

Rapid Communication**Records of alien plants new for the Flora of The Balearic Islands (West-Mediterranean)**

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OPEN ACCESS**Abstract**

Increasing worldwide rates of plant introductions is an environmental issue that makes necessary to continuously update alien checklists. The Balearic Islands (an archipelago located in the Western Mediterranean basin) has been strongly influenced by tourism during the last decades, causing an increase of alien species arrival. After two years of field surveys (2021–2022), here we report and discuss the presence of 12 alien plant species previously unknown for the Balearic archipelago. Species records include the known invasives *Tradescantia fluminensis*, *Cylindropuntia tunicata* and *Erythrostemon gilliesii*. World widespread and of variable invasiveness *Salpichroa organifolia*, *Portulacaria afra*, *Buddleja madagascariensis*, and less recorded *Aloiampelos ciliaris*, and *Aloe x delaetii*, *Dracaena draco* and *Justicia adhatoda*. Finally, *Euphorbia canariensis* and *Sedum multiceps*, both rarely recorded being these records the second and third observations outside their native range.

Key words: invasive, Spain, plant introductions, allochthonous

Introduction

Allochthonous plant species are considered one of the main environmental issues worldwide, being especially relevant in the Mediterranean basin (Médail 2017). Since awareness of this problem, considerable research has been conducted to assess both patterns and consequences (Arianoutsou et al. 2021). These studies rely necessarily on plant records as the main source of information to approach plant introductions, and among others to disentangle their impact (Bresch et al. 2013). In this sense, periodical plant records publications and databases allow us to fulfil the lack of knowledge offering valuable information, mainly at a regional scale.

The Balearic Islands is an archipelago located in the western Mediterranean, influenced by human activity for millennia, and thus the recipient of a considerable number of plant introductions (Burjachs et al. 2017). Traditional farming and cattle rise have been the main influence for landscape, and the main source of plant introductions. Since the 1950, the increasing tourism

caused both landscape modifications due to increased population density, urbanization, and loss of traditional activities such as agriculture or cattle rise (Pons and Rullán 2014). As a direct consequence, increased activities such as gardening, and horticultural practices have gained importance as a source of new plant introductions (Podda et al. 2010). Alien flora of the Balearic Islands has been previously assessed by Moragues and Rita (2005), and Podda et al. (2010) indicating the presence of 300 to 360 alien species. Since then, further records have reported considerable number of new alien novelties, both from presumed recent introduction and old unrecorded naturalized taxa (Cardona et al. 2021 and included references). These records allow to consider that alien flora of the Balearic Islands is still far from being fully complete, and subject to changing conditions. In this sense, better identification tools for complex families, increased surveys, and the ongoing process of plant introduction *per se* allow to predict the increase of Balearic alien flora.

Considering the importance of proper assessment of plant introductions, the aim of this study is to put into knowledge new alien taxa recorded during 2021 and 2022 to formally report these species in the Balearic Islands.

Materials and methods

Plants records presented in this study are species observed by the authors during 2021 and 2022 surveys around the Balearic Islands, precisely Mallorca, Ibiza, and Formentera. For all taxa images were recorded and samples collected for proper identification in the laboratory. Herbarium vouchers were collected by each author and deposited in the Herbarium of Dr. Leonardo Llorens and Dr. Lorenzo Gil deposited in Can Quintana (University of the Balearic Islands), and available at request to Dr. Gil (lorenzo.gil@uib.es). Code of registration is indicated in each taxon description. Geographical coordinates, date of first recording and a synthetic description of the individual/s observed is indicated for each species. Plant identifications were assessed with different sources which are indicated for each taxon. Overall, The European Garden Flora (Cullen et al. 1984) was consulted as a general reference to ensure identification if better sources were not available. General plant distribution and specific absence of records in the Balearic Islands was assessed by consulting previous alien floras from the Balearic Islands (Moragues and Rita 2005; Podda et al. 2010) and the online databases GBIF (2022), BIOATLES (2022), ANTHOS (2022) and ORCA (2022). Additionally, published articles were used as descriptive sources to indicate both native and introduced distributions (see under each taxon for details). Records of cultivated plants in the Balearic Islands (specifically from GBIF database) were not considered as previous presence of the species in the archipelago. Invasive status is discussed for each species based on previous

