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Research Article

First records of the Australian invasive weed *Atriplex semilunaris* Aellen (Amaranthaceae s.l.) in Gran Canaria and Tenerife (Canary Islands, Spain)

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Abstract

The Australian invasive weed *Atriplex semilunaris* Aellen – in the Canary Islands known so far from the islands of Fuerteventura and Lanzarote, where it is listed among the most invasive species – was recently recorded for the first time in the islands of Gran Canaria and Tenerife, a significant expansion of its distribution in the archipelago. Details about these first records, including a distribution map and new illustrations, are presented. Its recent appearance in Gran Canaria and Tenerife is very important, as it may be the gateway for its introduction to the rest of the islands of the archipelago. The ecological threats associated with the expansion of the species are discussed and the measures that seem appropriate are indicated. Finally, it cannot be ruled out that the species will spread further to the nearby North African coastal areas (or is already occurring there unnoticed), where the chance of establishment and expansion is optimal.

Key words: Australia, Chenopodiaceae, IAS, Macaronesia, new records, North Africa, weeds

Introduction

The genus *Atriplex* L. (Amaranthaceae s.l., Chenopodiaceae) currently includes around 260 species that occur throughout the temperate and subtropical regions of the world, with possible center of diversity in Asia (Žerdoner Čalasan et al. 2022). Many species are confined to deserts or steppe-like habitats and are resistant to salt and drought (Glenn et al. 2012). In the Canary Islands, only two species are "probably native": *A. glauca* L. [only subsp. *ifniensis* (Caball.) Rivas-Mart. et al.] and *A. halimus* L. (BIOTA 2024). However, six additional species are naturalized there. Except for the almost cosmopolitan *A. prostrata* Boucher ex DC. (whose origin seems to be the Eurasian and Mediterranean region; POWO 2024), all are Australian endemics that are particularly well adapted to the harsh environmental conditions (extremely dry and sunny) encountered in some of the islands of the archipelago. It concerns: *A. lindleyi* Moq., *A. nummularia* Lindl., *A. semibaccata* R. Br., *A. semilunaris* Aellen and *A. suberecta* I. Verd. Out

of these, *A. semilunaris* is the second most recent introduction in the Canary Islands, only preceded by *A. lindleyi* (Padrón-Mederos et al. 2009). It is a decumbent to erect perennial herb, branched from the base and 20-70(-100) cm tall. Leaves are alternate, the medium-sized ones 3–5 × 1–2 cm, ovate-lanceolate to more or less narrowly rhombic, margins are roughly toothed-lobed in their upper half, long cuneate at the base. Flowers are produced in the axils of the upper leaves and in terminal spike-like inflorescences. Fruiting bracteoles are rhombic-deltoid, with toothed-spinulous margins and with two spiny crescent-shaped appendages on the back; the bracteoles are not fused, except at the base where they form a 1–2 mm long tube. Although the species is relatively easy to identify based on these characteristics, it may be overlooked due to its superficial similarity to other Canarian or North African species such as *A. glauca*. *Atriplex semilunaris* naturally occurs in claypans, salt lakes, subcoastal dunes, floodplains and rocky hillsides, with a rather limited natural distribution that is confined to Western Australia. In the Canary Islands, it was first recorded in 2003 in Fuerteventura (Reyes-Betancort and Scholz 2004; Brandes and Garve 2005) and a few years later, from 2008 onwards, also in Lanzarote (Padrón-Mederos et al. 2009). In no time, *A. semilunaris* has spread all over Fuerteventura: in 2009 already, it was classified as a transformer species (i.e., an invasive plant which changes the character, condition, form or nature of ecosystems over a substantial area relative to the extent of that ecosystem; Richardson et al. 2000) occupying more than 300 km^2 (Martín Osorio et al. 2009). It is found along most of the eastern coast of the island and in some inland places, growing mainly in communities belonging to the *Mesembryanthemion crystallini* Rivas-Martínez et al. 1993, in disturbed areas with more or less saline soils (roadsides, abandoned fields), where it frequently occurs in almost pure stands. Moreover, it has invaded *Polycarpaeo niveae-Traganetea moquini* A. Santos ex Rivas-Martínez & Wildpret 2002 communities in beach-areas and in some places it is becoming increasingly common in marginal, degraded areas of salt marshes occupied by *Zygophyllo fontanesii-Arthrocnemetum macrostachyi* Fernández Galván & Santos, 1984 (Martín Osorio et al. 2009). Similar behavior has subsequently been recorded from the island of Lanzarote where it is included in the top 20 of plant invaders (Paredes Gil 2018). As a consequence, *A. semilunaris* was included in the list of invasive alien species in Spain (Ministerio de Agricultura, Alimentación y Medio Ambiente 2013). The species was sometimes brought in with wool in Europe in the past, as an ephemeral introduction (e.g. Aellen 1939; Pyšek et al. 2012). However, apart from the Canary Islands, it is apparently not known to have become established anywhere else in the world outside of Australia. Interestingly, in Kuwait the use of this species was considered to combat desertification and prevent soil erosion (Suleiman and Bhat 2004). It is unclear whether it was actually used for this purpose, but in any case the species does not occur in the wild there (Omar 2024).

