

## CORRECTED PROOF

## Rapid Communication

***Aeonium haworthii* Webb & Berthel. and *Crassula ovata* (Mill.) Druce (Crassulaceae): New records for the Algerian alien flora**Nora Sakhraoui<sup>1</sup>, Amel Boudries<sup>1</sup>, Azzedine Hadeff<sup>1</sup>, Filip Verloove<sup>2</sup> and Franz Essl<sup>3</sup><sup>1</sup>Department of Ecology and Environment, Faculty of Sciences, University 20 August 1955 Skikda, BP. 26 El-Hadaiek Road, Skikda, 21000, Algeria<sup>2</sup>Meise Botanic Garden, Nieuwelaan 38, B-1860 Meise, Belgium<sup>3</sup>BioInvasions. Global Change. Macroecology Group, Department of Botany and Biodiversity Research, University of Vienna, Rennweg 14, 1030 Vienna, AustriaCorresponding author: Nora Sakhraoui ([sakhraouinora05@gmail.com](mailto:sakhraouinora05@gmail.com))

**Citation:** Sakhraoui N, Boudries A, Hadeff A, Verloove F, Essl F (2023) *Aeonium haworthii* Webb & Berthel. and *Crassula ovata* (Mill.) Druce (Crassulaceae): New records for the Algerian alien flora. *BioInvasions Records* 12 (in press)

**Received:** 25 March 2023**Accepted:** 23 July 2023**Published:** 5 October 2023**Handling editor:** Carla Lambertini**Thematic editor:** Giuseppe Brundu**Copyright:** © Sakhraoui et al.

This is an open access article distributed under terms of the Creative Commons Attribution License (Attribution 4.0 International - CC BY 4.0).

**Abstract**

This paper expands the list of alien species of Crassulaceae that escaped from cultivation in Algeria and mainland North Africa, as a result of the discovery of two new alien species in the Skikda region (northeastern Algeria) in 2021 and 2023. *Aeonium haworthii* was recorded in a semi-natural habitat, the maritime cliff of the Stora region, and seems completely naturalized in this locality. *Crassula ovata* was recorded in an urban environment, where it colonizes balconies and roofs; at present, this species is considered to be a casual. These results are supported by field photos of both species, a distribution map and an updated list of alien Crassulaceae species reported so far from mainland North Africa (Algeria, Morocco and Tunisia).

**Key words:** alien species, escapes, green spaces, habitat, naturalization, North Africa, succulents

## OPEN ACCESS

**Introduction**

The Crassulaceae family includes herbs, shrubs and more rarely trees (Simpson 2010) that belong to about 35 genera and 1400 species (Christenhusz and Byng 2016). The family is widely distributed, with diversity centers in some semi-arid regions of the world including South Africa, Mexico, southwestern North America, Mediterranean Europe and parts of the Orient (Smith et al. 2019).

Most species of this family proliferate in arid conditions and can cope well with drought stress thanks to water reserves stored in their leaves and/or stems and the CAM (Crassulacean Acid Metabolism) photosynthetic pathway which allows them to reduce evapotranspiration (Chen and Blankenship 2021). These characteristics, together with easy vegetative propagation, have probably facilitated the introduction and wide use of many species of this family as ornamental plants in different parts of the world.

In Algeria, the Crassulaceae family is represented, according to Dobignard and Chatelain (2011), by four native genera (*Crassula* L., *Pistorinia* DC.,

*Sedum* L. and *Umbilicus* DC.) and one introduced genus (*Aeonium* Webb & Berthel.); in total, 28 species including one Algerian endemic (*Sedum multiceps* Coss. & Durieu) and one naturalized species (*Aeonium arboreum* (L.) Webb & Berthel.) have been recorded so far in Algeria. However, more recently the study of Zeddami and Raus (2012) increased the number of alien Crassulaceae established in Algeria by adding one genus with one species (*Kalanchoe* × *houghtonii* D.B. Ward, erroneously identified as *K. daigremontiana* Raym.-Hamet & H. Perrier, see Herrando-Moraira et al. 2020).

