

ELECTRONIC COMMERCE OF THE ENDEMIC PLANTS OF NORTHERN MOROCCO (MEDITERRANEAN COAST-RIF) AND TUNISIA OVER THE INTERNET COMERCIO ELECTRÓNICO DE LAS PLANTAS ENDÉMICAS DEL NORTE DE MARRUECOS (COSTA MEDITERRÁNEA-RIF) Y TÚNEZ A TRAVÉS DE INTERNET

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Abstract

Background: Internet trade popularize the ornamental interest of plants but can also threaten species' wild populations, if this activity is performed in uncontrolled and unauthorised ways.

Questions: What endemic plants of Morocco and Tunisia are traded over the Internet by whom and at what prices?

Studied species: 94 endemic plants of northern Morocco and 83 of Tunisia.

Study site and dates: Tunisia and northern Morocco (Mediterranean coast and Rif region); internet survey between September 2018 and December 2019.

Methods: To understand the extent of this new form of trade, we recorded the type of plant material sold over the Internet for the studied taxa, their prices and suppliers using online platforms.

Results: Four northern Moroccan taxa (4.25 % of the total local endemics) were found as marketed by 18 nurseries in Europe, North America, Australia and New Zealand, while no marketing activity was detected for Tunisian endemic plants. The nurseries involved offer for sale and distribution living individuals of *Abies marocana* at €12.00-259.50, *Rhodanthemum hosmariense* at €0.35-19.5, *Salvia interrupta* subsp. *pau* at €6.23-8.90, and bulbs of *Acis tangitana* at €1.05-3.95. Although these taxa are classified as endangered, they are traded worldwide without permit of the Moroccan authorities. The source and origin of the plant material are not clearly indicated, and only some nurseries report that their marketed material comes from own cultivated stocks.

Conclusions: The implementation of protection laws/regulations and the monitoring of nurseries' websites are recommended to control the illegal trade of wild plant material.

Keywords: Conservation, Nagoya Protocol, North Africa, neglected & underutilized species, wild plants traffic, threatened, ornamental value.

Resumen

Antecedentes: El comercio en Internet populariza el interés ornamental de las plantas, pero también puede amenazar las poblaciones silvestres de las especies.

Preguntas: ¿Cuáles plantas endémicas de Túnez y norte de Marruecos se comercializan a través de Internet, por quienes y en qué precios?

Especies estudiadas: 83 plantas endémicas de Túnez y 94 del norte de Marruecos.

Lugar de estudio y fechas: Túnez y norte de Marruecos (costa mediterránea y región del Rif); investigación en internet entre septiembre de 2018 y diciembre de 2019.

Métodos: Registramos el tipo de material vegetal vendido a través de Internet por los taxones estudiados, sus precios y los proveedores usando plataformas en línea.

Resultados: Se encontraron cuatro taxones del norte de Marruecos (4.25 %) comercializados por 18 viveros en Europa, América del Norte, Australia y Nueva Zelanda y ninguna actividad comercial para las plantas endémicas de Túnez. Los viveros ofrecen a la venta individuos vivos de *Abies marocana* a 12.00-259.50 €, *Rhodanthemum hosmariense* a 0.35-19.5 €, *Salvia interrupta* subsp. *pau* a 6.23-8.90 €, y bulbos de *Acis tangitana* a 1.05-3.95 €. Aunque en peligro de extinción, estos taxones se comercializan en todo el mundo sin permisos de las autoridades marroquíes. La fuente y origen del material vegetal no están claramente indicados y solo algunos viveros informan que el material comercializado proviene de sus propios cultivos.

Conclusiones: Se recomienda la implementación de leyes/regulaciones de protección y el monitoreo regular de los sitios online de los viveros para controlar el comercio ilegal de material vegetal silvestre.

Palabras clave: Conservación, Protocolo de Nagoya, África del Norte, especies desatendidas y subutilizadas, tráfico de plantas, amenazadas, valor ornamental.

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Electronic commerce has become a popular new way of trading plants, as it is accessible and familiar to people of all ages and all interests (Sajeva *et al.* 2013, Shirey *et al.* 2013, Krigas *et al.* 2014, Lavorgna 2014, Humair *et al.* 2015, Olmos-Lau & Mandujano 2016, Hinsley & Roberts 2017, Krigas *et al.* 2017, Vaglica *et al.* 2017, Hinsley *et al.* 2018). Illegal and poorly regulated trade of wild plants over the Internet and/or offline practices is a global issue that could undermine conservation efforts (Flores-Palacios & Valencia-Díaz 2007, Shirey *et al.* 2013, Krigas *et al.* 2017, Menteli *et al.* 2019). This international trade of plants triggers some concerns and requires a high level of alertness because of its complexity and the possible over-exploitation of species due to illegal practices. If not performed sustainably, international trade of wild plants can threaten phylogenetic resources and local subsistence economies (Khabbach *et al.* 2011, Libiad *et al.* 2011, Shirey & Lamberti 2011, Hinsley *et al.* 2016), as occurs in low-income countries (Atiqul Haq *et al.* 2011). Furthermore, platforms as Facebook and Skype can aggravate this situation facilitating uncontrolled exchanges of plant material in private between individuals worldwide (Shirey *et al.* 2013, Lavorgna 2014, Olmos-Lau & Mandujano 2016).

In some cases, the number of plant species sold online (*e.g.*, south-eastern Asian orchids) has been estimated to be comparable to that on offline trade (Hinsley & Roberts 2017). The situation is more alarming for plants whose trade is difficult to estimate due to data limitations or unregistered/misclassified status (Sajeva *et al.* 2013). To address threats to biological resources worldwide, several countries have agreed on the Convention on International Trade in Endangered Species (CITES) of Wild Fauna and Flora, and more recently, on the Nagoya Protocol (see EU Regulation 511/2014) connected with the Convention of Biological Diversity regulating the access to and the benefit sharing of genetic resources (<https://www.cbd.int>). However, several websites still continue selling endangered species without providing CITES documents or country permits (Shirey & Lamberti 2011, Krigas *et al.* 2014, Hinsley & Roberts 2017, Krigas *et al.* 2017), and perhaps another problem is that plant species considered at risk by national legislation are sold without strict regulations within specific countries (*e.g.*, Grigoriadou *et al.* 2020).