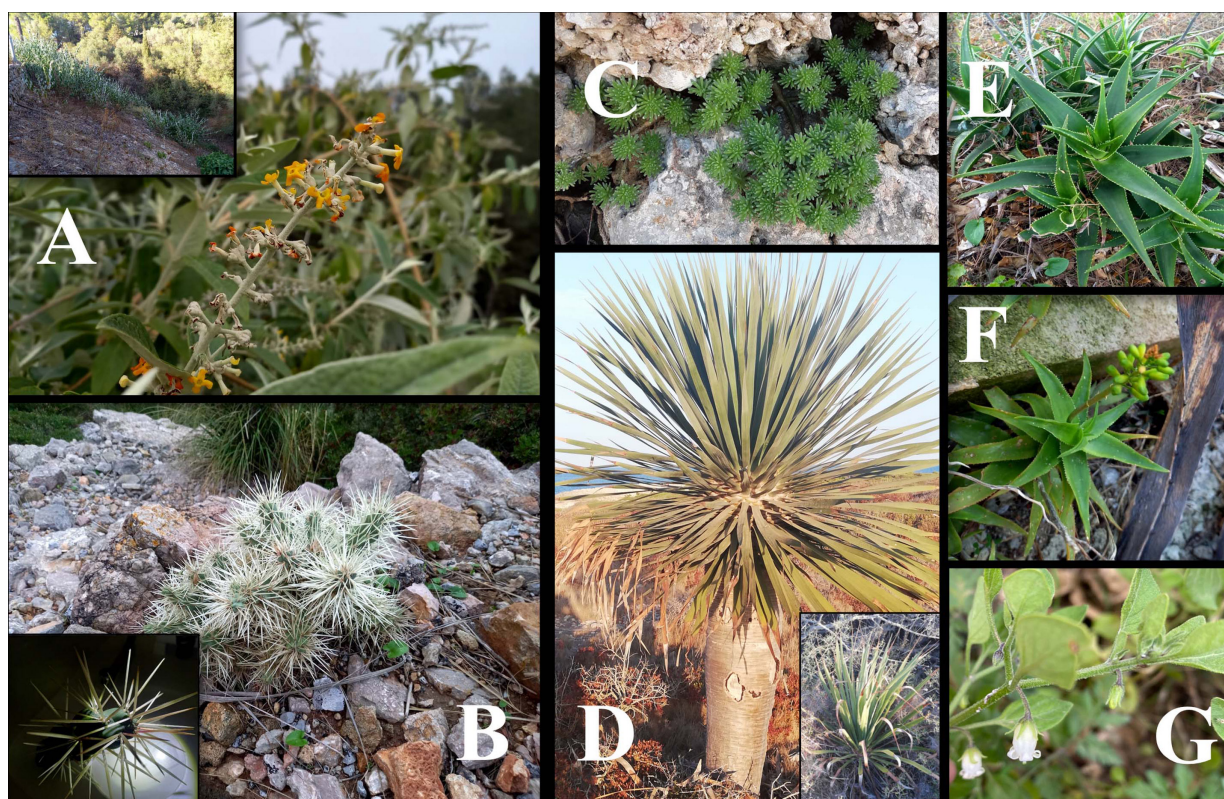


Figure 1. New alien records from the Balearic Islands: A. *Buddleja madagascariensis*, B. *Cylindropuntia tunicata*, C. *Sedum multiceps*, D. *Dracaena draco*, E. *Aloe x delaetii*, F. *Aloiampelos ciliaris*, G. *Salpichroa oranifolia*. Photos by Cerrato (A, B, E, F and G) and Gil (C and D).

records in other areas of the world and description of plants presently recorded in this study. All taxa are referred in BIODIBAL (<https://biodibal.uib.cat/>), an online database for Balearic Islands biodiversity.

