

Assessment of plant diversity of endemic species of the Saharo-Arabian region in Egypt

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Abstract: Savanna, semi-deserts, and hot deserts characterize the Saharo-Arabian region, which includes Morocco, Mauretania, Algeria, Tunisia, Libya, Egypt, Palestine, Kuwait, Saudi Arabia, Qatar, Bahrain, the United Arab Emirates, Oman, Yemen, southern Jordan, Syria, Iraq, Iran, Afghanistan, Pakistan, and northern India. Its neighboring regions, the Sudano-Zambezian region belonging to the Paleotropical Kingdom and the Mediterranean and Irano-Turanian regions included in the Holarctic Kingdom, share a large portion of their flora with the Saharo-Arabian region. Despite the widespread acknowledgment of the region's global importance for plant diversity, an up to date list of the Saharo-Arabian endemics is still unavailable. The available data are frequently insufficient or out of date at both the whole global and the national scales. Therefore, the present study aims at screening and verifying the Saharo-Arabian endemic plants and determining the phytogeographical distribution of these taxa in the Egyptian flora. Hence, a preliminary list of 429 Saharo-Arabian endemic plants in Egypt was compiled from the available literature. Indeed, by excluding the species that were recorded in any countries or regions outside the Saharo-Arabian region based on different literature, database reviews, and websites, the present study has reduced this number to 126 taxa belonging to 87 genera and 37 families. Regarding the national geographic distribution, South Sinai is the richest region with 83 endemic species compared with other eight phytogeographic regions in Egypt, followed by the Isthmic Desert (the middle of Sinai Peninsula, 53 taxa). Sahara regional subzone (SS1) distributes all the 126 endemic species, Arabian regional subzone (SS2) owns 79 taxa, and Nubo-Sindian subzone (SS3) distributes only 14 endemics. Seven groups were recognized at the fourth level of classification as a result of the application of the two-way indicator species analysis (TWINSPAN) to the Saharo-Arabian endemic species in Egypt, i.e., I *Asphodelus refractus* group, II *Agathophora alopecuroides* var. *papillosa* group, III *Anvillea garcinii* group, IV *Reseda muricata* group, V *Agathophora alopecuroides* var. *alopecuroides* group, VI *Scrophularia deserti* group, and VII *Astragalus schimperi* group. It's crucial to clearly define the Saharo-Arabian endemics and illustrate an updated verified database of these taxa for a given territory for providing future management plans that support the conservation and sustainable use of these valuable species under current thought-provoking devastating impacts of rapid anthropogenic and climate change in this region.

Keywords: endemism; phytogeographical regions; Saharo-Arabian floristic region; Egyptian flora; plant diversity; two-way indicator species analysis (TWINSPAN)

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1 Introduction

The desert biome includes a number of geographic regions distinguished by a high level of aridity, a significant amount of bare soil, and some organisms that have developed specific adaptations to survive in a very dry climate (Ezcurra et al., 2006). According to Costanza et al. (2014), deserts occupy almost 33.0% of the Earth's surface. Deserts are susceptible to climate variability due to their hot climate and water scarcity issues (Meigs, 1953; El-Nesr et al., 2010). Based on the rate of precipitation, Wickens (1998) divided the world's desert areas into three categories: semi-arid areas, which receive an average of between 200 and 400 mm of precipitation annually; arid areas, which receive less than 200 mm of precipitation annually; and hyper-arid areas, with an average of 12 months without precipitation. There are several different types of deserts in the world, including coastal, tropical and subtropical, rain shadow, continental interior, and polar deserts (Marshak, 2015); usually, these deserts are found in rocky or sandy landscapes (Smith and Pettorelli, 2020). The climates of deserts and semi-deserts are characterized by major continental rain shadows and subtropical high-pressure belts (Keith et al., 2020). On the other hand, the impacts of atmospheric stability can be increased by a combination of geographic, topographic, and oceanographic factors. For example, the location and size of Sahara and Arabian deserts are influenced by the high-pressure belt that lies over the Tropic of Cancer and the effects of continental (Nash, 2012).

As with all types of desert geomorphology, Saharo-Arabian floristic region has deep-rooted plants and shaded therophytes, salt and limestone crusts, and biotic crusts that stabilize sand dunes (Breckle et al., 2001). The Saharo-Arabian region also belongs to shield deserts that formed above very old crystalline floors, which were cracked and reinforced by pressure and heat during many millions of years, resulting in gently sloping swells and basins that retain the best groundwater sources (Ezcurra et al., 2006). Some deserts, such as the Sonoran-Chihuahuan region of the United States and Mexico and the Karoo of South Africa, are key biodiversity hotspots on a global scale (Myers et al., 2000), supporting human cultures and providing a variety of local and international ecosystem services (McClung et al., 2019). The Sahara Desert and the nearby arid Sahel are habitats for high number of endemic species and a patchy distribution region of other species that are limited to small, vulnerable, and humid habitats (Brito et al., 2014). Isolated and remnant bodies of water (lakes, seasonal rivers, and oases) surrounded by sand act as refugia for relict populations and serve as sites for the evolution of rare species (Trape, 2013). Indeed, the presence of water in drylands is a powerful predictor of species richness and community distribution (Cornwell and Ackerly, 2009).