Our study aims to open an unexplored conservation frontier in Mediterranean North Africa regarding the electronic trade of endemic plants. The study focused on the e-commerce of plants with narrow distribution ranges and limited areas of occupancy in the wild, thus subjected to elevated extinction risk. We examined what endemic plants are traded over the Internet, the plant parts that are commercialized, the concomitant selling prices and the variability of involved suppliers, thus documenting their ornamental value. This was done to estimate the extent of this horticultural commerce and to get insights regarding its compliance with domestic laws and international conventions.

Materials and methods

The study area ([Figure 1](#)) covers the Mediterranean part of northern Morocco (Rif region and the Mediterranean coast) and Tunisia (seven biogeographic subdivisions). Morocco and Tunisia (Maghreb countries) are considered as biodiversity hotspots within the Mediterranean basin with 4,500 and 2,526 vascular plants, respectively (Médail & Quézel 1997). To prepare the list of endemic taxa (species and subspecies) of the studied regions, we examined floristic studies (see Libiad *et al.* 2020) and consulted four online databases (Euro+Med Plantbase, Plant List, African Plant Database, Plants of the World Online). To evaluate which steno-endemic plants are available for sale on the Internet [$n = 177$ taxa (Libiad *et al.* 2020), *viz.* 94 endemic taxa of Mediterranean part of northern Morocco and 83 endemic taxa of Tunisia] we followed previously published methods (Krigas *et al.* 2014, Olmos-Lau & Mandujano 2016, Krigas *et al.* 2017, Menteli *et al.* 2019), focusing on the trade of living plants, bulbs or seeds (individual seeds, seeds in package, seeds per gram), but we excluded the trade of dried herbal material cut from plants (wild growing or cultivated) used for tea making or condiment.

To obtain a snapshot of the e-commerce of steno-endemic plants, we conducted online species-specific searches on the supply of plant materials between September 2018 and December 2019. For each taxon, we searched for trade indications using scientific names and available synonyms found in Euro+Med Plantbase (not common or vernacular names) to avoid false positive search results (Krigas *et al.* 2014, Humair *et al.* 2015). As a starting point, we selected two platforms (collective websites), including the Royal Horticultural Society's (RHS) Plant Finder, which includes

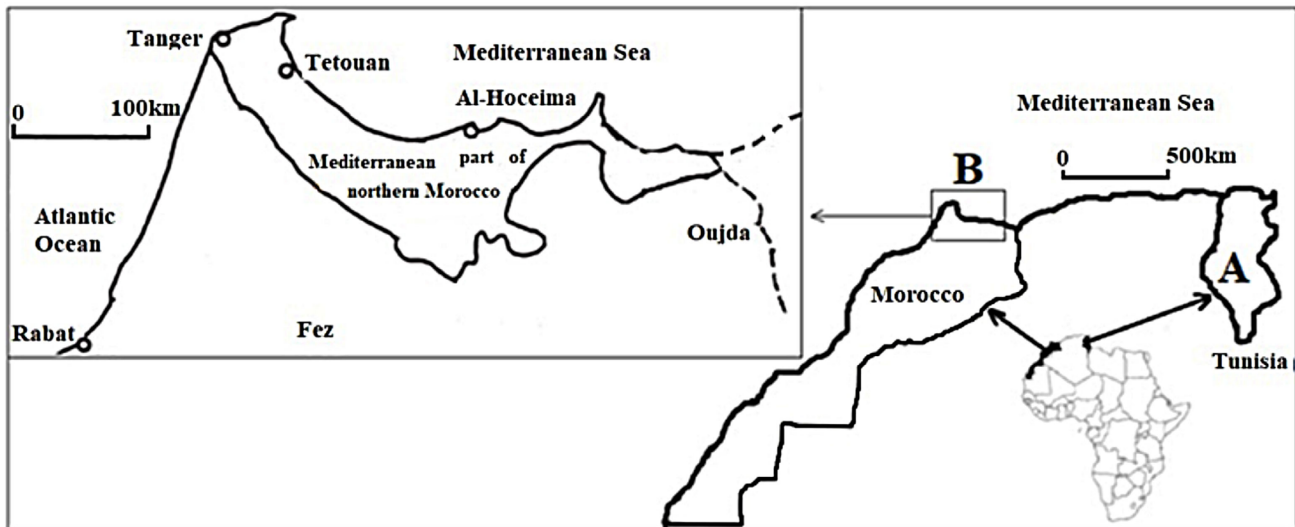


Figure 1. Geographical location of the study area in Northern Africa (middle) indicating the targeted area of Tunisia (A) and Morocco (B).

75,000 plants worldwide and provides access to about 550 European nurseries (mainly in UK and also in France, www.rhs.org.uk/plants/search-form), and the Plant Information Online (<http://archive.plantinfo.org/plantinfo.umn.edu/search/plants.html>), which includes nearly 105,000 plants and provides access to 2,625 seed companies and nurseries of North America (mainly in USA and Canada). Following the purchase indications in these platforms, we visited the websites of all the nurseries designated as points of sale, focusing on the information provided by their webpages (Krigas *et al.* 2014). We also collected information using the Google web browser using the general expression “buy + each taxon’s scientific name” and consulted one-by-one the first 100 results to check if the nurseries were marketing endemic plants of the study area. All websites/platforms were visited twice between September 2018 and December 2019. In addition, we conducted additional searches on eBay and the CITES database, which did not yield any results. For each query, we recorded the taxon traded, the type of plant material marketed (seeds, bulbs, live plant), the price and currency per type of plant material under sale, the country and the URL link of the nursery, and the origin of the plant material marketed (if available). For each taxon we recorded the extinction risk status (Libiad *et al.* 2020) and sought information on the processes followed and measures taken for its exploitation in the study area.

Results

Among the 94 endemic plants of Mediterranean part of northern Morocco, four taxa were found marketed on the Internet (Table 1), which represents 4.25 % of northern Moroccan endemics. The endemic plants marketed online are *Abies marocana* Trab. (Figure 2), *Acis tingitana* (Baker ex Ball) Lledó, A.P. Davis & M.B. Crespo (Figure 3), *Rhodanthemum hosmariense* (Ball) B.H. Wilcox, K. Bremer & Humphries (Figure 4) and *Salvia interrupta* Schousb. subsp. *pau* (Maire) Maire (Figure 5). These species belong to four botanical families (Pinaceae, Amaryllidaceae, Asteraceae and Lamiaceae, respectively), and three biological forms (phanerophyte, geophyte and chamaephyte). No Tunisian endemic taxon was found as traded over the internet.