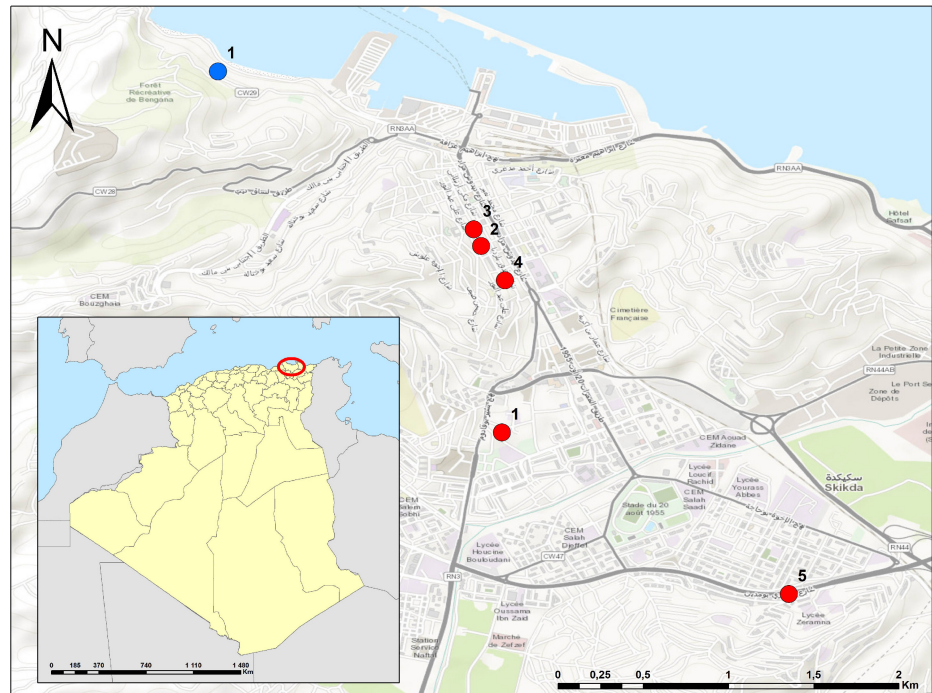
The present work, once again, extends the number of alien Crassulaceae in Algeria, since it reports the escape from cultivation of two alien species not previously reported in the country. *Aeonium haworthii* Webb & Berthel. and *Crassula ovata* (Mill.) Druce were discovered in the Skikda region (northeastern Algeria) during field surveys between 2021 and 2023. Both species are widely cultivated in gardens and nurseries in the region, along with other species of the Crassulaceae family (Sakhraoui 2021); they are particularly appreciated for their foliage and their decorative habit.

For this study, we recorded information concerning these occurrences, in particular data on the mode of spreading and the nature of the colonized habitats of the studied species in Algeria. Further, we provide a distribution map of the localities, photographs of the species in the colonized habitats, and a list of alien species of Crassulaceae reported so far in Algeria and other countries of the mainland North Africa (Morocco and Tunisia).

## Materials and methods

The escaped populations of *Aeonium haworthii* and *Crassula ovata* were found during field surveys, carried out by the first author, for monitoring the dynamics of previously recorded potentially invasive alien plants species (see Sakhraoui et al. 2019, 2022a, b) in the Skikda region. Both species were observed on several occasions (at least twice per season) between 2021 and 2023. The species were identified by consulting Maire (1977), Hernández Romero et al. (2012) and Flora de Canarias ([http://www.floradecanarias.com/aeonium\\_haworthii.html](http://www.floradecanarias.com/aeonium_haworthii.html)); however, the descriptions given in this paper are mainly based on our own field observations of the Algerian plants.

The determination of the biological characteristics relating to flowering, fruiting and reproduction required seasonal monitoring. The latter was done in situ with the exception of the monitoring of fruiting in *C. ovata* which was carried out in the gardens of the Joint Research Service “Botanical Extension Pole” of the University of Skikda where a few individuals are cultivated in pots, because the individuals that have escaped from cultivation grow at inaccessible heights that do not allow their examination. The degree of naturalization of the escaped individuals was assessed according to Pyšek et al. (2004). The status categories used are casual (alien plants that may flourish and even reproduce occasionally outside cultivation in an area, but that eventually die out because they do not form self-sustaining populations, and rely on repeated introductions for their persistence), and naturalized



**Figure 1.** Distribution of recorded populations of *Crassula ovata* (red dots) and *Aeonium haworthii* (blue dot) in the Skikda region (northeastern Algeria). The numbers of the populations correspond to Table 1.

(alien plants that sustain self-replacing populations for at least 10 years without direct intervention by people (or in spite of human intervention) by recruitment from seeds or ramets (tillers, tubers, bulbs, fragments, etc.) capable of independent growth).

Further, a literature search was carried out to assess the distribution of the studied species in adjacent regions particularly in Morocco and Tunisia, as well as to confirm the absence of previous records for Algeria. The sources that have been consulted in this regard are the African Plant Database (APD 2023), Euro+Med PlantBase (2023), Global Biodiversity Information Facility (GBIF 2023), and Plants Of the World Online (POWO 2023).

## Results

### *Localities and populations size*

*Aeonium haworthii* and *Crassula ovata* have been exclusively recorded in the town of Skikda where they colonize different habitats. The population of *A. haworthii* is larger than the one of *C. ovata*, however, the number of localities of the latter is higher (Figure 1). Information relating to these records, including the characterization of the localities and their geographic coordinates, is detailed below.

### **1. *Aeonium haworthii* Webb & Berthel.**

Syn.: *Sempervivum haworthii* (Webb & Berthel.) Salm-Dyck ex Christ.