The Saharo-Arabian region, from a phytogeographic perspective, is the vast desert belt that stretches eastward from the Atlantic coast of Morocco and Mauritania, through the Sahara Desert, Sinai Peninsula, extra tropical Arabia, southern Iraq, Iran, and Afghanistan, and terminates in the deserts of India and Pakistan (Sind Province, Thar Desert, and Punjab Province) (Zohary, 1973). Its borders are the Mediterranean region in the north and west, the Irano-Turanian region in the east, and the Sudano-Zambezi region and the Tropic of Cancer in the south. It is characterized by extremely dry air, high temperatures, and little precipitation (Heine, 1962). Because of the length of dry season, the low continentality index, and mild winters, the Saharo-Arabian region as a whole differs climatically from its neighbors, particularly the Irano-Turanian neighborhood (Léonard, 1988). Precipitation during the summer in the Saharo-Arabian region varies significantly geographically between the west of Sahara Desert and its east. It is commonly believed that topographic heterogeneity raises the endemism rate (Djamali et al., 2012). According to White and Léonard (1991), they divided the Saharo-Arabian region into three subzones: Sahara regional subzone (SS1), Arabian regional subzone (SS2), and Nubo-Sindian subzone (SS3). White and Léonard (1991) stated that the majority of Egypt excepting for the Mediterranean coastal strip and Elba Mountains is located in the SS1 zone.

White and Léonard (1991) revised the approach of Zohary (1973) and extended the Somalia-Masai regional center of endemism and the Afro-Montane archipelago-like regional

center of endemism into southwestern Arabia and divided Saharo-Sindian zone into SS1, SS2, and SS3. The SS1 subzone includes Morocco, Mauritania, Algeria, Tunisia, Libya, and Egypt. The SS2 subzone represents the eastern Saharo-Arabian of Zohary (1973), including Palestine, Kuwait, Saudi Arabia, Qatar, Bahrain, the United Arab Emirates, Oman, Yemen, and south of Jordan, Syria, and Iraq. And the SS3 subzone represents the old Sudano-Decanian tropical vegetation of Zohary (1973), including south of Iran, Afghanistan, Pakistan, and northern India.

Endemic taxa are those that are found only in a certain place and represent an essential feature of spatial distribution (Morrone, 2008). Because they have distinctive genetic materials and are capable of satisfying the fundamental necessities of people, endemic plants are highly valued (Skarbek, 2008). However, they are more vulnerable to changes in the environment and threats caused by humans. Because of this, endemic plants are more likely to become extinct. As a result, conserving endemic plants is regarded as a global concern (El-Khalafy et al., 2021a). Manes et al. (2021) stated that globally, endemic species are three times more likely to become extinct than native species. Endemism is mentioned as a stage before extinction by Hobohm et al. (2014). As a result, endemic plants are the focus of most global conservation efforts, which are mostly carried out *in situ* through protected areas, *ex situ* through gardening, and cryo-conservation through the banks of seeds and biotechnological approaches (Coelho et al., 2020).

Few endemic species and genera, as well as none endemic families, are characteristics of the Saharo-Arabian region, according to Wickens (1977) and Boulos (1997). The vegetation of the deserts in Egypt is certainly a unique type of natural plant life (El-Amier and Abdul-Kader, 2015). According to Moustafa (1990) and El-Khalafy et al. (2021a), South Sinai Mountains are a significant habitat for Egypt's endemism because they have larger outcrops of rare species-supporting smooth-faced rocks and a more humid climate than much of the rest of Sinai Peninsula (Danin, 1972, 1978, 1983). Therefore, the mountainous southern Sinai Peninsula has a higher biodiversity as compared with the rest of Egypt (Abd El-Ghani et al., 2017).

Deserts are a significant conservation concern because of their great biodiversity, uniqueness, and rising survival hazards. The future survival of deserts and their species relies on developing strategies for conservation that are capable of dealing with the challenges provided by rapidly shifting climatic conditions. Regional biodiversity knowledge is typically lacking or outdated (Brito et al., 2018). There is no enough data about the list of endemic plant species of the Saharo-Arabian region in Egypt and the vegetation distribution map of these species. Therefore, an accurate list of endemic species is necessary to understand species diversity in regions under heavy anthropogenic impact. It can be utilized as a baseline reference for future monitoring programs as well as to offer data for future *in situ* and *ex situ* conservation planning activities. So, this study aims to provide an authenticated database of endemic plant species of the Saharo-Arabian region in Egypt and study the national and global distribution of these species.