The results of the study of endemic plants from northern Morocco traded over the Internet and marketed throughout the world are certainly underestimated in terms of traded volume. It is quite possible that a higher volume of transactions is involved but, due to several reasons, they cannot be spotted easily. For example, *S. interrupta* subsp. *pau* is marketed under two synonyms, while *R. hosmariense* is marketed under three scientific names (synonyms), three common names connected to its genus, and three vernacular names (Table 2, Appendix 1). *Abies marocana* is

Table 1. Endemic species and subspecies of northern Morocco (Mediterranean coast and Rif region) marketed over the Internet by different websites of nurseries (see [Appendix 1](#) for details) with international commercial activity.

Taxon	Websites of nurseries / Year accessed
<i>Abies marocana</i>	Bloom River Gardens / 2021 Conifers Garden / 2021 Cloud Mountain Farm Center / 2021
<i>Rhodanthemum hosmariense</i>	Garden Beauty / 2021 Amazon / 2019 Beth Chatto's Plants and Gardens / 2021 Craigiehall Nursery / 2019 Boundary Nursery / 2019 Dancing Oaks Nursery and Gardens / 2019 Greenleaf Nurseries / 2021 FlorAccess / 2021 Tortworth Plants / 2021 Kernock Park Plants / 2021 Macplants Berrybank Nursery / 2021
<i>Acis tingitana</i>	Hill View Rare Plants / 2021 Ryan Stephen / 2021 Broadleigh Gardens / 2021
<i>Salvia interrupta</i> subsp. <i>pau</i>	Les Senteurs du Quercy / 2021

marketed under two synonyms and also under two common names ([Table 2](#), [Appendix 1](#)). *Acis tingitana* is promoted in social sites and networks under different names, such as Moroccan snowflakes, and under two different synonyms ([Table 2](#), [Appendix 1](#)). Sometimes these websites present it as the rare *Leucojum* ([Table 2](#), [Appendix 1](#)) or inform that these real snowflakes are often perceived as the poor cousins of the snowdrops (see Ryan Stephen website in [Appendix 1](#)).

The endemic plants of northern Morocco are marketed in two forms, including individual living plants for *Abies marocana*, *Rhodanthemum hosmariense* and *Salvia interrupta* subsp. *pau*, and bulbs for *Acis tingitana*. Individual plants are the most common form of sale, where prices of *R. hosmariense* vary from €0.35 to €19.5, prices of *A. marocana* are between €12 and €259.5, and prices of *S. interrupta* subsp. *pau* range from €6.23 to €8.90 ([Table 3](#)). Regarding the bulbs of *A. tingitana*, they are offered from €1.05 to €3.95 each ([Table 3](#)).

We detected 18 nurseries involved in the online trade of these plants, covering Europe (11 nurseries), North America (four nurseries), Australia (two nurseries) and New Zealand with (one nursery) ([Tables 1](#), [2](#)). In addition to these nurseries, the endemic plants of northern Morocco are listed on two websites without mention of the selling price (Cotswold Garden Flowers and Les Senteurs du Quercy in [Appendix 1](#)). We also noted that many Facebook pages promote these plants but without indicating neither prices nor sale terms (e.g., Red Earth Bulbs, [Appendix 1](#)). Online stores at the national level were not involved in this activity. The sites promote the international sale and/or distribution of plants in the form of living individuals for three taxa or in the form of bulbs for *A. tangitana* ([Table 3](#)). Currently, *A. marocana* is traded via the Internet by four nurseries (three in USA and one in Europe) and a website (Plant_Lust,