In the present paper the further spread of *A. semilunaris* in the Canary Islands is documented, with emphasis on the first records of the species in the islands of Tenerife and Gran Canaria, since 2018 and 2020 respectively.

Materials and methods

The distribution data presented in this article are the result of numerous fieldwork sessions by the authors in recent years. The first populations were discovered rather by chance. In order to obtain a better understanding of the real distribution of the species, a more targeted search was conducted, in locations and habitats that seemed suitable for the species (i.e. strongly anthropogenically influenced coastal habitats). The species was identified using relevant literature sources, including Aellen (1938, 1960), Wilson (1984) and Reyes-Betancort and Scholz (2004). Voucher specimens were collected in some of the populations and these were deposited in the herbaria of Meise Botanic Garden, Belgium (BR), the Jardín de Aclimatación de la Orotava in Puerto de la Cruz, Tenerife, Spain (ORT), the Jardín Botánico Canario Viera y Clavijo in Las Palmas de Gran Canaria, Gran Canaria, Spain (LPA), and the University of Valencia, Spain (VAL). Likewise, numerous photos were taken in several of the discovered localities. Records (including photographs) from Tenerife and Gran Canaria from 2022 and 2023 by the first author were moreover registered on the observation.org online platform (https://observation.org/), data which were subsequently also included in GBIF (Global Biodiversity Information Facility; https://www.gbif.org/).

Results

Atriplex semilunaris *Aellen in Tenerife (Figures 1–3)*

In Tenerife, *A. semilunaris* was discovered by one of us (JARB) in December 2018 in San Miguel de Tajao, at the drive-out of the TF-1 motorway, near the entrance of the P.I.R.S. landfill. Soon afterwards, in January 2019 its presence there was confirmed by the first author (FV). In the intervening years, the species was regularly observed in this locality and the number of individuals has obviously increased. By October 2022 a solitary individual was recorded ca. 1 km further south, along the TF-1 motorway (FV). In general, however, the species currently does not show any notable expansion towards surrounding areas, although the local conditions are favorable for the species. The species grows in disturbed habitats characterized by the annual communities of *Mesembryanthemion crystallini* and the shrubby ones of the *Launaeo arborescentis-Schizogynion sericeae* Rivas-Martínez et al. 1993.

It is unknown when and how *A. semilunaris* arrived in this locality (the same moreover applies to the other populations in the other islands). On Google Streetview images from January 2009 and July 2014 the species seems to be absent from this locality, to the extent that this can be assessed from these images. As the plants occur at the entrance of a massive landfill,