2 Materials and methods

2.1 Study area

Less than 25.0% of Egypt's land area is in the south of the Tropic of Cancer, and it is located between latitudes 22° and 32°N, and longitudes 24° and 36°E (Egypt is primarily in the temperate zone). The study area of Egypt includes: the Western Desert except the western Mediterranean coast that extends for an average distance of 45–50 km in north-south direction from the coast (Bidak et al., 2013), the Eastern Desert with Red Sea except the Gebel Elba Mountains, the Sinai Peninsula except the eastern Mediterranean coast that extends for an average distance of 10–15 km in north-south direction from the coast (Zahran et al., 1985), and the Nile Valley and Nile Delta except the coastal land of northern delta that extends for 15–25 km in north-south direction from the coast (Zahran and Willis, 2009). The Saharo-Arabian region in this study includes: Morocco, Mauretania, Algeria, Tunisia, Libya, Egypt, Palestine, Kuwait, Saudi Arabia, Qatar,

Bahrain, the United Arab Emirates, Oman, Yemen, southern Iraq, Iran, Afghanistan, and Pakistan, as well as northern India (21 countries in total). Due to lack of data, Western Sahara is not included in the research scope of this paper. Lebanon belongs to the Mediterranean region, so Lebanon is also not included in this paper.

2.2 Data sources and verification literature

2.2.1 Endemic species

The preliminary list of the Saharo-Arabian endemics was compiled from three primary sources that researched the plants of this region. These sources include Bornkamm and Kehl (1990), Boulos (1999–2005), and Abd El-Ghani et al. (2017). Indeed, Boulos (1999–2005) recorded 199 Saharo-Arabian endemic species in the Egyptian flora, while Abd El-Ghani et al. (2017) recorded 187 taxa and Bornkamm and Kehl (1990) recorded 102 Saharo-Arabian endemic species in the Western Desert region of Egypt. All the plants identified in these studies as the Saharo-Arabian endemic plants were included in the preliminary list. Finally, we got a preliminary list with 429 taxa (Table S1).

Then, the preliminary list of endemic plants of the Saharo-Arabian region in Egypt was assessed to confirm their occurrence by literature analysis. If the taxon was recorded in any countries outside the Saharo-Arabian region, it was excluded from the list. The preliminary list was assessed by the literature listed in Tables 1, 2, and 3. Table 1 shows the articles or books relating to the flora of Egypt; Table 2 shows the literature relating to the floras of other Saharo-Arabian countries; and Table 3 shows websites and global online databases relating to the Saharo-Arabian endemic plants.

Table 1 References of flora of Egypt used for the verification of occurrence of the Saharo-Atabian endemic plants in Egypt

Author	Article or book title	Journal or publisher	Publication year
Abd El-Ghani, Hamdy, and Hamed	Habitat diversity and floristic analysis of Wadi El-Natron depression, Western Desert, Egypt	Phytologia Balcanica	2015
Ahmed, Shaltout, Hosni, et al.	Flora and vegetation of the different habitats of the western Mediterranean region of Egypt	Taeckholmia	2015
Bedair, Shaltout, Ahmed, et al.	Characterization of the wild trees and shrubs in the Egyptian flora	Egyptian Journal of Botany	2020
Bedair, Ibrahim, Alyamani, et al.	Impacts of anthropogenic disturbance on vegetation dynamics: a case study of Wadi Hagul, Eastern Desert, Egypt	Plants	2021
Bedair, Shaltout, and Halmy	A critical inventory of the Mediterranean endemics in the Egyptian flora	Biodiversity and Conservation	2023
El-Khalafy	Red list of the endemic and near endemic plant species in Egypt	Tanta University	2018
El-Khalafy, Shaltout, and Ahmed	Updating and assessing plant endemism in Egypt	Phytotaxa	2021
El-Khalafy, Ahmed, Shaltout, et al.	Re-assessment of the endemic taxa in the Egyptian Flora	African Journal of Ecology	2021
El-Khalafy	Biodiversity characteristics of endemic taxa in Egyptian flora	Tanta University	2023
El-Khouly and Negm	Management and Development of Agricultural and Natural Resources in Egypt's Desert	Springer Nature	2021
El-Saied, El-Ghamry, Khafagi, et al.	Floristic diversity and vegetation analysis of Siwa Oasis: An ancient agro-ecosystem in Egypt's Western Desert	Annals of Agricultural Science	2015
Kamel, Zaghoul, Abd El-Wahab, et al.	Current status of the flora of North Sinai: losses and gains	Catrina	2008
Salama, Abd El-Ghani, and Gadallah	Diversity and Plant FGs of the Vegetation in Eastern Desert of Egypt	Lambert Academic Publishing	2016
Shaltout, El-Din, and Ahmed	Plant Life in the Nile Delta	Tanta University Press	2010