This species was found at a single locality, more precisely on a rocky cliff exposed to sea spray (Figure 2A, B), at the edge of the ledge road leading to



**Table 1.** Geographic coordinates of recorded localities of *Aeonium haworthii* and *Crassula ovata* escaped from cultivation in Skikda city (northeastern Algeria).

Id	Species	Locality	Habitat	Latitude	Longitude	Altitude (m)	Population size
1	<i>Aeonium haworthii</i>	Stora	Coastal cliff	36.888172°	6.893359°	34	dozens of individuals
1	<i>Crassula ovata</i>	Mekki Ourtilani street	Balcony	36.877048°	6.908383°	48	1 individual
2	<i>Crassula ovata</i>	Belizidia street	Balcony	36.879078°	6.906919°	51	1 individual
3	<i>Crassula ovata</i>	Avenue of Revolution	Balcony	36.879731°	6.906715°	54	1 individual
4	<i>Crassula ovata</i>	Avenue of Bachir Boukadoum	Gutter of a house	36.868851°	6.908028°	27	1 individual
5	<i>Crassula ovata</i>	Avenue of Houari Boumediene	Metal roof	36.860476°	6.923604°	32	1 individual



**Figure 2.** Population of *Aeonium haworthii* on a coastal cliff at Stora (Skikda, northeastern Algeria): individuals without flowers, 21 January 2021 (A), rosette of fleshy leaves, 21 January 2021 (B), individuals with flowers, 06 May 2021 (C), details of flowers, 06 May 2021 (D). Photos by N. Sakhraoui.

the port of Stora (Municipality of Skikda); there, dozens of individuals of different sizes were first observed on 09.02.2021 (15 tufts were identified with sizes varying from 25 cm to more than 1 m in diameter), then re-observed on 15.05.2022 and 05.03.2023 (Table 1, Population no. 1); during

these surveys, young individuals were recorded several times. This species grows on shallow soil at platforms and cracks together with native species, in particular *Achyranthes aspera* L., *Antirrhinum majus* L., *Centranthus ruber* (L.) DC., *Dactylis glomerata* L., *Dittrichia viscosa* (L.) Greuter, *Daucus carota* L., *Echium creticum* L., *Lobularia maritima* (L.) Desv., *Lotus drepanocarpus* Durieu, *Malva sylvestris* L., *Matthiola incana* (L.) R. Br., *Pallenis maritima* (L.) Greuter, *Parietaria judaica* L., *Plantago serraria* L., *Sedum caeruleum* L. and *Senecio leucanthemifolius* Poir. Naturalized alien species were also recorded in this locality, including *Drosanthemum floribundum* (Haw.) Schwantes (Sakhraoui et al. 2023), *Nephrolepis exaltata* (L.) Schott and *Oxalis pes-caprae* L. Further, native shrubs and large tussock grasses were also noted, such as *Ampelodesmos mauritanicus* (Poir.) Durand et Schinz, *Artemisia arborescens* (Vaill.) L., *Chamaerops humilis* L., *Genista numidica* (Spach) Batt. subsp. *numidica*, *Pistacia lentiscus* L. and *Olea europaea* L.

In Skikda, *A. haworthii* is often grown in pots as an ornamental plant at balconies and terraces, from where it probably escaped to colonize the semi-natural habitat. In the field, we noticed that the flowering period of this species is short. Pale yellow flowers were observed at the beginning of May, and the flowering period was already over at the end of the same month (Figure 2C, D). Seeds were not collected because the plants did not produce fruit in Algeria. The dispersal is probably from stem fragments and leaves which root easily once detached from the mother plant. This species also produces adventitious roots which facilitate vegetative spread.

#### *Status of naturalization of Aeonium haworthii*

According to the criteria used, *A. haworthii* can be considered naturalized, since it has been growing in this semi-natural habitat, according to the testimony of inhabitants, for several years, mixes with the native flora and the size of the population has steadily increased.

#### **2. *Crassula ovata* (Mill.) Druce**

This species was mainly observed in the old town of Skikda where four out of five recorded individuals were found. It was first observed on 18.04.2021 at Mekki Ourtilani street, where an individual up to 80 cm tall and carrying flowers was found hanging on the wall of a balcony of an old house (Table 1, individual no 1). About 300 m from this spot, in Belizidia street, another mature individual exceeding 80 cm in height was found on 21.05.2021, again clinging to the wall of a balcony where other alien species were cultivated in pots, including *Euphorbia milii* Des Moul., *Coleus scutellarioides* (L.) Benth., *Dracaena trifasciata* (Prain) Mabb. and *Heptapleurum arboricola* Hayata (Table 1, individual no. 2). On the same day, an individual, more than 90 cm tall, was observed clinging to a balcony at the Revolution Avenue (Table 1, individual no. 3); the two latter individuals were re-observed on





**Figure 3.** *Crassula ovata* in urban habitat at Skikda city (northeastern Algeria): on balcony, 19 May 2022 (A), on metal roof, 01 June 2022 (B), flowers of individual on balcony, 21 January 2023 (C). Photos by N. Sakhraoui and A. Boudries.