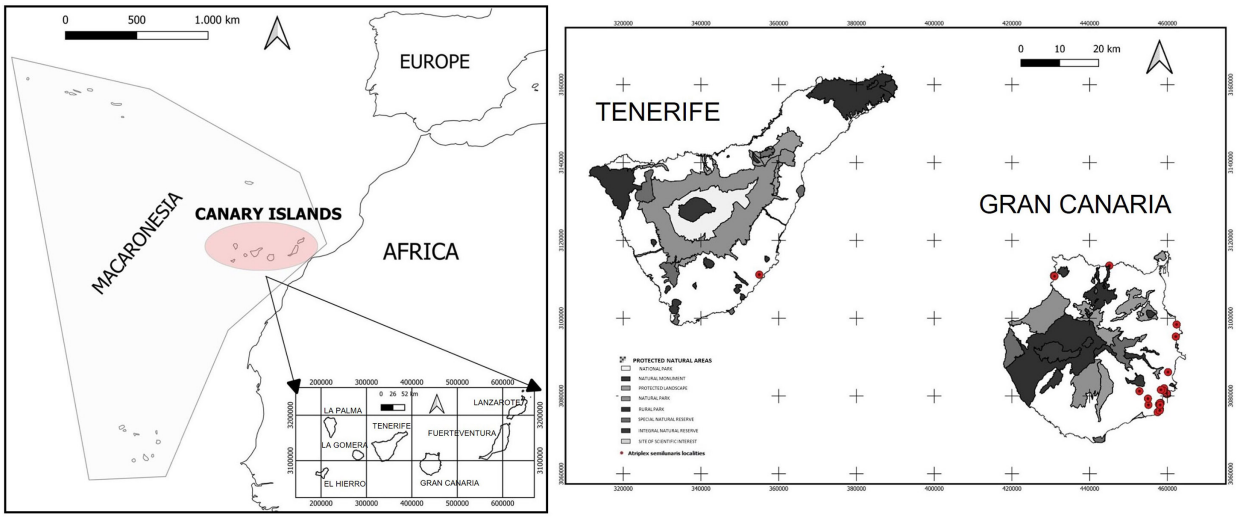

Figure 1. Localities (red bullets) of *Atriplex semilunaris* Aellen on the islands of Tenerife and Gran Canaria detected during this study.

Figure 2. Inflorescence of *Atriplex semilunaris* Aellen in Arico, Tenerife, 19 January 2019, F. Verloove.

with many trucks driving back and forth, it is tempting to think that the plant may have been brought in with waste and the associated transport. Since 2019 the locality has been monitored by the Canarian Early Warning Network for Invasive Species (RedEXOS 2024).

Figure 3. Habit and habitat of *Atriplex semilunaris* Aellen in Arico, Tenerife, 19 January 2019, F. Verloove.

Herbarium specimens:

TENERIFE: Arico, San Miguel de Tajao, drive-out of TF1-motorway at P.I.R.S., arid roadside, numerous individuals but only locally (a recent introduction), 19.01.2019, *F. Verloove* 13463 (BR0000025951394V).

Atriplex semilunaris *Aellen in Gran Canaria (Figures 1, 4, 5)*

In Gran Canaria *A. semilunaris* was first recognized by one of us (JARB) in January 2020 through a photograph uploaded to Facebook by Francisco Molina González, taken on the coast of the municipality of Gáldar, in the northwestern part of the island. The species was found to the west of Llanos de La Botija, near the Barranco del Juncal, in abandoned tomato fields, where it is occasionally forming dense stands. Subsequently, in October 2020, the second author (MAPM) found this species in the eastern part of the island in Montaña los Vélez (north of Arinaga) and in surrounding places such as the Polígono Industrial of Arinaga and also below Los Corralillos, all located in the municipality of Agüimes. All these locations are characterized by the presence of quite busy traffic roads and the frequent occurrence of earth moving activities (soil, rubble, etc.), similar to the location where the species was previously discovered in Tenerife. It appears that these are related to the initial introduction and further spread of the species on both islands. The locality of Los Corralillos has been assessed in November 2022 by the Canarian Early Warning Network for Invasive Species (RedEXOS 2024).

Figure 4. Habitat of *Atriplex semilunaris* Aellen in northwestern Gran Canaria (Gáldar), 17 March 2024, A. Reyes-Betancort.

Figure 5. Typical heavily disturbed habitat of *Atriplex semilunaris* Aellen in eastern Gran Canaria (Santa Lucía de Tirajana), 21 December 2023, F. Verloove.