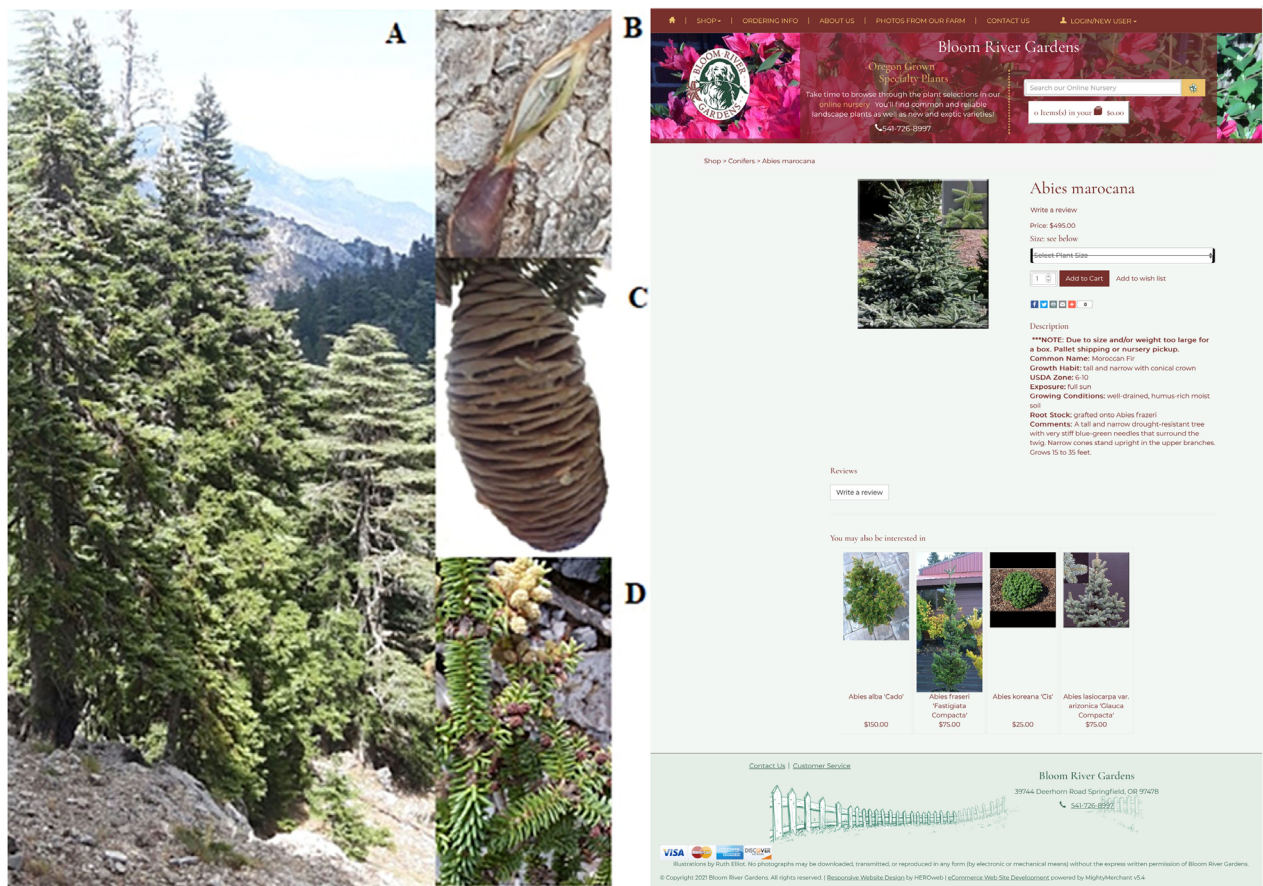


Figure 2. Left: *Abies marocana* wild-growing population (A), germinated seed (B), cone (C) and inflorescence (D). Photos from Tis-souka mountain, Rif, Morocco (1,300 m) [01.05.2019]. Right: Screenshot of a website in USA selling this taxon on the internet as of January 2021 (Bloom River Gardens, see Appendix).

[Appendix 1](#)). *Rhodanthemum hosmariense* is traded from a North American e-commerce company (Seattle, USA) and another 10 nurseries, from which eight are in Europe (one in The Netherlands and seven in UK), one in the USA and one in New Zealand. *Acis tingitana* was found in the catalogues of three online nurseries (two in Australia and one in UK), in the website of another nursery in the United Kingdom (Cotswold Garden Flowers, [Appendix 1](#)) and in a Facebook page that promotes this plant without specifying its selling price (Red Earth Bulbs, [Appendix 1](#)).

The websites of sellers do not provide clear information about the origin of their plant products. Some nurseries mention that the material comes from their own cultivated stocks and some websites point to collaborations with nurseries. No seller's website indicates that plants come from material received via botanical gardens and just a few of them make mention to specific growing conditions of the traded plants (e.g., Bloom River Gardens, [Appendix 1](#)). In fact, some sellers mention that they ship from one country to another. It appears that the trade of these endemic taxa covers many European countries, USA and Canada, and Australia and New Zealand.

Some online nurseries involved in the e-trade generally refer to 'Moroccan species grown in their gardens' without mentioning how they accessed to the original material (e.g., Ryan Stephen, [Appendix 1](#)). Other nurseries specify that the plants come from Morocco without defining how they were acquired (e.g., Broadleigh Gardens, [Appendix 1](#)) or declare that their plant collection 'comes mainly from seeds exchanges all over the world or from their own expeditions for seeds collection' (e.g., Hill View Rare Plants, [Appendix 1](#)).

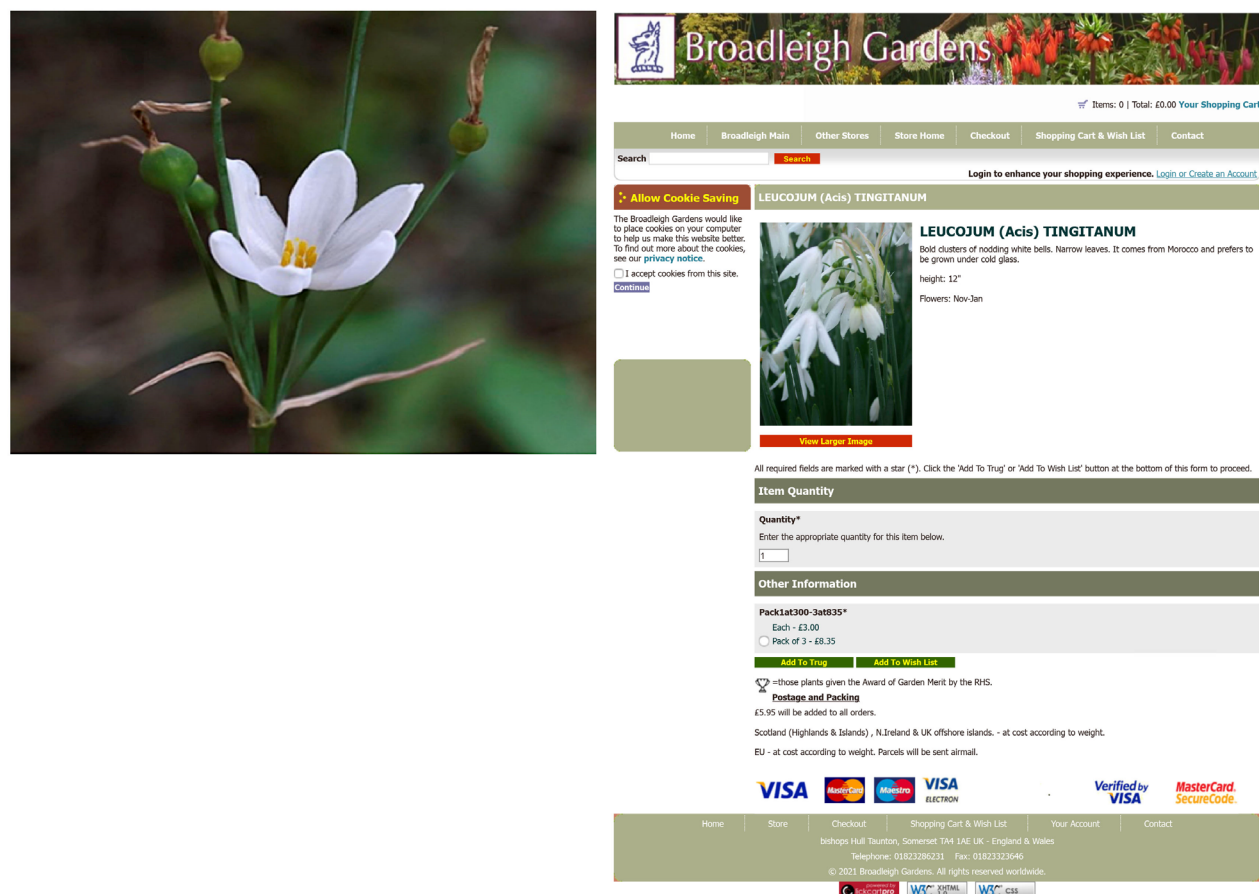


Figure 3. *Acis tingitana*, flower and fruit capsules. Photo from Rif, Morocco, Rmilat forest (www.teline.fr; Photo credit: Abdelmonaim Homrani Bakali, reproduced with permission). Right: Screenshot of a website in UK selling this taxon on the internet as of January 2021 (Broadleigh Gardens, see [Appendix 1](#)).