19.05.2022 and 15.02.2023. On 25.04.2022, another individual was found at Bachir Boukadoum Avenue growing in the gutter of an old house (Table 1, individual no 4).

In the new town of Skikda, the fifth individual, measuring around 25 cm, was observed on 17.10.2021 and re-observed on 09.05.2022 and 27.02.2023 at Houari Boumediene street (Table 1, individual no. 5), hanging from the metal roof of a store where it grows on a thin substrate resulting from the accumulation of dust (Figure 3A, B); there, further alien species were also recorded such as *Kalanchoe* × *houghtonii* D.B. Ward and *Nephrolepis exaltata*. In all these localities, *C. ovata* occurred with single individuals.

In Algeria, the flowering period of *C. ovata* extends from mid-January to the beginning of March. The flowers are of variable colors, i.e., white or light pink (Figure 3C). Seeds and fruit were not seen in the gardens of the Joint Research Service “Botanical Extension Pole” of the University of Skikda, and the field observations indicate that *C. ovata* is probably dispersed only by stem fragments or detached leaves.

#### *Status of naturalization of Crassula ovata*

*Crassula ovata* is represented by only a few individuals that persist in the recorded localities but do not form self-sustaining populations and do not spread beyond the urban environment yet, therefore it should be considered a casual species in Algeria according to the criteria used.

### **Discussion**

#### *Status of A. haworthii and C. ovata in Algeria and North Africa*

The literature research revealed no previous reports for *A. haworthii* in Algeria. In contrast, there are two observations for *C. ovata* on the iNaturalist platform (<https://www.inaturalist.org/observations/91779260>, <https://www.znaturalist.org/observations/107543445>) included in GBIF (2023). However, the two photos posted on iNaturalist, taken respectively in April 2008 and February 2022 in urbanized sites in the wilaya (= district) of Algiers, unfortunately do not allow to identify the colonized habitat, i.e. to assess whether these observations refer to planted or escaped individuals. Either way, these occurrences indicate that *C. ovata* is present in other parts of the country where it is also likely to escape cultivation.

In mainland North Africa, the escape of *A. haworthii* from cultivation has been reported so far only in Tunisia where it was reported as alien with unknown status by El Mokni et al. (2019). Thus, the record from Skikda is the first one for mainland North Africa where the species is clearly naturalized.

*Crassula ovata* on the other hand, has been reported only from the Canary Islands (<https://www.biodiversidadcanarias.es/biota/especie/E07446>) and Madeira (Vieira 2002), but there are no records for mainland North Africa.

#### *Species description, distribution and spreading in Algeria*

*Aeonium haworthii* is a succulent subshrub native to Tenerife (the largest of Spain’s Canary Islands) (Walker 2021) from where it was introduced to different regions of the world as an ornamental plant. Its escape from cultivation has been reported in a few countries, notably in New Zealand (Webb et al. 1988) and in the United States where it is naturalized in California ([https://www.calflora.org/entry/occdetail.html?seq\\_num=mu20189](https://www.calflora.org/entry/occdetail.html?seq_num=mu20189)). In Europe, *A. haworthii* has been reported as casual in Spain (Aymerich and Sáez 2019) and naturalized in Italy (Galasso et al. 2019) and Portugal (Domingues De Almeida and Freitas 2006).

Individuals naturalized in Algeria are characterized by slender and branched stems that can exceed 50 cm in height, with numerous adventitious roots. Leaves are thick and ciliate on the margin, green or a little glaucous, often bordered with purple. They are organized in rosettes that can exceed 10 cm in diameter. The petals of the flowers are pale yellow and the sepals are slightly pink. *Aeonium haworthii* closely resembles *A. castello-paivae* Bolle which was also cultivated in Algeria (Maire 1977) and probably still is. Both species can easily be confused, however, their separation is facilitated by examining the flowers which are greenish-white in *A. castello-paivae*.

*Aeonium haworthii* is endemic to the Anaga mountains in northeastern Tenerife, where it grows commonly on dry cliffs and rocks from sea level to 1,000 m altitude (Walker 2021). To some extent, the Stora region, where the Algerian population is located, offers habitats (mostly rocky areas at sea level) that fit the species well and that are similar to those in the native range. Thus, further spread seems likely – as has already been observed with its congener *A. arboreum* Webb & Berthel. which occurs in a large population at the same site among native shrubs.

*Crassula ovata* is a succulent subshrub native to Cape Provinces, KwaZulu-Natal and Mozambique (POWO 2023). It has been introduced in many regions of the world as an ornamental plant. It is reported as an alien species in China (Wang et al. 2015), California, Mexico, Australia and New Zealand (CABI Compendium 2023). In the northern part of the Mediterranean, it has been reported as a casual species in Spain (Aymerich and Sáez 2019), Italy (Galasso et al. 2019) and Portugal (Domingues De Almeida 2018).