A few years later, the species was recorded in abundance by the first author (FV) in December 2023 in adjacent areas slightly further south. It was first observed in Pozo Izquierdo, in the municipality of Santa Lucía de Tirajana, where it is ubiquitous, with thousands of individuals, in ruderalized coastal habitats (roadsides, vacant lots in residential areas, dry waste grounds, etc.). It extends further south to the estuary of the Barranco de

Tirajana in Castillo del Romeral. Further inland the species spreads along the GC-194 road towards El Doctoral. It was also observed in El Doctoral itself (alongside the Calle Franchy Roca, near the entrance of the petrol station). Further south, in El Matorral (municipality of San Bartolomé de Tirajana), *A. semilunaris* was observed at the drive-in of the GC-1 motorway. Also, scattered occurrences, usually with small numbers, were recorded again in the south of the Arinaga industrial area.

Even more recently, in April and May 2024, one of us (MSP) discovered additional new populations in the municipalities of Moya and Telde, confirming the expansion drive of this species on the island. *Atriplex semilunaris* was first observed, by chance, in San Andrés (Moya), in the northern part of the island, on the coast near the mouth of the Azuaje ravine. In this locality a high number of individuals (approximately 500 mature individuals) was found, at different stages of development, including abundantly fruiting individuals. The population at present occupies about 250 m^2, with scattered specimens about 200 m away from the main group. Companion species are very diverse and range from Macaronesian endemics to invasive pantropical weeds, for example (names in accordance with POWO 2024): *Patellifolia procumbens* (C. Sm. ex Hornem.) A.J. Scott, Ford-Lloyd & J.T. Williams, *Mesembryanthemum crystallinum* L., *M. nodiflorum* L., *Launaea nudicaulis* (L.) Hook.f., *Cenchrus setaceus* (Forssk.) Morrone, *Atriplex suberecta*, *Datura innoxia* Mill., *Tetragonia echinata* Aiton, *Schizogyne sericea* (L.f.) DC. and *Astydamia latifolia* (L.f.) Baill. From this, it can be deduced that in the north of Gran Canaria the species occurs in disturbed habitats (mainly dominated by *Mesembryanthemion crystallini* communities) but potentially also in more natural communities such as the *Frankenio-Astydamietum latifoliae* Lohmeyer & Trautmann ex A. Santos 1976, and *Astydamio latifoliae-Euphorbietum aphyllae* (Rivas Goday & Esteve 1965) A. Santos 1983. Subsequently, more targeted fieldwork in habitats that seemed suitable for the species was carried out in order to determine the real distribution of *A. semilunaris* in the coastal areas of Gran Canaria, in particular in the northern and northeastern parts of the island. This showed that the species does not yet occur in the protected natural area of Jinámar (Playa de Jinámar and Playa de Bocabarranco) and has not currently been observed on the coast of Las Palmas de Gran Canaria (La Laja, La Isleta, El Rincón). Other verified locations that did not yield populations include: Tufia (Telde), Melenara (Telde), El Puertillo (Arucas) and Quintanilla (Arucas). However, new populations were also found, firstly in La Mareta (Telde) on the northeastern coast, where only a few (5–10) young specimens occur. It therefore seems that the species was recently introduced to this locality. Its occurrence there (just as well as elsewhere in Gran Canaria) could be associated with the construction sector, more specifically due to the import of sand and gravel from Fuerteventura.

The species was accompanied by, among others, *Patellifolia procumbens*, *Mesembryanthemum crystallinum*, *Launaea nudicaulis*, *Cenchrus setaceus*, *Atriplex glauca* L., *Chenopodiastrum murale* (L.) S. Fuentes, Uotila & Borsch and *Cynodon dactylon* (L.) Pers. Here, the species occurs in similar disturbed habitats but potentially also in the association of the Sweet spurge shrubland, *Euphorbietum balsamiferae* Sunding 1972, which demonstrates the great invasive potential of this species. In the latter habitat it is found with other notable invaders such as *Cenchrus setaceus* or *Atriplex suberecta*. Finally, *A. semilunaris* was also observed a bit further south, in La Gomera (Salinetas-Telde), where a single individual was seen, accompanied by *Patellifolia procumbens*, *Mesembryanthemum crystallinum*, *Launaea nudicaulis*, *Cenchrus setaceus* and *Atriplex suberecta*.