Most websites claim that they do not provide any phytosanitary certificate or CITES certificate because “it is the buyer’s responsibility to verify any import restrictions in his country”. Some others refer to the endangered status of species specifying for phytosanitary authorisations and customs clearance (e.g., Conifers Garden, [Appendix 1](#)) or indicate distinctions between plants protected by British or European laws and by laws enforced in other countries (e.g., Kernock Park Plants, [Appendix 1](#)). Sometimes the websites state that the nursery is not authorised to comply with the biosecurity requirements (e.g., Hill View Rare Plants, [Appendix 1](#)) or they acknowledge the impact of their activities in terms of good environmental management and code of good practice (e.g., Garden Beauty, [Appendix 1](#)).

The taxa traded over the Internet are steno-endemics confined to a small number of localities and with a small number of known populations in the Moroccan Rif ([Table 4](#)). For the *ex-situ* conservation of *Abies marocana*, two botanical expeditions were carried out in the Province of Chefchaouen, in Tissouka (01 May 2019, 1,310 m), and in the Talassemrane Park, in Jbel Lakraâ, between Bab Rouida and the forest house (02 September 2019, 1,539-1,700 m). The first expedition allowed locating populations of *A. marocana* in the wild and the second one allowed to collect ripe seeds for long-term conservation (we also noticed signs of forest clearing and uprooted trees). Seed-lots were deposited at the seed bank of the Balkan Botanic Garden of Kroussia, Institute of Plant Breeding and Genetic Resources, Hellenic Agricultural Organization Demeter under the IPEN (International Plant Exchange Network) number MO-1-BBGK-20,428, endorsing the provisions of the Nagoya Protocol as outlined in the EU Directive 511/2014.

Table 2. Synonyms and/or vernacular names appearing in the internet market for the four local endemic plants of Morocco traded internationally (see [Appendix 1](#) for details).

Taxon's scientific name	Synonym(s) or vernacular name(s) as marketed	Websites / Year accessed
<i>Abies marocana</i>	<i>A. pinsapo</i> subsp. <i>marocana</i> , <i>Picea marocana</i> , Moroccan fir, Rif fir	Conifers Garden / 2021 Bloom River Gardens / 2021 Plant Lust / 2021 Cloud Mountain Farm Center / 2021
<i>Acis tingitana</i>	<i>Leucojum fontianum</i> , <i>Leucojum tingitanum</i> , Moroccan snowflakes, rare <i>Leucojum</i>	Ryan Stephen / 2021 Hill View Rare Plants / 2021 Cotswold Garden Flowers / 2021 Broadleigh Gardens / 2021 Red Earth Bulbs / 2021
<i>Rhodanthemum hosmariense</i>	<i>Leucanthemum hosmariense</i> , <i>Chrysanthemum hosmariense</i> , <i>C. maresii</i> . var. <i>hosmariense</i> , <i>Pyrethropsis hosmariense</i> , <i>Rhodanthemum</i> Marrakech or Casa-blanca (Moroccan daisy), white or large daisy	Boundary Nursery / 2019 Craigiehall Nursery / 2019 FlorAccess / 2021 Garden Beauty / 2021 Amazon / 2019 Beth Chatto's Plants and Gardens / 2021 Greenleaf Nurseries / 2021
<i>Salvia interrupta</i> subsp. <i>pau</i>	<i>S. interrupta</i> , <i>S. pau</i>	Les Senteurs du Quercy / 2021

Discussion

Bulbous plants are highly appreciated in the worldwide horticultural market (Krigas *et al.* 2017, Menteli *et al.* 2019). Although there are Tunisian endemic bulbous plants with possible ornamental value (Libiad *et al.* 2020) (e.g., *Belvalia dolichophylla* Brullo & Miniss., *B. galitensis* Bocchieri & Mossa, *Hyacithoides kroumiriensis* El Mokni, Domina, Sebei & El Aouni, *Oncostema maireana* Brullo, Giusso & Terrasi) or plants with tuberous roots, such as Orchidaceae (members of genera *Ophrys* and *Serapias*), the absence of Tunisian endemic taxa among the plants traded over the Internet is surprising. This may indicate that the worldwide ornamental market is not interested yet in

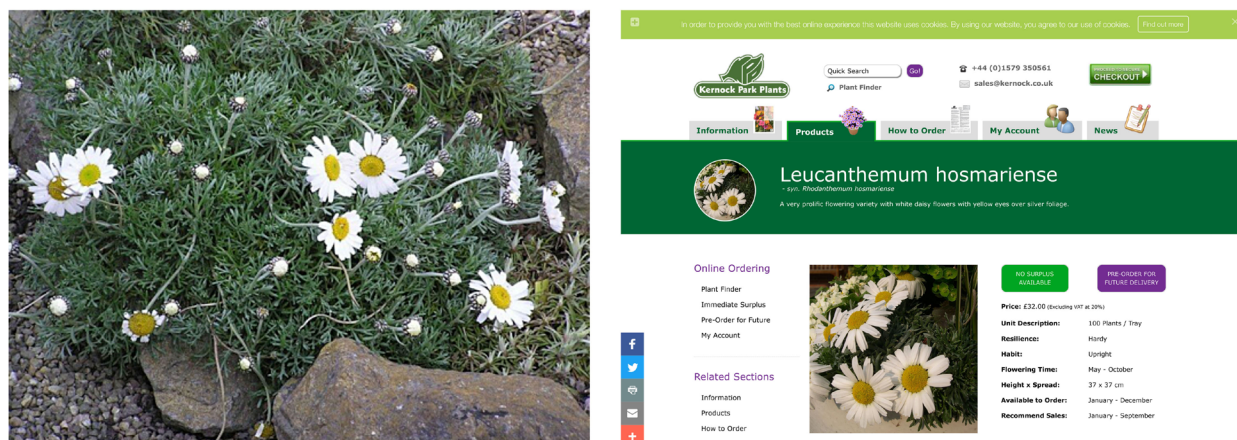


Figure 4. Left: *Rhodanthemum hosmariense* cultivated privately (Matelma 2021; Photo credit: Françoise de La Porte, reproduced with permission). Right: Screenshot of a website in UK selling this taxon on the internet as of January 2021 (Kernock Park Plants, see [Appendix 1](#)).

these endemics or may be due to strict domestic controls prohibiting illegal export of materials. To a certain extent, this trend may also reflect the unresolved taxonomic distinction (Libiad *et al.* 2020) regarding many of the Tunisian endemics.