Data were additionally gathered from field trips. Cairo University, Alexandria University, the herbaria of Kafrelsheikh University, Assiut University, Tanta University, Agriculture Museum of Cairo, National Research Centre of Egypt, Desert Research Center of Egypt, and National Registry for Egyptian Herbaria also provided plant data for the endemic species research. The accessible literature (articles, books, master's theses, doctoral dissertations, and scientific reports) in above mentioned institutes was also used for gathering the information. The taxa in the list were organized alphabetically using the Angiosperm Phylogeny Group IV system (Byng et al., 2016). The accepted name of the recorded taxa was assessed using the World Checklist of selected Plant Families (WCSP) and Plants of the World Online (POWO) websites.

The final checklist of the present study includes three categories: the excluded species (surely non-Saharo-Arabian endemics), the included species (surely Saharo-Arabian endemics), and the extended species (species that are primarily found in the Saharo-Arabian region but extend to nearby regions). This study provides a critical and dynamic checklist of the Saharo-Arabian endemic plants in Egypt (Table S1).

Table 2 References of floras of other countries in the Saharo-Arabian region used for the verification of occurrence of the Saharo-Arabian endemic plants in Egypt

Author	Article or book title	Publisher or journal name	Publication year
Abdullah and Al-Dosari	Vegetation of the State of Kuwait	IUCN and Environment Public Authority of Kuwait	2022
Ali and Jafri	Flora of Libya. Volumes 1–144	University of Tripoli	1976
Almasri, Hmidan, Shater, et al.	Syria country report on the identification of important plant areas (IPAs) in Syria (Rapid assessment)	National Coordinating Organization Syrian Society for Conservation of Wild Life	2010
Chaudhary	Flora of the Kingdom of Saudi Arabia. Volume 1–3	Ministry of Agriculture and Water of Saudi Arabia	1999–2001
El-Gadi	Flora of Libya. Volumes 145–147	University of Tripoli	1986
Feinbrun-Dothan	Flora Palaestina: Part Three, Ericaceae to Compositae	The Israel Academy of Science and Humanities	1978
Feinbrun-Dothan	Flora Palaestina: Part Four. Text. Alismataceae to Orchidaceae.	The Israel Academy of Science and Humanities	1986
Floc'h, Boulos, and Véla	Synonymous Catalog with Commentary of the Flora of Tunisi	Ministry of Environment and Sustainable Development, Tunisia	2010
Ghazanfar	Status of the flora and plant conservation in the Sultanate of Oman	Biological Conservation	1998
Guest	Flora of Iraq, Vol. 1	Ministry of Agriculture of Iraq	1966
Kilian, Hein, and Hubaishan	New and noteworthy records for the flora of Yemen, chiefly of Hadhramout and Al-Mahra	Willdenowia	2002
Meddour, Sahar, and Médail	Checklist of the native tree flora of Algeria: diversity, distribution, and conservation	Plant Ecology and Evolution	2021
Norton, Böer, Allan, et al.	An Illustrated Checklist of the Flora of Qatar	United Nations Educational Scientific and Cultural Organization (UNESCO)	2009
Taifour	Jordan Plant Red List Volume II	Royal Botanic Garden of Jordan	2017
Taifour and El-Oqlah	Jordan Plant Red List Volume I	Royal Botanic Garden of Jordan	2016
Taleb and Fennane	Vascular Plant Communities of Morocco: Phytosociology, Ecology and Geography	Springer International Publishing	2019
Yaseen, Ahmad, Sultana, et al.	Ethnobotany of medicinal plants in the Thar Desert (Sindh) of Pakistan	Journal of Ethnopharmacology	2015
Zohary	Flora Palaestina Part I	The Israel Academy of Science and Humanities	1968
Zohary	Flora Palaestina Part II	The Israel Academy of Science and Humanities	1987

2.2.2 Geographical distribution

In the present study, we identified the phytogeographical sectors according to Täckholm (1974). The system of White and Léonard (1991) was used for the assessment of the recorded taxa's global distribution (floristic regions). We defined the distribution of the taxa that were recorded in the countries of the Saharo-Arabian region depending on several databases (Table 3). Floras of countries in the Saharo-Arabian region were also used for the assessment of recorded taxa (Table 4).

