Article

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

Abstract

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

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

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Introduction

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

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

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

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

Materials and Methods

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

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

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

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

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

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

Results and Discussion

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

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

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

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

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

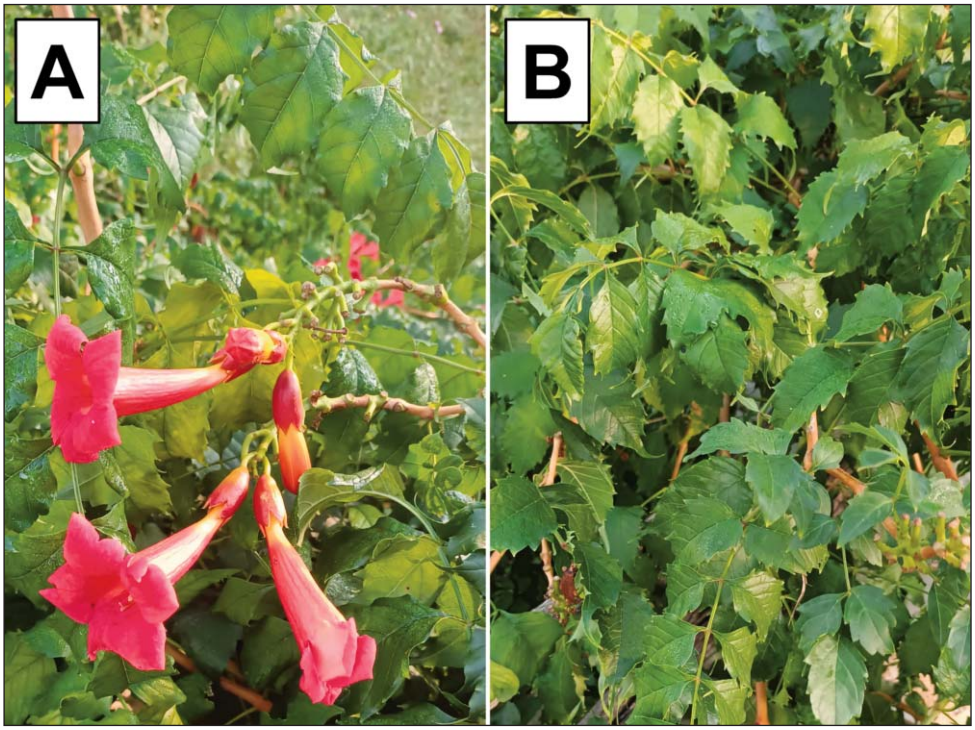

Fig. 1. Flowers (A) and leaves (B) of *Campsis radicans* (L.) Bureau.

Canna coccinea Mill.

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

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

****Cardiospermum grandiflorum*** Sw.

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

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

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

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

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

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

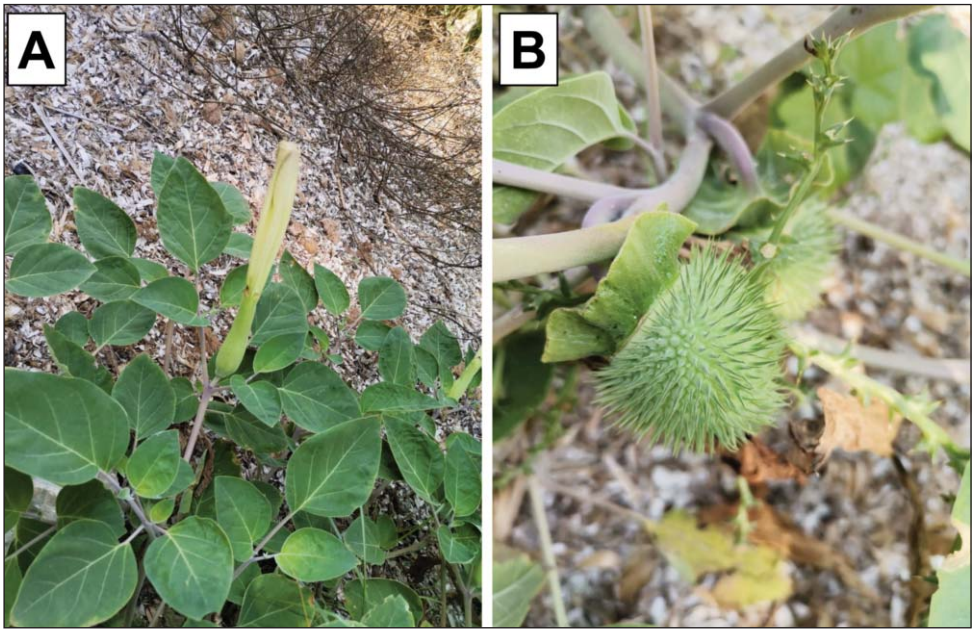

Fig. 2. Flowering plant (A) and fruit (B) of *Datura wrightii* Regel.

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

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

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

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

Lagunaria patersonia (Andrews) G. Don

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

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

Parkinsonia aculeata L.

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

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

****Portulaca grandiflora*** Hook.

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

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

Salix alba L.

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

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

Sorghum bicolor (L.) Moench

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

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

Sporobolus indicus (L.) R.Br.

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

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

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

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

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

Conclusions

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

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