The individuals observed in Algeria do not exceed 90 cm in height, but in cultivation in open ground, the plant can exceed 1m in height (Sakhraoui *pers. obs.*). The individuals are branched, bearing small oval leaves, about 4 cm long, of jade green color often reddish at the leaf edge. The leaves at the base of the stems may desiccate during the flowering period, while those on the top of the stems persist. Flowers are small and white or light pink.

*Crassula ovata* has medicinal properties, in particular it is used to disinfect wounds and cure diarrhea (Muiruri and Mwangi 2015). However, these properties do not seem to be known in Algeria, where the species is exclusively used in ornamentation.

Until now, it solely colonizes urban habitats. Many species of the genus *Crassula* are known to be highly adaptable to a wide range of environments (Jones 2011). Further, cities are known to offer a greater diversity of environmental conditions compared to rural regions of the same size (Schmidt et al. 2014). As propagule pressure by ornamental plants is also higher in cities, the spread of alien species often starts there (Marco et al. 2010; Mclean et al. 2017).

In the study area, *A. haworthii* and *C. ovata* are widely used as indoor plant (Sakhraoui *pers. obs.*). The plants cultivated on balconies and terraces are exposed to wind and rainfall, which can contribute to mechanical



**Table 2.** Overview of alien species of the Crassulaceae family recorded from continental North Africa.

Species	Native range (POWO 2023)	Country	Status
<i>Aeonium arboreum</i> Webb & Berthel.	Canary Islands, South west Morocco.	Algeria, Morocco, Tunisia (Dobignard and Chatelain 2011)	Naturalized
<i>Aeonium haworthii</i> Webb & Berthel.	Tenerif (Canary Islands)	Tunisia (El Mokni et al. 2019)	Alien with unknown status
<i>Cotyledon orbiculata</i> L.	South west Angola to Cape Provinces	Tunisia (El Mokni et al. 2019)	Naturalized
<i>Crassula decumbens</i> Thunb.	South Africa, Australia, Central Chile	Tunisia (Dobignard and Chatelain 2011)	Naturalized
<i>Crassula helmsii</i> (Kirk) Cockayne	Australia, New Zealand	Tunisia (Dobignard and Chatelain 2011)	Naturalized
<i>Kalanchoe daigremontiana</i> Raym.-Hamet & H. Perrier	South west Madagascar	Morocco (Dobignard and Chatelain 2011), Tunisia (Sukhorukov et al. 2018)	Naturalized
<i>Kalanchoe delagoensis</i> Eckl. & Zeyh.	South Central & South Madagascar	Tunisia (Sukhorukov et al. 2018)	Casual?
<i>Kalanchoe fedtschenkoi</i> Raym.-Hamet & H. Perrier	Central & South Central Madagascar.	Tunisia (Sukhorukov et al. 2018)	Naturalized (in urban habitat)
<i>Kalanchoe ×houghtonii</i> D.B. Ward	Artificial hybrid	Algeria (erroneously identified by Zeddami and Raus (2012) as <i>K. daigremontiana</i> see Herrando-Moraira et al. 2020), Tunisia (Sukhorukov et al. 2018),	Escaped from cultivation (= casual?)
<i>Kalanchoe laxiflora</i> Baker	East Central Madagascar	Morocco (Dobignard and Chatelain 2011)	Casual
<i>Kalanchoe marmorata</i> Baker	Eritrea to Rwanda and North Tanzania	Tunisia (El Mokni and Sáez 2019)	Casual
<i>Kalanchoe sexangularis</i> N. E. Br.	South Zambia to North KwaZulu-Natal	Tunisia (El Mokni and Sáez 2019)	Casual
<i>Sedum praealtum</i> A. DC.	Mexico to El Salvador	Morocco (Dobignard and Chatelain 2011), Tunisia (El Mokni et al. 2019)	Casual in Morocco, Locally escaped (= casual?) in Tunisia

damage to shoots and leaves enhancing vegetative reproduction and spread. In addition, it is probable that garden waste is responsible for the appearance of *A. haworthii* in the locality where it was observed.

Although the invasion history and impact of both species are still unknown, they could spread in the local environment and compete with the native flora. This is more likely for *A. haworthii* which has already naturalized in a semi-natural environment, showing a great capacity of adaptation.

#### *Alien Crassulaceae in continental North Africa*

Besides the studied species, several other species of the Crassulaceae family have already been reported as alien for continental North Africa. So far, 13 species that belong to 5 genera have been listed (Table 2). However, this number is considerably smaller than the number of species recorded in the northern part of the Mediterranean (see Galasso et al. 2018; Aymerich and Sáez 2019) where *Aeonium* and *Crassula* are both among the best represented genera in relation to the number of species (e.g. 6 species of *Aeonium* and 6 species of *Crassula* in Italy and 4 species of *Aeonium* and 7 species of *Crassula* in Spain).