Results and discussion

Floristic research between 2021 and 2022 has generated data on 12 alien taxa new to the Balearic Islands (Supplementary material Table S1 for geo-referenced records of newly recorded species). Short descriptions of taxa and localities are listed below in alphabetical order.

Aloe x delaetii Radl (Family: Asphodelaceae)

(Figure 1E)

Synonym: *Aloiampelos ciliaris* (Haw.) Klopper & Gideon F.Sm. x *Aloe succotrina* Lam.

Mallorca, Alcúdia, 39°51'34.4"N; 3°06'47.8"E, Cerrato (23/01/2022). Three patches with variable number of rosettes (~ 15–20 each) growing between shrub clearings inside the urban area. (Herbarium code LLGLGV4269).

Horticultural hybrid resulted from *Aloiampelos ciliaris* and *Aloe succotrina* (both reported in the Balearic Islands) which previously was known outside cultivation in Valencia and Catalonia (Aymerich 2016). Further reports can be found for Malta and France (GBIF 2022) but based on reported images seem to be related to cultivated individuals. Overall traits can be summarized in a rosette of denticulate leaves more extended than related taxa, being leaf blade narrowed starting from the middle to the apex (Guillot et al. 2008).

***Aloiampelos ciliaris* (Haw.) Klopper & Gideon F.Sm. (Family:Asphodelaceae)**
(Figure 1F)

Synonym: *Aloe ciliaris* Haw.

Mallorca, Son Serra de Marina, 39°43'52.2"N; 03°14'04.3"E, Cerrato (15/01/2022). Three individuals growing with *Agave* spp. invading native shrubs of *Pistacia lentiscus* near Son Serra urbanization. Ibiza, Can Toni d'en Jaume Negre, 39°02'57.5"N; 1°28'50.5"E, Pinya (29/04/2022). Two individuals growing near a trail between agricultural fields. (Herbarium code LLGLGV4270).

Aloiampelos ciliaris is a species from South Africa native to the western and eastern Cape province. It can easily be distinguished from *Aloe* s. str. due to its shrubby/climbing growth form and spirally arranged leaves (Grace et al. 2013). Among *Aloiampelos* species, *A. ciliaris* can be identified based on the distinctive auriculate leaf sheath with fine hairs on the sheathing leaf base (Ellis 2013). For the European continent, reports can be found in the Iberian Peninsula both in Catalonia (Aymerich 2016) and Portugal (Jardim and Menezes de Sequeira 2015), and previous records are also known from Mediterranean coasts of France (Aymerich 2016). Other records in the Mediterranean region have been indicated as cultivated only (D'Agata et al. 2009).

***Buddleja madagascariensis* Lam. (Family: Scrophulariaceae)**
(Figure 1A)

Synonym: *Nicodemia madagascariensis* (Lam.) R.Parker

Mallorca, Torrent des Camp Gran, 39°51'29.6"N; 3°09'10.9"E, Cortés-Fernández, Perelló-Suau, Cerrato (31/08/2022). Individuals growing from the bridge edges (where this plant was originally cultivated) downfall to the torrent bed at both sides. Over 30 adult stands at each side with signs of pruning due to periodical clearing activities in the area. (Herbarium code LLGLGV4271).

Native to Madagascar, Pasta et al. (2016) gives several references and a brief review of *Buddleja madagascariensis* expansion around the world, and a more extensive review on its ecology and status in the Mediterranean region and Italy. Colonization and naturalization events are known mainly in tropical and subtropical areas around the world. In the Mediterranean region it has a long history of use for gardening, but naturalization has been considered more limited. When escaping to natural or seminatural areas, Mediterranean localities (Sicily, Greece, Crete and with doubts in southern France and north Africa) record local invasibility. *B. madagascariensis* can be easily differentiated from the common cultivated and invasive *B. davidii* thanks to its laxer inflorescence of orange petal-colored flowers, and strong color contrast between adaxial and abaxial side of the leaves (white pulverulent abaxial side). Description can be found in Wagner et al. (1999).