The study of the electronic commerce of endemic plants from northern Morocco identified four taxa marketed over the Internet, which is a small fraction (4.25 %) of the endemic flora of this region. This number is smaller as compared to other Mediterranean regions - e.g., 34 % of the Cypriot endemic flora (Krigas *et al.* 2017), 10 % of the Greek endemic flora (Krigas *et al.* 2014) and 13 % of the Cretan endemics (Menteli *et al.* 2019). Live plant is the most common form of sale of the endemic taxa of Mediterranean part of northern Morocco and this concurs with that reported in other studies (Krigas *et al.* 2017).

The endemic plants of northern Morocco are marketed as individual plants for three taxa and bulbs for *A. tingitana*. Although trade of seeds is more common than trade of living plants (Olmos-Lau & Mandujano 2016), and unlike to similar reports for e-traded plants of other Mediterranean regions (Krigas *et al.* 2014, 2017), the e-trade of seeds of Moroccan plants has not been recorded. The absence of seed trade of Moroccan endemic plants in the internet market is probably associated with the absence of sexual propagation protocols regarding the original plant material acquired by the nurseries. On the other hand, this may also mean that the traded material is probably only clonally propagated by the nurseries.

Given the vast scope of the Internet, online trade of endangered species has become a persistent threat that is difficult to measure or control (Olmos-Lau & Mandujano 2016). The northern Moroccan taxa that we found as traded around the world are not listed in the Appendices of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Consequently, we cannot accurately estimate the extent of this phenomenon and/or whether this trade is legal because the monitoring of illegal trafficking is intrinsically limited by the clandestine nature of the activity, the language, the search terms used and/or the lack of information (Sonricker-Hansen *et al.* 2012, Olmos-Lau & Mandujano 2016, Hinsley & Roberts 2017). This study highlights the electronic commerce of species included in the IUCN Red List ([Table 4](#)), namely *A. marocana*, which is listed as endangered with a decreasing population trend (Alaoui *et al.* 2011). In addition, three of these taxa are assessed nationally as endangered, namely *A. tingitana*, *R. hosmariense* and *S. interrupta* subsp. *pau* (Fennane 2017, 2018). This evidences the e-trade of range-restricted taxa in critical extinction risks, with areas of occupancy extremely limited to one or two sites in northern Morocco. Nevertheless, monitoring of e-trade in species that are not currently classified as threatened should also be made because they may be at an increased extinction risk in the future (Sonricker-Hansen *et al.* 2012, Krigas *et al.* 2014, 2017).

Table 3. Quantitative aspects of trade of endemic Moroccan taxa (living plants or bulbs) via the Internet (in € and \$, respectively)

Taxon	Country	Price*	Price/item (\$)	Price/item (€)
<i>Abies marocana</i>	USA	\$ 295.00	295.00	259.5
	HU	€ 12.00	13.6	12.00
	USA	\$ 29.95	29.95	26.3
<i>Rhodanthemum hosmariense</i>	UK	£ 9.99	13.00	11.5
	UK	£ 4.80	6.27	5.52
	UK	£ 5.95	7.77	6.85
	UK	£ 2.75	3.60	3.16
	UK	£ 2.70	3.50	3.1
	USA	\$ 13.00	17.00	14.96
	NZ	\$ 16.95	22.15	19.5
	NL	€ 1.86	2.11	1.86
	UK	£ 2.50	3.30	2.87
	UK	£ 30.50**	0.40	0.35
<i>Acis tingitana</i>	UK	£ 3.00	3.9	3.45
	AU	\$ 4.50	4.50	3.95
	AU	\$ 6.00***	1.20	1.05
	UK	£ 3.00	3.92	3.45
<i>Salvia interrupta</i> subsp. <i>pau</i>	FR	€ 8.90	10.11	8.90

* Original prices detected in nurseries' websites

** Price for 100 plants

*** Price for 5 bulbs

Morocco has national laws that protect phylogenetic resources at risk or threatened with extinction, consisting in many provisions that must be respected for any operation addressed to acquire specimens. In particular, the law No 29-05 (Dahir No 1-11-84 of 02 July 2011) focuses on the protection and the conservation of the native species of wild flora and fauna. The provisions of this law (Article 4) apply to the transit, export, possession, in whatever capacity, removal from the natural environment, transport and trade of species classified in one of the designated categories. Moroccan threatened species or species at risk not covered by CITES (Categories I, II, III), such as those found as traded herein, are included in this law as priority taxa in Category IV (species of national flora and fauna threatened with extinction, not classified in categories I, II and III, as well as species whose trade compromises their survival). The fifth article of this law specifies that 'it is forbidden, among other things, to export or re-export, to sell, to hold for sale or to offer for sale, to take from natural environment, to acquire or to exhibit for commercial purposes or to use for profit specimens or processed specimens of species classified in one of the categories of Article 4'. Provided that any export of such taxa does not harm the survival of the species in question and does not disturb the ecological balance of the territory where it is present, these permits are subject to verification (Article 16) upon presentation at the border post of export accompanied by an inspection of the shipment, including the examination of specimens. The special permits are nominative and are issued to the natural or legal persons who have requested them officially or to their representatives (Article 20), they are neither assignable nor transferable, with duration of twelve months (Article 22). Violations or attempted violations of the provisions of this regulation are classified according to their seriousness (Article 53). In light of this perspective and given that no indications are provided in the websites of nurseries regarding the origin of the initial plant material they trade and/or how it was obtained, the e-commerce of