Among all alien taxa of the Crassulaceae recorded in continental North Africa, species of the genus *Kalanchoe* are the most likely to expand their range considerably in the future, because they have the ability to produce large numbers of clonal propagules from their leaf margins that facilitate their spread (see Guerra-García et al. 2014). Moreover, several species of this genus have been reported as invasive in different regions of the world including the Mediterranean, where *K. daigremontiana* Raym.-Hamet &

H. Perrier and *K. ×houghtonii* D.B. Ward have been reported as invasive in Spain and Italy (Guillot Ortiz et al. 2015; Herrando-Moraira et al. 2020; Stinca et al. 2021).

## Conclusion

Based on our results, *C. ovata* should be added to the list of alien Crassulaceae reported from continental North Africa, the future spread of *A. haworthii* and *C. ovata* should be monitored in the Skikda region, and they should be searched for in other regions of northern Algeria. This work has shown that alien plant escapes still occur in Algeria, emphasizing the need for further field surveys.

## Acknowledgements

The authors would like to thank the associate editor C. Lambertini and the anonymous reviewers for their corrections and comments, Dr. J. Alfredo Reyes-Betancort, director of the Botanical Garden of Puerto de la Cruz, Tenerife for his contribution in the identification of *Aeonium haworthii*, and the Austrian Science Foundation FWF (gran no. I5825-B) for its funding.

## Funding declaration:

FE appreciates funding by the Austrian Science Foundation FWF (grant I 5825-B).

## Author's contribution:

Research conceptualization: Nora Sakhraoui; sample design and methodology: Nora Sakhraoui; investigation and data collection: Nora Sakhraoui and Amel Boudries; data analysis and interpretation: Nora Sakhraoui and Azzedine Hadeif; funding provision: Franz Essl; writing: Nora Sakhraoui and Franz Essl; review: Filip Verloove and Franz Essl.

## References

- Aymerich P, Sáez L (2019) Checklist of the vascular alien flora of Catalonia (northeastern Iberian Peninsula, Spain). *Mediterranean Botany* 40: 215–242, <https://dx.doi.org/10.5209/mbot.63608>
- Chen M, Blankenship RE (2021) Photosynthesis | Photosynthesis. In: Jez J (ed), *Encyclopedia of biological chemistry III*, third edition. Elsevier, Oxford, pp 150–156, <https://doi.org/10.1016/B978-0-12-819460-7.00081-5>
- Christenhusz MJM, Byng JW (2016) The number of known plants species in the world and its annual increase. *Phytotaxa* 261: 201–217, <http://dx.doi.org/10.11646/phytotaxa.261.3>
- Dobignard A, Chatelain C (2011) Index synonymique de la flore de l'Afrique du Nord. Conservatoire et Jardin Botaniques, Genève, Suisse, 449 pp
- Domingues De Almeida J (2018) New additions to the exotic vascular flora of continental Portugal. *Flora Mediterranea* 28: 259–278, <http://dx.doi.org/10.7320/FIMedit28.259>
- Domingues De Almeida J, Freitas H (2006) Exotic naturalized flora of continental Portugal – a reassessment. *Botanica Complutensis* 30: 117–130
- El Mokni R, Sáez L (2019) *Kalanchoe marmorata* Baker and *Kalanchoe sexangularis* N. E. Br. var. *sexangularis*. In: Raab-Straube E. von, Raus Th (eds), Euro+Med-Checklist Notulae 10. Willdenowia 49, pp 99–100, <https://doi.org/10.3372/wi.49.49111>
- El Mokni R, Elaissi A, Verloove F (2019) New succulents for the Tunisian and North African alien flora. *Haseltonia* 26: 68–77, <https://doi.org/10.2985/026.026.0110>
- Galasso G, Conti F, Peruzzi L, Ardenghi NMG, Banfi E, Celesti-Grapow L, Albano A, Alessandrini A, Bacchetta G, Ballelli S, Bandini Mazzanti M, Barberis G, Bernardo L, Blasi C, Bouvet D, Bovio M, Cecchi L, Del Guacchio E, Domina G, Fascetti S, Gallo L, Gubellini L, Guiggi A, Iamonico D, Iberite M, Jiménez-Mejías P, Lattanzi E, Marchetti D, Martinetto E, Masin RR, Medagli P, Passalacqua NG, Peccenini S, Pennesi R, Pierini B, Podda L, Poldini L, Prosser F, Raimondo FM, Roma-Marzio F, Rosati L, Santangelo A, Scoppola A, Scortegagna S, Selvaggi A, Selvi F, Soldano A, Stinca A, Wagensommer RP, Wilhelm T, Bartolucci F (2018) An updated checklist of the vascular flora alien to Italy. *Plant Biosystems* 152: 556–592, <https://doi.org/10.1080/11263504.2018.1441197>