***Cylindropuntia tunicata* (Lehm.) F.M.Knuth (Family: Cactaceae)**

(Figure 1B)

Synonyms: *Cactus tunicatus* Lehm

Mallorca, Cala Carbó, 39°55'10.9"N; 3°03'51.6"E, Cerrato (30/11/2021). One adult individual growing at one side of the trail, near native shrub communities. (Herbarium code LLGLGV4272).

Cylindropuntia is a complex genus form which several species have been previously recorded in the Balearic Islands and linked to gardening activities. Original to North America, *C. tunicata* can be misidentified easily with *C. pallida*, which has been previously recorded in Ibiza and Formentera (Sáez et al. 2016). Besides flower color, vegetative traits allow to distinguish both species. Verloove et al. (2017) indicate that both taxa can be separated due to lower number of spines in *C. tunicata* (4–7) regarding *C. pallida* (7–14), and different spine color being white yellowish in *C. pallida*, and white with reddish/brown stains, especially for young spines, in *C. tunicata*. Records have been indicated previously in Italy (Guiggi 2008), Canary Island (Verloove et al. 2017) and the Iberian Peninsula (Aymerich 2017; Laguna et al. 2013). Invasive status is known for Australia (Johnson et al. 2009) and South Africa (Paterson et al. 2021), mainly due to fast vegetative growth and cladode easy detachment, dispersal, and further rooting.

***Dracaena draco* (L.) L. (Family: Asparagaceae)**

(Figure 1D)

Synonym: *Asparagus draco* L.

Mallorca, Cala Petita, 39°32'49.4"N; 03°21'8.5"E, Gil (29/08/2021). Three individuals growing between shrubs of *Olea europaea* and *Pistacia lentiscus*. One individual is an adult which shows signs of reproductive effort capacity (flowering and fruiting) and the remaining two are plantlets. (Herbarium code LLGLGV4273).

Endemic to the Canary Islands, its use as an ornamental species is widespread but naturalization events are scarce or limited. Records of naturalization can be found mainly in Italy, where plants developing under natural conditions have been reported in Sicily (Domina and Amato 2013), and Sardinia (Galasso et al. 2021). Some records also indicate its casual presence in North Africa (El Mokni and Verloove 2022). Our records concur with previous observations of casual behavior but add successful germination and development under natural conditions.

***Erythrostemon gilliesii* (Hook.) Klotzsch (Family: Fabaceae)**

(Figure 2C)

Synonym: *Caesalpinia gilliesii* (Hook.) D.Dietr.

Mallorca, Bellavista, 39°28'38.4"N; 02°43'54.2"E, Mir-Rosselló (22/05/2022). One flowering individual growing on an open field near the urbanization, surrounded by *Achnatherum milliaceum*. (Herbarium code LLGLGV4274).