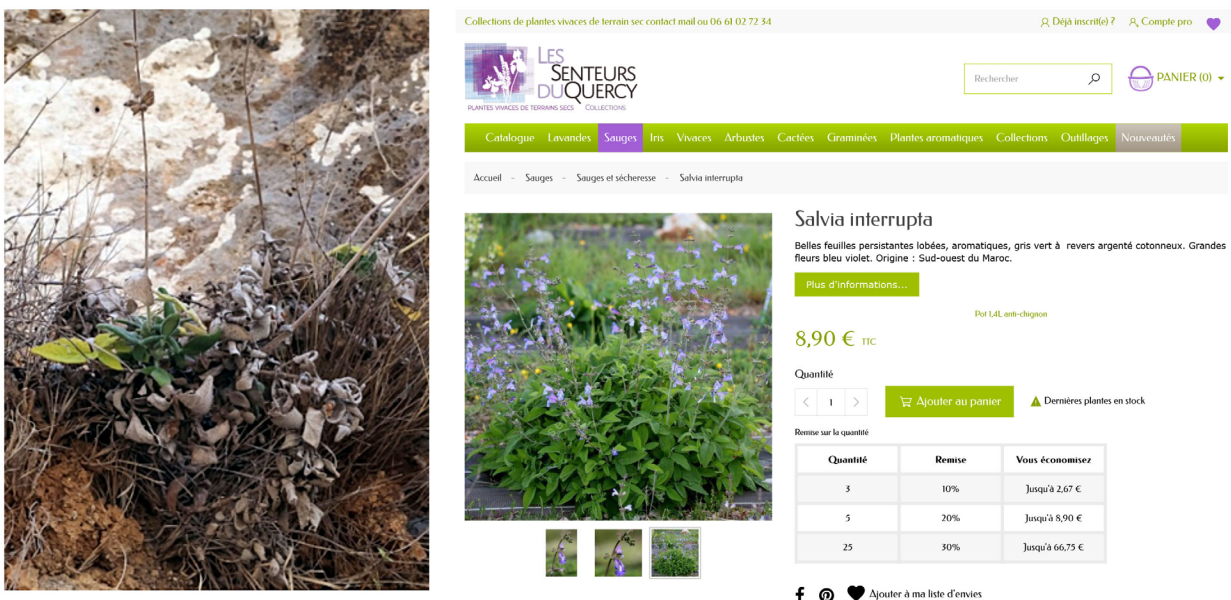


Figure 5. Left: *Salvia interrupta* subsp. *paui* dry leaves and fruiting inflorescence in wild habitats of Achekrade, Rif, Morocco (www.teline.fr/; Photo credit: Abdelmonaim Homrani Bakali, reproduced with permission). Right: Screenshot of a website selling this taxon on the internet as of January 2021 (Les Senteurs du Quercy, see [Appendix 1](#)).

Moroccan threatened species over the internet represents an infringement of legal regulations. In the case of Tunisia, the Forest Code (and its implementing texts) regulates in the same line the issues concerning rare and endangered species of flora and fauna, as well as species covered by international treaties (JORT No 60 of July 28, 2006).

Using threatened plant resources requires conservation measures *in-situ* and the countries must have the capability of monitoring and/or controlling the harvesting and export of their wild phylogenetic resources (Hinsley & Roberts 2017, Tomaskinova *et al.* 2019). In the same context, promotion of the sustainable cultivation of *A. tangitana* (Amaryllidaceae) for ornamental bulb supply and/or medicinal purposes could generate considerable incomes for the local population, as similar projects have been successfully implemented in Turkey to produce *Galanthus elwesii* Hook f. (Amaryllidaceae) bulbs. However, although reproduction and multiplication of Moroccan threatened species classified in one of the categories foreseen in the Article 4 of the above-mentioned national law is possible, this practice is always subjected to obtaining special permits (Article 39) after advice of competent organisms or scientific institutions. This permit is only granted if the procedure does not harm the survival and conservation of the species concerned (Article 40). Such sustainable and low-abiding practices may trigger the development of new horticultural and commercial skills among bulb producers and may be an alternative good-quality source of documented bulbs able to alleviate their collection from the wild (Entwistle *et al.* 2002). However, additional studies are required to define the potential negative impacts of these practices.

This study provides information on the state of electronic commerce of endemic plants from the Mediterranean part of northern Morocco. With extant national and international legal instruments regulating the trade of endangered species, our study brings into light evidence that this trade cannot be characterized as law-abiding. The nurseries related with the e-commerce of unique Moroccan plants ship uncontrolled quantities of unspecified origin to many countries worldwide, without permits issued by local authorities to access, harvest and sell these resources. As a measure to ensure that trade is law-abiding and does not harm the survival of these species in the wild, it is suggested that threatened species that are not currently covered by CITES but are found as traded in the international market (see other examples in Krigas *et al.* 2014, 2017, Menteli *et al.* 2019) should be urgently listed in the CITES Appendices

Table 4. Number of known populations and extinction risk status of the e-traded endemic plants (EN = Endangered) of northern Morocco.

Taxon	Extinction risk status (Population trend)	Number of known populations	References
<i>Abies marocana</i>	EN (Decreasing)	10	Mateos & Valdés 2009, Alaoui <i>et al.</i> 2011
<i>Acis tingitana</i>	EN (Unknown)	7	Mateos & Valdés 2010, Chambouleyron 2012, Rankou <i>et al.</i> 2015, Fennane 2018 www.teline.fr
<i>Rhodanthemum hos-</i> <i>mariense</i>	EN (Unknown)	5	Mateos & Valdés 2009, Chambouleyron 2012, Fennane 2017, www.floramaroccana.fr
<i>Salvia interrupta</i> subsp. <i>pau</i>	EN (Unknown)	5	Mateos & Valdés 2009, Chambouleyron 2012, Fennane 2017, www.teline.fr

(Olmos-Lau & Mandujano 2016). To avoid possible decline of wild populations of these species, their wild populations should be regularly monitored by local authorities, while their internet trade should be constantly tracked and investigated (Krigas *et al.* 2014, 2017, Menteli *et al.* 2019).