- Galasso G, Domina G, Ardenghi NMG, Aristarchi C, Bacchetta G, Bartolucci F, Bonari G, Bouvet D, Brundu G, Buono S, Caldarella O, Calvia G, Cano-Ortiz A, Corti E, D'Amico FS, D'Antracoli M, Di Turi A, Dutto M, Fanfarillo E, Ferretti G, Fiaschi T, Ganz C, Guarino R, Iberite M, Laface VLA, La Rosa A, Lastrucci L, Latini M, Lazzaro L, Lonati M, Lozano V, Luchino F, Magrini S, Mainetti A, Manca M, Mugnai M, Musarella CM, Nicoletta G, Olivieri N, Orrù I, Paziienza G, Peruzzi L, Podda L, Prosser F, Ravetto Enri S, Restivo S, Roma-Marzio F, Ruggero A, Scoppola A, Selvi F, Spampinato G, Stinca A, Terzi M, Tiburtini M, Tornatore E, Vetromile R, Nepi C (2019) Notulae to the Italian alien vascular flora. *Italian Botanist* 7: 157–182, <https://doi.org/10.3897/italianbotanist.7.36386>
- Guerra-García A, Golubov J, Mandujano MC (2014) Invasion of *Kalanchoe* by clonal spread. *Biological Invasions* 6: 1615–1622, <https://doi.org/10.1007/s10530-014-0820-0>
- Guillot Ortiz D, Lopez-Pujol J, Laguna Lumbreras E, Puche C (2015) *Kalanchoe daigremontiana* Raym.-Hamet & H. Perrier 'Iberian Coast'. *Bouteloua* 21: 35–48
- Hernández Romero F, Barone R, Rodríguez Navarro IML (2012) El bejeque endémico *Aeonium haworthii* en los tejados de Tacoronte. *Quercus* 319: 50–51
- Herrando-Moraira S, Vitales D, Nualart N, Gómez-Bellver C, Ibáñez N, Massó S, Cachón-Ferrero P, González-Gutiérrez PA, Guillot D, Herrera I, Shaw D, Stinca A, Wang Z, López-Pujol J (2020) Global distribution patterns and niche modelling of the invasive *Kalanchoe* × *houghtonii* (Crassulaceae). *Scientific Reports* 10: 31–43. <https://doi.org/10.1038/s41598-020-60079-2>
- Jones LA (2011) Anatomical adaptations of four *Crassula* species to water availability. *Bioscience Horizons* 4: 13–22, <http://dx.doi.org/10.1093/biohorizons/hzr002>
- Maire R (1977) Flore de l'Afrique du Nord, Dicotyledonae, Vol 14. Lechevalier, Paris, 379 pp
- Marco A, Lavergne S, Dutoit T, Bertaudiere-Montes V (2010) From the backyard to the backcountry: how ecological and biological traits explain the escape of garden plants into Mediterranean old fields. *Biological Invasions* 12: 761–779, <https://doi.org/10.1007/s10530-009-9479-3>
- McLean P, Gallien L, Wilson JR, Gaertner M, Richardson DM (2017) Small urban centres as launching sites for plant invasions in natural areas: insights from South Africa. *Biological Invasions* 19: 3541–3555, <https://doi.org/10.1007/s10530-017-1600-4>
- Muiruri DM, Mwangi W (2015) Phytochemical and Antimicrobial Activity of (*Crassula ovata*) Jade Plant on Different Strains of Bacteria. *European Journal of Medicinal Plants* 11: 1–12, <https://doi.org/10.9734/EJMP/2016/19753>
- Pyšek P, Richardson DM, Rejmanek M, Webster GL, Williamson M, Kischner J (2004) Alien plants in checklist and floras: towards better communication between taxonomist and ecologist. *Taxon* 53: 131–143, <https://doi.org/10.2307/4135498>
- Sakhraoui N (2021) La flore horticole cultivée dans la wilaya de Skikda: état des lieux et stratégies de gestion durable. PhD Thesis, Mohamed Chérif Messaadia University, Souk Ahras, Algeria
- Sakhraoui N, Metallaoui S, Chefrou A, Hadeff A (2019) La flore exotique potentiellement envahissante d'Algérie: première description des espèces cultivées en pépinières et dans les jardins. *Biotechnologie Agronomie Société et Environnement* 23: 63–73, <https://doi.org/10.25518/1780-4507.17902>
- Sakhraoui N, Verloove F, Hadeff A (2022a) First record of *Ficus microcarpa* (Moraceae) in Algeria. *Hacquetia* 21: 347–354, <https://doi.org/10.2478/hacq-2022-0008>
- Sakhraoui N, Verloove F, Essl F, Hadeff A (2022b) First record of *Austrocyllindropuntia cylindrica* (Lam.) Backeb. and first data about the naturalization of *Austrocyllindropuntia subulata* (Muehlenpf.) Backeb. in Algeria. *BioInvasions Records* 11: 351–359, <https://doi.org/10.3391/bir.2022.11.2.07>
- Sakhraoui N, Boughendjioua H, Smith GF, Essl F (2023) *Drosanthemum floribundum* (Haw.) Schwantes: first record as a naturalised species in Algeria. *Bradleya* 41: 230–233
- Schmidt KJ, Poppendieck H-H, Jensen K (2014) Effects of urban structure on plant species richness in a large European city. *Urban Ecosystems* 17: 427–444, <https://doi.org/10.1007/s11252-013-0319-y>
- Simpson MG (2010) Diversity and Classification of Flowering Plants: Eudicots. In: Simpson MG (ed), *Plant Systematics* (2nd Edition). Academic Press, pp 275–448, <https://doi.org/10.1016/B978-0-12-374380-0.50008-7>
- Smith GF, Figueiredo E, Van Wyk AE (2019) Chapter 3, Crassulaceae in Southern Africa. In: Smith GF, Figueiredo E, Van Wyk AE (eds), *Kalanchoe* (Crassulaceae) in Southern Africa. Academic Press, pp 17–22, <https://doi.org/10.1016/B978-0-12-814007-9.00003-7>
- Stinca A, Musarella CM, Rosati L, Laface VLA, Licht W, Fanfarillo E, Wagensommer RP, Galasso G, Fascetti S, Esposito A, Fiaschi T, Nicoletta G, Chianese G, Ciaschetti G, Salerno G, Fortini P, Di Pietro R, Perrino EV, Angiolini C, De Simone L, Mei G (2021) Italian Vascular Flora: New Findings, Updates and Exploration of Floristic Similarities between Regions. *Diversity* 13: 1–46, <https://doi.org/10.3390/d13110600>
- Sukhorukov AP, Kushunina M, El Mokni R, Sáez Goñalons L, El Aouni MH, Daniel TF (2018) Chorological and taxonomic notes on African plants, 3. *Botany Letters* 165: 228–240, <https://doi.org/10.1080/23818107.2018.1465467>