Table 3 Global online databases utilized for the verification of occurrence of the Saharo-Arabian endemic plants in Egypt

Database	Website
African Plant Database	https://africanplantdatabase.ch/en
Algeria Native Plants	https://algerianativeplants.net/html-ang/plante-algerie-recherche.php
Catalogue of Life	http://www.catalogueoflife.org/annual-checklist/2010
Database of Weed Species in Crops and Countries	https://www.fao.org/agriculture/crops/thematic-sitemap/theme/biodiversity/weeds/db-countries/l/en/
Euro+Med Plant Base	https://europlusmed.org/
Flora of Greece	https://portal.cybertaxonomy.org/flora-greece/intro
Flora of Israel Online	http://flora.org.il
Flora of Lebanon	http://lebanon-flora.org/
Flora of Libya	https://www.floraoflibya.services.ly/
Flora of Morocco	https://herbaria.plants.ox.ac.uk/bol/floraofmorocco/Explore
Flora of Pakistan	http://www.efloras.org/index.aspx
Flora of Qatar	https://www.floraofqatar.com/
Flora of the Kingdom of Saudi Arabia	https://floraofksa.myspecies.info/
Global Biodiversity Information Facility (GBIF)	https://www.gbif.org/
Global Compositae Database (GCD)	https://www.compositae.org/index.php
Global Plants on JSTOR	https://plants.jstor.org/
Legume Information System (LIS)	https://www.legumeinfo.org/taxa/
National Registry for Egyptian Herbaria	http://networks.asrt.sci.eg/Herbarias/Index?searchBy=Species&Search_Data
Old Dominion University Plant Site: Checklist of Plants of the Hashemite Kingdom of Jordan	https://ww2.odu.edu/~lmusselm/plant/index.php
Plant Diversity of Saudi Arabia	https://www.plantdiversityofsaudi Arabia.info/index.htm
Plants of the Middle East	https://www.plantsofthemiddleeast.com/
Plants of the World Online (POWO)	http://www.plantsoftheworldonline.org
Turkish Plants Data Service (TÜBİVES)	http://194.27.225.161/yasin/tubives/index.php
World Plants	https://www.worldplants.de/world-plants-complete-list/complete-plant-list

2.3 Multivariate analysis

The two-way indicator species analysis (TWINSPAN) was used to classify species and countries of occurrence (Hill, 1979). The detrended correspondence analysis (DECORANA) was used for the ordination of countries and species (Hill and Gauch, 1980). We classified the groups of countries using TWINSPAN according to the common species among each group of countries. And we named each group according to its first dominant species. The Community Analysis Package (IRC house, Hampshire, UK) was used for the TWINSPAN and DECORANA analysis (Seaby and Henderson, 2007).

3 Results

3.1 Verification of the list

The prepared prelist of endemic plants of the Saharo-Arabian region in Egypt included 429 taxa. The present study authorized 126 taxa (29.4% of the total 429 taxa) as surely Saharo-Arabian endemics in Egypt (Table S1). The number of the excluded taxa (surely non-Saharo-Arabian endemics) in this study was 209 taxa (48.7%). Three taxa were recognized as the Saharo-Arabian endemics only by the present study, 104 taxa (82.5% of the total Saharo-Arabian endemics) were recognized as the Saharo-Arabian endemics by this study and one previous study—Boulos (1999–2005), 18 taxa (14.3%) were recognized as the Saharo-Arabian endemics by the present study and two previous studies—Boulos (1999–2005) and Abd El-Ghani et al. (2017), only one taxon (0.79%) was recorded as the Saharo-Arabian endemic plant by the present study and three previous studies—Bornkamm and Kehl (1990), Boulos (1999–2005), and Abd El-Ghani et al. (2017). On the other hand, 28 taxa were excluded by the present study only, 122 taxa were excluded by the present study and one previous study (of which 115 taxa were excluded

Table 4 References used for the assessment of the geographical distribution of the Saharo-Arabian endemic plants in Egypt