Conclusions

Plant e-commerce is a global issue and a good understanding of this activity requires coordinated monitoring efforts by scientists, managers, and authorities. The absence of Tunisian endemic taxa in trade over the Internet is remarkable and therefore it is essential to examine if this illustrates a real picture, given that relevant vendors of such resources seem to be increasing (Menteli *et al.* 2019). We suggest that Tunisian and Moroccan scientists and/or authorities should repeat this study soon, since this activity does not seem to respect national and/or international regulations. To assess this risk and regulate the traffic, the access to these resources and the fair and equitable benefit sharing from their trade, the North African authorities should be encouraged to (i) monitor regularly the wild populations of threatened species, (ii) survey repeatedly the e-trade of their local endemics paying attention to potential new entries, (iii) fully implement the provisions of the Nagoya Protocol, and/or (iv) undertake promptly initiatives to list the threatened taxa in the CITES Appendices. These measures could be performed by authorities of the Moroccan and Tunisian Ministries dealing with environmental issues with the help of domestic scientific communities. These measures could help to exert sovereign rights over genetic resources and to avoid depletion of biodiversity. Creation of and/or participation in surveillance networks /mechanisms (Sonricker-Hansen *et al.* 2012) could increase cooperation and facilitate the control of this type of illegal international trade.

Acknowledgements

This work was supported by the ARIMNet2 2017 Transnational Joint Call through the MULTI-VAL-END project entitled 'Multifaceted Valorisation of single-country Endemic plants of Crete, Greece, Tunisia and Rif, Morocco for sustainable exploitation in the agro-alimentary, horticultural-ornamental and medicinal-cosmetic sectors' and was co-founded the Hellenic Agricultural Organization Demeter of Greece, the State Secretariat for Higher Education and Scientific Research (SEESRS) of Morocco, and the Institution de la Recherche et de l'Enseignement Supérieur Agricoles (IRESA), Ministère de l'Agriculture, Republic of Tunisia. ARIMNet2 (ERA-NET) has received funding from the European Union's Seventh Framework Programme for research, technological development and demon-

stration under grant agreement no. 618127. We thank the reviewers and the associate editor for their constructive comments.

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Associate editor: Ernesto Badano

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AK, investigation, writing-original draft, review; ML, investigation, writing-original draft, review; MEH, investigation, validation, review; SB, investigation, validation, review; WMK, investigation, validation, review; FL, validation, review; ZGG, investigation, validation, review; VM, data curation, investigation, methodology; DV, methodology, review; GT, validation, review; NK, conceptualization, investigation, methodology, review, project administration.

Appendix 1. Websites of the internet market trading local endemic plants of Morocco internationally during 2019-2021 (*: no longer available on the internet)

***Abies marocana* Trab.**

Bloom River Gardens (accessed July 13, 2021) - https://www.bloomriver.com/home/br2/page_19_7/abies_marocana.html.%20Access%20%5b13

Cloud Mountain Farm Center (accessed July 13, 2021) - <https://www.cloudmountainfarmcenter.org/nursery/maracona-pin-fir-2/>

Conifers Garden (accessed July 13, 2021) - <https://conifersgarden.com/rare-conifers/abies-pinsapo-var.-marocana>

Plant Lust (accessed July 13, 2021) - <https://plantlust.com/plants/36467/abies-marocana/>

***Acis tingitana* (Baker ex Ball) Lledó, A.P. Davis & M.B. Crespo**

Broadleigh Gardens (accessed July 13, 2021) - <https://www.broadleigh-bulbs-spring.co.uk/shop/index.php?app=gbu0&ns=prodshow&ref=leuctingitanum&sid=5ee50owo14xug39r6wpxp1963fg0m77v2>

*Cotswold Garden Flowers (accessed July 13, 2021) - <https://www.cgf.net/plantdetails.aspx?id=2245>

Hill View Rare Plants (accessed July 13, 2021) - <https://hillviewrareplants.com.au/plant/acis-tingitana>

Red Earth Bulbs (accessed July 13, 2021) - <https://www.facebook.com/redearthbulbfarm/posts/leucojum-tingitanum-a-rare-leucojum-snowflake-not-to-be-confused-with-galanthus-981687518562179>

*Ryan Stephen (accessed July 13, 2021) - <https://stephenryan.com.au/acis-tingitana> (accessed December 13, 2019)

***Rhodanthemum hosmariense* (Ball) B.H. Wilcox, K. Bremer & Humphries**

*Amazon (accessed December 13, 2019) - <https://www.amazon.co.uk/Leucanthemum-Hosmariense-Moroccan-Perennial-Plants/dp/B010K4ZDU2>

Beth Chatto's Plants and Gardens (accessed July 13, 2021) - <https://www.bethchatto.co.uk/conditions/plants-for-dry-conditions/rhodanthemum-hosmariense.htm>

*Boundary Nursery (accessed December 13, 2019) - <https://boundarynursery.co.uk/shop-for-plants/leucanthemum-hosmariense-alpine>

*Craigiehall Nursery (accessed December 13, 2019) - https://www.craigiehallnursery.co.uk/ourshop/prod_2109467-Rhodanthemum-hosmariense-AGM.html

*Dancing Oaks Nursery and Gardens (accessed December 13, 2019) - https://dancingoaks.com/products/rhodanthemum_hosmariense

FlorAccess (accessed July 13, 2021) - <https://www.floraccess.com/en/v/29880/experts-in-green/rhodanthemum-hosmariense-mix/>

*Garden Beauty (accessed July 13, 2021) - <https://www.gardenbeauty.co.uk/plant-details/hosmariense/rhodanthemum/rhohos-plant-collections.php>

Kernock Park Plants (accessed July 13, 2021) - <https://www.kernock.co.uk/acatalog/Leucanthemum-hosmariense-U452.html>

Greenleaf Nurseries (accessed July 13, 2021) - <https://www.greenleafnurseries.co.nz/shop/shrubs/perennials/pyrethropsis-rhodanthemum-chrysanthemum-hosmariense-pb6-5/>

Macplants Berrybank Nursery (accessed July 13, 2021) - <https://www.macplants.co.uk/viewItem.php?id=1529&navPageId=8887&startNo=&searchText=&plantTypeId=0&aspectId=0&soilTypeId=0&potId=0&heightId=&colourId=0&seasonId=0&recommendationId=0&award=>

Matelma (accessed July 13, 2021) - <https://www.matelma.com/fr-fr/encyclopedie-des-plantes/2401/rhodanthemum-hosmariense>

Tortworth Plants (accessed July 13, 2021) - https://www.tortworthplants.co.uk/ourshop/prod_3713623-Rhodanthemum-hosmariense-9cm-pot.html

***Salvia interrupta* Schousb. subsp. *pau* (Maire) Maire**

Les Senteurs du Quercy (accessed July 13, 2021) - <https://www.senteursduquercy.com/sauges-et-secheresse/659-salvia-interrupta.html>