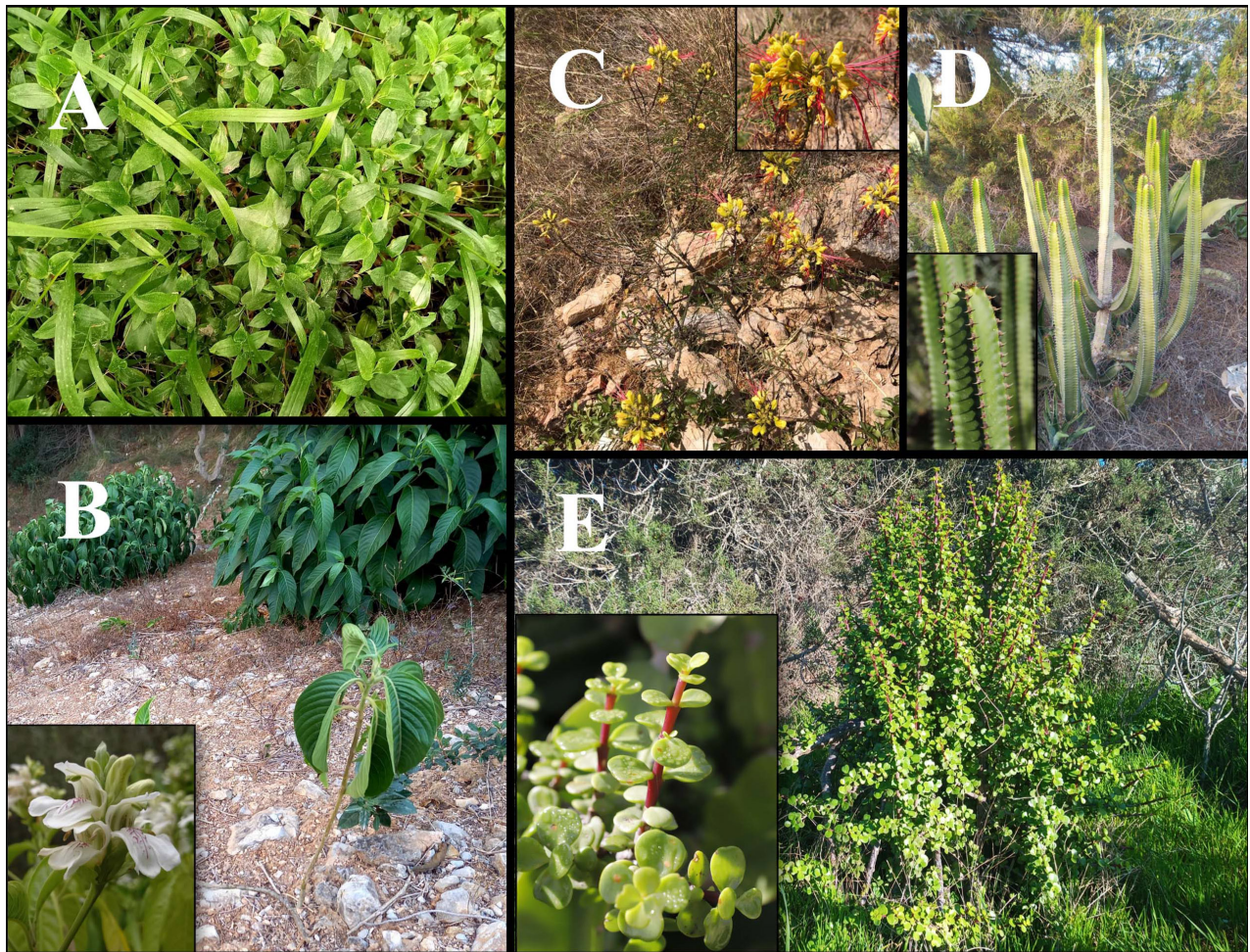


Figure 2. New alien records from the Balearic Islands: A. *Tradescantia fluminensis*, B. *Justicia adhatoda*, C. *Erythrostemon gilliesii*, D. *Euphorbia canariensis*, E. *Portulacaria afra*. Photos by Cerrato (A and B), Mir Rosselló (C) and Ribas Serra (D and E).

Erythrostemon gilliesii can be differentiated from other *Erythrostemon* species by its longly exserted red stamens (Gagnon et al. 2016). This species, original from Argentina, is cultivated as ornamental in tropical, sub-tropical and warm-temperate regions (Verloove 2017). It has been reported as subspontaneous in the South of Europe including Greece (Arianoutsou et al. 2010), Italy (Ferretti et al. 2013) and Spain (Gómez-Bellver et al. 2019). Although we only detected a single small individual in the indicated location, the high invasiveness of the species in sub-tropical islands (Verloove 2017) makes it advisable to monitor its behavior in the near future.

***Euphorbia canariensis* L. (Family: Euphorbiaceae)**

(Figure 2D)

Formentera, Sant Ferran de Ses Roques, 38°42'10.9"N; 1°27'16.7"E, Ribas-Serra A. (12/09/2022). One individual growing with *Agave* spp. and *Opuntia* spp. near a private property, at a shrubland of *Juniperus phoenicea*, *Olea europaea* and *Pinus halepensis*. (Herbarium code LLGLGV4275).

Euphorbia canariensis is an endemic species of the Canary Islands, which has been widely used for gardening but rarely escaped from cultivation.