Author	Article or book title	Journal or publisher	Publication year
Abdullah and Al-Dosari	Vegetation of the State of Kuwait	IUCN and Environment Public Authority of Kuwait	2022
Ali and Jafri	Flora of Libya. Volumes 1–144	University of Tripoli	1976
Almasri, Hmidan, Shater, et al.	Syria country report on the identification of important plant areas (IPAs) in Syria (Rapid assessment)	National Coordinating Organization Syrian Society for Conservation of Wild Life	2010
Al-Sodany, El-Khalafy, Ahmed, et al.	Plant communities associated with Egyptian endemic flora	Egyptian Journal of Botany	2024
Boulos	Flora of Egypt. Volumes 1–4	Al-Hadara Publishing	1999–2005
Chaudhary	Flora of the Kingdom of Saudi Arabia. Volumes 1–3	Ministry of Agriculture and Water of Saudi Arabia	1999–2001
El-Gadi	Flora of Libya. Volumes 145–147	University of Tripoli	1986
El-Hadidi	List of Threatened Plants in the Flora of Egypt	Kew	1979
El-Hadidi	Flora Aegyptiaca	Palm Press	2003
Floc'h, Boulos, and Véla	Synonymous Catalog with Commentary of the Flora of Tunisia	Ministry of Environment and Sustainable Development, Tunisia	2010
Ghazanfar	Status of the flora and plant conservation in the Sultanate of Oman	Biological Conservation	1998
Kilian, Hein, and Hubaishan	New and noteworthy records for the flora of Yemen, chiefly of Hadhramout and Al-Mahra	Willdenowia	2002
Meddour, Sahar, and Médail	Checklist of the native tree flora of Algeria: diversity, distribution, and conservation	Plant Ecology and Evolution	2021
Norton, Böer, Allan, et al.	An Illustrated Checklist of the Flora of Qatar	UNESCO	2009
Täckholm	Students' Flora of Egypt	Cairo University Press	1974
Taifour	Jordan Plant Red List Volume II	Royal Botanic Garden of Jordan	2017
Taifour and El-Oqlah	Jordan Plant Red List Volume I	Royal Botanic Garden of Jordan	2016
Taleb and Fennane	Vascular Plant Communities of Morocco: Phytosociology, Ecology and Geography, Geobotany studies	Springer International Publishing	2019
Yaseen, Ahmad, Sultana, et al.	Ethnobotany of medicinal plants in the Thar Desert (Sindh) of Pakistan	Journal of Ethnopharmacology	2015
Zohary	Flora Palaestina Part I	The Israel Academy of Science and Humanities	1968
Zohary	Flora Palaestina Part II	The Israel Academy of Science and Humanities	1987

as well as Boulos (1999–2005), while 7 taxa were excluded as well as Abd El-Ghani et al. (2017), 59 taxa were excluded by the present study and two previous studies (of which 15 taxa were excluded as well as Boulos (1999–2005) and Abd El-Ghani et al. (2017), while 44 taxa were excluded as well as Bornkamm and Kehl (1990) and Boulos (1999–2005)). Besides, 94 taxa (21.9%) were primarily found in the Saharo-Arabian region and extend to nearby regions (i.e., extended species).

The present study verified 126 endemic taxa of the Saharo-Arabian region in Egypt (109 species, 17 subspecies), belonging to 87 genera and 37 families. The major taxonomic divisions revealed that the eudicots had the most diversity including 33 families, 82 genera, 103 species, and 14 subspecies, the monocots included 3 families, 4 genera, 6 species, and 2 subspecies, and the gymnosperm included 1 family (Ephedraceae). The most representative family was Asteraceae (17 species; 13.5%), followed by Lamiaceae (13 species; 10.3%), and Caryophyllaceae and Fabaceae (12 species, respectively; 9.5%) (Table 5).

3.2 Geographical distribution

3.2.1 National geographic distribution

According to Täckholm (1974), he divided Egypt (except the Mediterranean coast and Red Sea coast) into nine phytogeographic regions. The South Sinai (south of the Sinai Peninsula) was the most rich region, comprising 83 taxa (65.9%) of the total endemic species (e.g., *Reseda stenostachya* Boiss., *Convolvulus spicatus* Peter ex Hallier f., and *Phagnalon sinaicum* Bornm. & Kneuck.), followed by the Isthmic Desert (the middle of Sinai) (53 taxa; 42.1%) (e.g., *Pterocephalus arabicus* Boiss. *Bellevialia zoharyi* Feinbrun, and *Allium rothii* Zucc.), the Arabian Desert (located in the eastern Nile River) (40 taxa; 31.7%) (e.g., *Centaurea scoparia* Sieb. ex Spreng., *Echinops glaberrimus* DC., and *Launaea spinosa* (Forssk.) Sch. Bip. ex Kuntze), the Oases (8 taxa; 6.3%), the Red Sea and Nile Delta (5 taxa; 4.0%), the Nile Valley (4 taxa; 3.2%), the Libyan Desert (3 taxa; 2.4%), and the Nile Faiyum (1 taxon; 0.8%) (Fig. 1).

3.2.2 Global geographical distribution

The recorded 126 species in this study are endemics to the Saharo-Arabian region and located in Egypt. The SS1 subzone had all the 126 Saharo-Arabian endemic taxa (100.0%), the SS2 subzone had 79 taxa (62.7%), and the SS3 subzone distributed 14 taxa (11.1%) (Table S2). In this study, the Saharo-Arabian region included 21 countries (6 countries in Africa and 15 countries in Asia, excluding Western Sahara due to lack of data). The highest number of the Saharo-Arabian endemic plants in Egypt was recorded in Palestine (79 taxa; 62.7%), followed by Jordan (72 taxa; 57.1%), Saudi Arabia (67 taxa; 53.2%), Iraq (19 taxa; 15.1%), and Iran (14 taxa; 11.1%); while the lowest number of taxa was recorded in Mauritania and India (2 taxa and 1.6% for each other) (Fig. 2).