- Vieira RM da S (2002) Flora da Madeira: Plantas vasculares naturalizadas no arquipélago da Madeira. Funchal, Museu Municipal do Funchal, 281 pp
- Walker CC (2021) Atlantic *Aeoniums*. *New Zealand Cactus & Succulent Journal* 74(2): 20–34
- Wang ZO, Guillot D, López-Pujol J (2015) *Crassula ovata*, a new alien plant for mainland China. *Collectanea Botanica* 34: e009; <http://dx.doi.org/10.3989/collectbot.2015.v34.009>
- Webb CJ, Sykes WR, Garnock-Jones PJ (1988) Flora of New Zealand, Naturalised Pteridophytes, Gymnosperms, Dicotyledons. Botany Division DSIR, Christchurch, New Zealand, 1365 pp
- Zeddami A, Raus Th (2012) *Kalanchoe daigremontiana* Raym-Hamet & H Perrier (Crassulaceae). In: Greuter W, Raus Th (eds), Med-Checklist Notulae 31. *Willdenowia* 42: 287–295, <https://doi.org/10.3372/wi.42.42215>

### Web sites and online databases

- APD (2023) African Plant Database, *Aeonium haworthii* Webb & Berthel., *Crassula ovata* (Mill.) Druce. Conservatoire et Jardin botaniques; Pretoria: South African National Biodiversity Institute. <https://africanplantdatabase.ch/en/nomen/140116>; <https://africanplantdatabase.ch/en/nomen/55876> (accessed 19 January 2023)
- CABI Compendium (2023) *Crassula ovata* (jade plant). <https://doi.org/10.1079/cabicompendium.113574> (accessed 15 February 2023)
- Euro+Med PlantBase (2023) *Aeonium haworthii* (Webb & Berthel.) Webb & Berthel. [https://europlusmed.org/cdm\\_dataportal/taxon/58079da3-f82d-45f2-a78e-912a8af9e8de](https://europlusmed.org/cdm_dataportal/taxon/58079da3-f82d-45f2-a78e-912a8af9e8de) (accessed 10 January 2023)
- GBIF (2023) Global Biodiversity Information Facility. *Aeonium haworthii* Webb & Berthel., *Crassula ovata* (Mill.) Druce. Checklist dataset. <https://www.gbif.org/species/104242520>; <https://www.gbif.org/species/5362063> (accessed 17 February 2023)
- POWO (2023) Plants of the World Online. *Aeonium haworthii* Webb & Berthel., *Crassula ovata* (Mill.) Druce. Facilitated by the Royal Botanic Gardens, Kew. <https://powo.science.kew.org/taxon/urn:lsid:ipni.org:names:272228-1> (accessed 19 February 2023)