the initially successful student revolt of 1968), remained hostile toward OPTIMA for many years. Few French botanists then dared becoming OPTIMA members, the prominent exception being Gérard Aymonin (1934-2014) who, being professor at the Muséum National d'Histoire Naturelle in Paris, lived outside the sphere of influence of academia; indeed, dozens of young French botanists, who joined OPTIMA then, did so in incognito and were omitted from our membership lists.

As you will by now have perceived, Heywood was in many ways OPTIMA's spiritual father. His ideas on what was needed to make membership attractive to many, heavily influenced the development of the Organisation's action programme. The set-up of scientific committees, the offer of reprint exchange facilities (in a time when reprints were still



Fig. 1. Part of the participants at the I OPTIMA Meeting, Heraklion, Krity, 22-28 September, 1975. 1-4, The four Musketeers: 1, V. H. Heywood; 2, W. Greuter; 3, H. Runemark; 4, G. Moggi. 5-6, The organizers: 5, G. Kamari; 6, D. Phitos (Photo provided by Prof. Georgia Kamari).

widely used and circulated), the opportunity to offer or request research materials (seeds and propagules, or plant specimens for exchange), the OPTIMA awards system, all this and much more prospered under Heywood's guidance; the Med-Checklist project (which was never completed due to the unfortunate failure to obtain ongoing funding) was his particular pet. But first and foremost in his heart were the OPTIMA Meetings (Fig. 2).

We are here celebrating the 17th such Meeting, all of which I attended (Heywood was present at all but one, as was Georgía Kamari now here with us). The first Meeting was organised by herself and her husband, Dimitrios Phitos, who sadly cannot be here today, due to ill health. It took place in September 1975 in Iraklion (Crete, Greece), less than one



Fig. 2. Prof. Vernon Hilton Heywood during the last OPTIMA Meeting he attended (XV Meeting, Montpellier, 6-11 June, 2016) (Photo C. Obón).

year after OPTIMA's founding date, and was a remarkable success. There were 72 registered participants in attendance (32 Greek, 40 foreign), which may seem few, but is quite a feat if one considers that the official invitation to hold the Meeting in Crete was issued as late as July 1975, being presented, by a Greek delegation, to a Board Meeting, during the 12th International Botanical Congress in Leningrad. Within merely two months, the programme was set up, the speakers enrolled, and the excursions organised (an excursion guide was printed, in which several new species were described and named). The OPTIMA Meetings were to become a genuine success story, the main reasons being: the high scientific standard of the scientific programmes; the platform they offer to the younger generation of botanists, particularly but not exclusively of the host country, to present themselves before a distinguished international audience; and the correlated fact that among the attendees there continues to be a high proportion of faithful patrons, not to say addicts, who are want to miss even a single Meeting unless prevented from attendance by cogent reasons (such as the Twin Towers terrorist attack of 11 September 2001, two days ahead of the opening of the 10th Meeting in Palermo).

To conclude: only one-half of OPTIMA's four Musketeers are still alive, and none of the French group. We stand today to honour the memory of the most influential of OPTIMA's fathers, Vernon Heywood, in full awareness of the importance of his contribution to our Organisation's inception and long-term success.

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