3.3 Endemic species in Egypt

Remarkably, 25 taxa (19.8%) of the recorded species in this study were exclusive to Egypt (Table 6), and 18 taxa (14.3%) were near endemic (in Egypt and another country). To be specific, 7 taxa were recorded in Egypt and Palestine (*Haloxylon negevensis* (Iljin & Zohary) L. Boulos, *Allium decaisnei* C. Presl, *Atractylis boulosii* Täckh., *Eremogone sinaica* (Boiss.) Dillenb. & Kadereit, *Astragalus amalecitanus* Boiss., *Origanum isthmicum* Danin, and *Reaumuria negevensis* Zohary & Danin), 6 species in Egypt and Saudi Arabia (*Pistacia khinjuk* Stocks, *Ducrosia ismaelis* Asch., *Picris sulphurea* Delile, *Crucihimalaya kneuckeri* (Bornm.) Al-Shehbaz, O'Kane & R. A. Price, *Colchicum guessfeldtianum* Asch. & Schweinf., and *Centaureum malzacianum* Maire), 4 species in Egypt and Jordan (*Pterocephalus arabicus* Boiss., *Convolvulus schimperi* Engl., *Phlomis aurea* Decne., and *Veronica kaiseri* Täckh.), and 1 species in Egypt and Iran (*Silene odontopetala* var. *congesta* Boiss.). Whereas *Scrophularia deserti* Delile and *Astragalus schimperi* Boiss. were abundantly distributed in the countries of the Saharo-Arabian region.

3.4 Clustering analysis

Seven groups were recognized at the fourth level of classification as a result of the application of

TWINSpan to the Saharo-Arabian endemic plants in Egypt (Fig. 3; Table 7). Figure 4 shows the results of DECORANA analysis. We determined the names of the groups according to the first dominant species that had the highest presence percentage in each group, as follows:

Table 5 Taxonomic diversity of the Saharo-Arabian endemic plants in Egypt

	Family	Number of genus	Number of species	Number of subspecies
Gymnospermae	Ephedraceae	1	0	1
Monocotyledon	Amaryllidaceae	1	3	0
	Asparagaceae	2	2	2
Dicotyledon	Poaceae	1	1	0
	Amaranthaceae	2	1	2
	Anacardiaceae	1	0	1
	Apiaceae	4	4	0
	Apocynaceae	2	2	0
	Asphodelaceae	1	1	0
	Asteraceae	14	17	0
	Boraginaceae	2	2	0
	Brassicaceae	5	4	1
	Campanulaceae	1	1	0
	Caprifoliaceae	1	2	0
	Caryophyllaceae	6	12	4
	Cistaceae	1	3	0
	Colchicaceae	1	1	0
	Convolvulaceae	1	2	0
	Euphorbiaceae	1	1	0
	Fabaceae	6	12	1
	Gentianaceae	1	1	0
	Hypericaceae	1	1	0
	Lamiaceae	10	13	1
	Molluginaceae	1	1	0
	Plantaginaceae	3	2	1
	Polygalaceae	1	0	2
	Polygonaceae	2	1	1
	Primulaceae	1	1	0
	Resedaceae	1	2	0
	Rhamnaceae	1	1	0
	Rosaceae	2	2	0
	Rubiaceae	2	2	0
	Rutaceae	1	1	0
	Scrophulariaceae	2	4	0
	Solanaceae	1	1	0
Tamariaceae	1	1	0	
Zygophyllaceae	2	4	0	
Total		87	109	17