This species can be easily identified due to its stem morphology, distance between spines and plant size and growth form (Cullen et al. 1984). Records for this species outside the Canary Islands are scarce and anecdotal without formal references. Some records are indicated in the GBIF (2022) database but correspond to cultivated individuals. Misfud (2002) indicated its cultivated presence in Malta and occasional casual growth near gardens. The individual here recorded can be considered the first record outside its native range, being one individual, which probably escaped through pruning wastes. Clonal reproduction (as small stems arising next to the main individual) can be noticed, implying active autonomous growth in the area.

***Justicia adhatoda* L. (Family: Acanthaceae)**

(Figure 2B)

Synonym: *Adhatoda vasica* Nees.

Mallorca, Torrent des Camp Gran, 39°51'29.6"N; 03°09'10.9"E, Cortés-Fernández, Perelló-Suau, Cerrato (31/08/2022). Individuals growing from the bridge edges (where this plant was originally cultivated) downfall to the torrent bed at both sides. Additionally, more individuals can be seen growing and expanding between shrubs outside the water and course near the road. Population shows high number of adult stands (more than 50 individuals) but also several plantlets which mainly grow in bushy shaded areas or in the torrent bed. (Herbarium code LLGLGV4276).

Species native to tropical South-East Asia widely used for gardening. Published records of escaped plants are slim with localities indicated in Sicily and Malta (Mifsud 2002), Greece (Galanos 2015), and some records in Spain (GBIF 2022). Invasive capacity has not been assessed or indicated in any region where cultivated. Richardson (1998) notes it among other species which have tendency to naturalization when escaped from cultivation. Traits for identification can be found on flower and inflorescence form and color (Cullen et al. 1984; Mifsud 2002) as well as seed and capsule traits (Graham 1988).

***Portulacaria afra* Jacq. (Family: Didiereaceae)**

(Figure 2E)

Formentera, Sant Francesc Xavier, 38°42'29.8"N; 01°25'45.4"E, Ribas-Serra A. (03/10/2022). Four individuals growing with *Agave* spp. and *Opuntia* spp. near a private state, invading a shrubland of *Juniperus phoenicea*, *Olea europaea* and *Pinus halepensis*. (Herbarium code LLGLGV4277).

Native to the eastern part of South Africa, *Portulacaria afra* is an evergreen succulent shrub/tree with distinctive succulent round shaped leaves and red stems. Due to its flexibility for plant growth under various shapes and sizes, it is a widespread ornamental species. Invasiveness is limited since it has been recorded several times outside its native range usually as a casual species related to pruning wastes. The species has been recorded as casual in the Iberian Peninsula (Aymerich 2017), Canary Islands (Otto and Verloove 2016), Sicily (Pasta et al. 2017) and Australia (Gosper et al. 2015).

***Salpichroa organifolia* (Lam.) Baill. (Family: Solanaceae)**

(Figure 1G)

Synonym: *Atropa organifolia* (Lam.) Desf.

Mallorca, University of the Balearic Islands, 39°38'13.3"N; 02°38'54.8"E, Cardona (05/04/2022). One individual growing below a *Phytolacca dioica* tree in the parking lot. The plant showed abundant growth and flowering, but no fruit or seed production were observed. (Herbarium code LLGLGV4278).

South American species known to have spread to different regions of the world. Main pathway of introduction has been indicated through accidental seed contamination of container plants used for gardening in public areas, at least in Fuerteventura (Canary Islands) and presumably elsewhere (Brandes 2018). Its introduced distribution covers North America, Europe (both the Mediterranean and Temperate regions), Australia, New Zealand, and Japan, being listed as invasive in Japan and California (USA) (Brandes 2018). The individual here recorded can be considered of least concern since failure to produce seeds allows to consider it a single introduction event and invasion status can be regarded as casual.

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

(Figure 1C)

Mallorca, Ariany, 39°38'55.7"N; 03°06'54.2"E, Gil (17/01/2022). Two individuals growing on a rocky wall jointly with native species *Sedum dasyphyllum*, *S. sediforme* and *S. rubens*. (Herbarium code LLGLGV4279).