As a result, the species has spread across a large part of the east coast of Gran Canaria in just a few years. The most invaded strip is not coincidentally the most urbanized and most disturbed part of the island (Figure 1).

Herbarium specimens:

GRAN CANARIA: Ingenio, alrededores de la Gasolinera Disa Km 21 de la autovía, escasa, 47 m.s.m. (28R 460.178, 3.086.142), 02.11.2020, *M.A. Padrón Mederos* (ORT 47387); Agüimes, Polígono Industrial de Arinaga, abundante, varias localidades, 28 m.s.m. (28R 458.942, 3.081.710), 02.11.2020, *M.A. Padrón Mederos* (ORT 47389); Agüimes, Cruce Arinaga, hacia Los Corralillos, borde crta., 125 m.s.m. (28R 454.778 3.083.772), 20.11.2022, *M.A. Padrón Mederos* (ORT 48314); Santa Lucía de Tirajana, Pozo Izquierdo, GC-194 road near the village, dry roadside, in few years' time ubiquitous in the entire area, 21.12.2023, *F. Verloove* 14947 (BR, dupl. VAL); Agüimes, Arinaga, industrial area, near estuary of Barranco del Polvo, scattered populations in this area, 22.12.2023, *F. Verloove* 14960 (BR); Gáldar, Lomo del Cardonal, en cultivos de tomates abandonados, 92 m.s.m (28R 430.985, 3.110.769), 17.03.2024, *J.A. Reyes-Betancort & A. González Hernández* (ORT 48518, 48519, 48520); Telde, La Mareta, 29 m.s.m. (28R DR 62386 98411), 18.04.2024, *M. Salas Pascual* (LPA 41408-41409); Telde, Salinetas, La Gomera, avenida de entrada a Salinetas, 26 m.s.m. (28R DR 62169 95287), 18.04.2024, *M. Salas Pascual* (LPA 41410, 41411, 41412); Moya, San Andrés, desembocadura del Barranco de Azuaje, 5 m.s.m. (28R DS 45070 13512), 29.03.2024, *M. Salas Pascual* (LPA 41413, 41414, 41415).

Discussion and conclusion

The Australian herb *A. semilunaris*, which naturally only occurs in Western Australia, is very resistant to drought, making it potentially applicable in areas that are severely affected by drought, e.g. for erosion control or for pasture restoration. At least in Kuwait this possibility was explored in the

recent past (Suleiman and Bhat 2004). It could also be applied for that purpose in climatologically similar areas, for example, North Africa and some of the Canary Islands. Although it remains a mystery how exactly the species got there [it is rather unlikely that the species was introduced directly and accidentally from Australia; the same applies to another relatively recently introduced Australian species in Gran Canaria, *Maireana brevifolia* (R. Br.) Paul G. Wilson; Reyes-Betancort et al. 2002], it is a fact that *A. semilunaris* did indeed appear (in the wild) in the Canary Islands about 20 years ago, first in Fuerteventura and shortly afterwards also in Lanzarote. As far as we could determine, these are the only areas worldwide where the species has naturalized outside Australia. Thanks to the climatic conditions that are very suitable for the species and the abundance of invadable habitats, the species was able to establish itself in a short time and spread quickly, to such an extent that soon after its introduction it was already classified as a "transformer species" (Martín Osorio et al. 2009).

Taking into account the current wide distribution of the species in Fuerteventura and Lanzarote, and the frequent transports between these islands and other islands of the archipelago (particularly Gran Canaria and Tenerife), it was a matter of time before *A. semilunaris* would emerge elsewhere. It is therefore not surprising that at the end of 2018 the authors also saw the species for the first time outside the original naturalization area, first in Tenerife and soon afterwards also in Gran Canaria. How exactly the species reached Tenerife and Gran Canaria is subject to speculation, but it was most likely introduced as a contaminant in soil and other building materials, directly from Fuerteventura and/or Lanzarote. While in Tenerife the species remains restricted to a small area for the time being and shows little expansion, in Gran Canaria it has spread over a significant part of the eastern and northern coasts in a short time. Geographically, Gran Canaria is closer to Fuerteventura and Lanzarote (as well as to North Africa) and also climatologically there may be a slightly higher similarity with these areas than with Tenerife, which may (partly) explain this different behavior.