Perennial *Sedum* species endemic to Algeria. Its use for gardening is widespread due to its small size, yellow flowers, and clustered glabrous leaves at the top of a woody stem. Due to this same ornamental use the only records outside Algeria are Corsica and some localities in South France (Byalt et al. 2011), being this record the third area outside its native range. Individuals observed where thriving on a traditional rocky wall, being its origin due to seed germination or pruning remains. Intentional cultivation can't be discarded.

***Tradescantia fluminensis* Vell. (Family: Commelinaceae)**

(Figure 2A)

Mallorca, Son Rapinya, 39°35'06.3"N; 02°36'48.0"E, Cerrato (06/03/2022). Numerous individuals growing and covering the bed of the Torrent of Sant Magí, mainly in the shaded areas under *Olea europaea* trees and jointly with other alien taxa related to humid habitats such as *Cyperus alternifolius* or *Asparagus* spp. More individuals could be found in nearby trails inside the forest. (Herbarium code LLGLGV4280).

Native to tropical areas of South America, this species has been reported colonizing and invading wetlands around the world in areas such as Japan, North America, Australia, and New Zealand among others (Seitz and Clark 2016). For the Mediterranean region several countries have recorded

its presence both at eastern and western Mediterranean region, including islands such as Cyprus (Spitale and Papatheodoulou 2019). For the Balearic Islands, previous studies already indicated its presence as a cultivated species (Pla et al. 1992). This record can be considered the first evidence of its presence under natural/seminatural habitats. Even though shading has been indicated as a possible management measurement to avoid further invasion (Seitz and Clark 2016), the population here presented seems to benefit from humid conditions under the shade canopy of trees growing near the water course.

Conclusions

Balearic novelties presented in this study evidence the ongoing process of introductions. Data presented is mainly related to gardening species and in many cases their introduction can be traced to their sources (i.e. gardens). Increasing field surveys and tools, such as reliable information for proper identification, allow a better understanding of both recent and old introductions. Species such as *Tradescantia fluminensis*, known as cultivated since 1992, have not been until now observed under natural/seminatural conditions probably due to regional lack of sampling effort. Other cases are known as long escaped taxa which have been overlooked or not identified. This last phenomenon is especially applicable to complex groups such as the Cactaceae family, as occurs for “chollas” cacti (Cylindropuntieae), and the Asphodelaceae family with *Aloe* spp. These cases join complex and sometimes unresolved taxonomy, with nomenclatural confusions and ambiguities which have delayed their formal recording in the archipelago. For these cases, high vegetative resemblance, hybrids, and gardening forms add more difficulty explaining their neglect. As a result of these records, there is an increased awareness on the ecological impact of these new aliens. Invasiveness of the species presented in this study is variable. Of the recorded taxa, four species can be considered especially dangerous since invasiveness has been previously observed and assessed in other regions (*Erythrostemon gilliesii*, *Cylindropuntia tunicata*, *Tradescantia fluminensis*) or individuals observed in Balearic localities display active dispersal to native habitats (*Justicia adhatoda* and *Tradescantia fluminensis*). Four more taxa (*Buddleja madagascariensis*, *Dracaena draco*, *Euphorbia canariensis*, and *Portulacaria afra*) can be indicated as locally invasive since dispersal seems to be limited, but competition and displacement of native plant communities can be observed where developing. The remaining taxa can be considered less-threatening according to field observations. However, invasive status may vary with time, and taxa such as *Buddleja madagascariensis* or *Erythrostemon gilliesii* (which have been reported as invasive species elsewhere) could change their ecological behavior.

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Authors contribution

All authors participated in the research conceptualization, field work and data collection. MDC and PMMR writing – original draft and review and editing. ARS, LGV, CVCA, ICF and SPF – writing review and editing. SPF – funding provision.

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Supplementary material

The following supplementary material is available for this article:

Table S1. Records of alien plant species from the Balearic Islands.

This material is available as part of online article from:

http://www.reabic.net/journals/bir/2023/Supplements/BIR_2023_Cerrato_etal_SupplementaryMaterial.xlsx