As in Fuerteventura and Lanzarote, *A. semilunaris* in Gran Canaria primarily occurs in highly disturbed, anthropogenic habitats, especially of the *Mesembryanthemion crystallini* class. However, its occurrence, together with species from more natural plant associations, such as from the *Frankenio-Astydamietum latifoliae*, the *Astydamio latifoliae-Euphorbietum aphyllae* or the *Euphorbietum balsamiferae*, is particularly worrying. As in Fuerteventura and Lanzarote, the further spread of *A. semilunaris* is closely monitored by the Early Warning Network of the Government of the Canary Islands (RedEXOS), in both Tenerife and Gran Canaria. Work has already been carried out to try to eradicate some of its populations, at least in Tenerife. It is, however, necessary that these management works be prolonged over time to avoid a greater expansion of the species, given the

high capacity for seed production and its proximity to roads that act as very efficient dispersal routes. Early detection is essential to contain this species and thus avoid its appearance in other localities or even on other islands where there are suitable habitats for its development, but where it has not yet been located. Taking into account what has happened on Fuerteventura and Lanzarote, the complete eradication of this species is unrealistic. *A. semilunaris* reproduces exclusively from seeds but these are already produced soon after germination and in large quantities. What does seem feasible is to try to prevent the species from reaching the protected natural areas closest to the recently discovered populations in Gran Canaria and Tenerife, where it would endanger the endemic species that occur there. On the island of Gran Canaria, the coastal area in the eastern part of the island where the species has been detected, from Arinaga to the coast of Telde, coincides with several of these areas: the Sitios de Interés Científico of Tufia and Jinámar and the Monumento Natural de Arinaga. In these locations, *A. semilunaris* threatens several local endemic species such as *Lotus kunkelii* (Esteve) Bramwell & D.H. Davis, *L. arinagensis* Bramwell and *Atractylis preauxiana* Sch. Bip., which grow in rocky areas with superficial sand, a habitat also occupied by the Australian invader. The population in Tenerife is located far from protected natural areas, but can still pose a threat to the local native flora. Moreover, because the species grows close to the motorway, it can quickly move to protected areas.

Finally, as the species continues to expand rapidly in the easternmost Canary Islands, it is becoming increasingly likely that it will also end up on the nearby North African coasts (or even already occurs there unnoticed). In recent years, several invasive species have crossed the Atlantic Ocean, such as *Zygophyllum gaetulum* Emb. & Maire subsp. *waterlotii* (Maire) Dobignard, Jacquemoud & D.Jord. from North Africa to the Canary Islands (Barone Tosco et al. 2003) and *Maireana brevifolia* in the opposite direction (Giardi and Homrani Bakali 2023). If *A. semilunaris* were to establish itself on the North African mainland, its unbridled expansion on a large scale is almost inevitable.

Post scriptum

After the acceptance of this paper, additional fieldwork was carried out by the first author in December 2024 in Gran Canaria. During this fieldwork the species was found in many new locations. In addition to new records within the already known distribution area, *A. semilunaris* was also discovered in new areas:

1) In the northwestern part of Gran Canaria in El Agujero (Gáldar), in the dried-out riverbed of the Barranco de Gáldar;
2) The species now also has reached the main touristic area in the southern part of the island (the wider Maspalomas area), where it was recorded

on the beach at Playa del Águila and in roadsides in Bahía Feliz and Playa del Inglés;

3) Finally, its presence in large numbers was also noted in the Barranco de Tirajana at El Doctoral and Aldea Blanca, where it had not yet been recorded a year earlier.

Author's contribution

Research conceptualization: FV. Data collection: FV, MAPM, MSP and JARB. Writing first draft: FV. Reviewing and editing first draft: MAPM, MSP and JARB.

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Supplementary material

The following supplementary material is available for this article:

Table S1. Geo-referenced records of *Atriplex semilunaris*

This material is available as part of online article from:
http://www.reabic.net/journals/bir/2025/Supplements/BIR_2025_Verloove_SupplementaryMaterial.xlsx