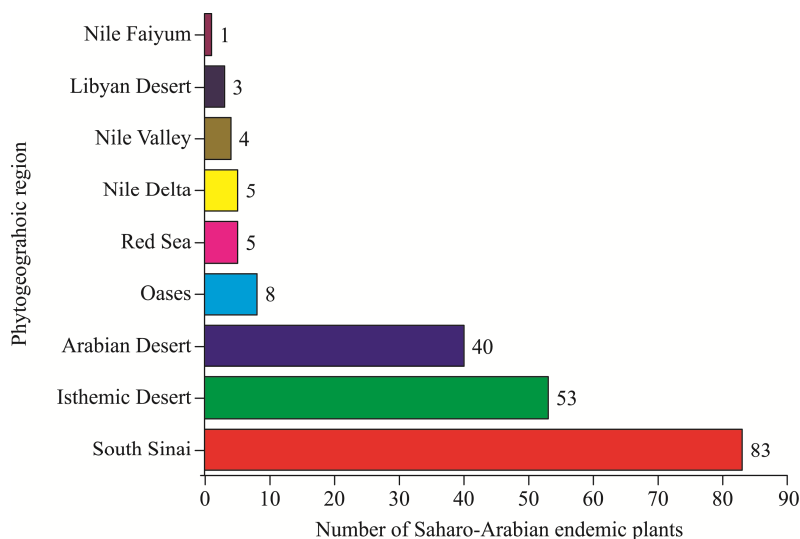


Fig. 1 Quantitative distribution of the Saharo-Arabian endemic plants in Egypt

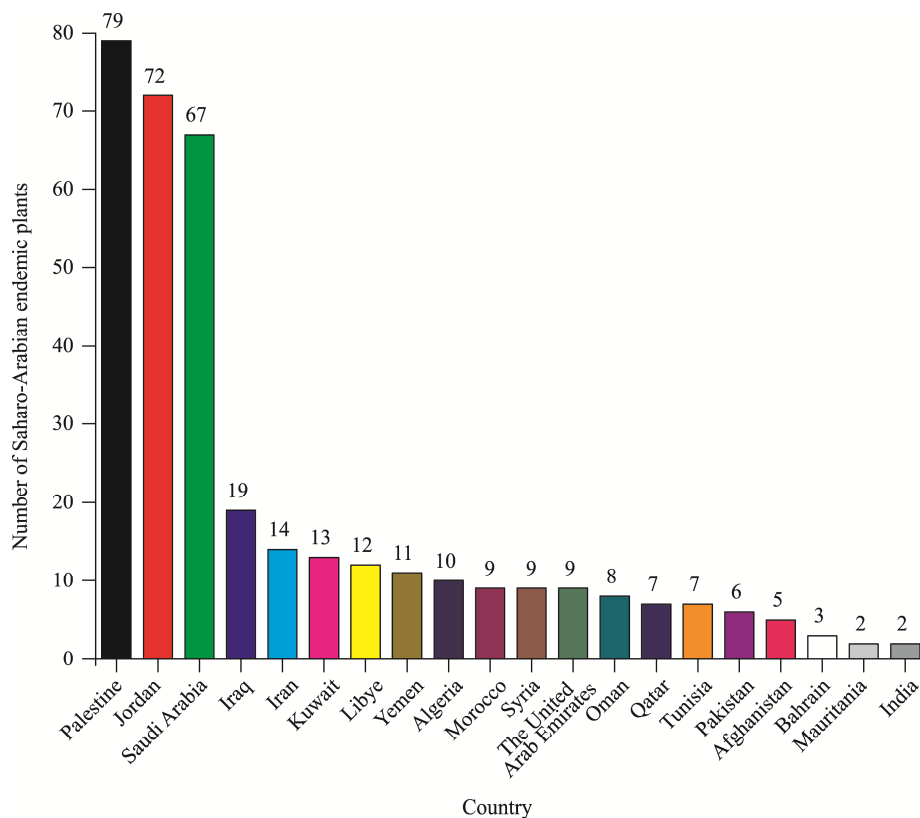


Fig. 2 Quantitative distribution of the Saharo-Arabian endemic plants in each Saharo-Arabian country. Note that the Western Sahara is not included in the research scope of this paper due to lack of data.

I *Asphodelus refractus* group. This group involved Tunisia, Algeria, Morocco, and Mauritania. The most common species among these countries were *Asphodelus refractus* Boiss., *Agathophora alopecuroides* (Delile) Fenzl ex Bunge, *Anvillea garcinii* (Burm.f.) DC., *Pseuderucaria teretifolia* (Desf.) O.E.Schulz, and *Zygophyllum scabrum* (Forssk.) Christenh. & Byng.

II *Agathophora alopecuroides* var. *papillosa* group. This group included only Libya. The

dominant species in Libya include *Agathophora alopecuroides* var. *papillosa* (Maire) Boulos, *Daucus sahariensis* Murb., and *Anvillea garcinii* (Burm. f.) DC.

III *Anvillea garcinii* group. This group included only Yemen. The dominant species in Yemen included *Anvillea garcinii* (Burm. f.) DC., *Gomphocarpus sinaicus* Boiss., and *Launaea spinosa* (Forssk.) Sch. Bip. ex Kuntze.

IV *Reseda muricata* group. This group involved Egypt, Saudi Arabia, Palestine, and Jordan. The most common species among these countries were *Reseda muricata* C. Presl, *Allium sinaiticum* Boiss., *Agathophora alopecuroides* (Delile) Fenzl ex Bunge, *Gomphocarpus sinaicus* Boiss., and *Anthemis scrobicularis* Yavin.

V *Agathophora alopecuroides* var. *alopecuroides* group. This group included Iran, Iraq, Qatar, and Kuwait. The most common species among these countries were *Agathophora alopecuroides* var. *alopecuroides*, *Silene arabica* F. N. Williams, *Astragalus schimperi* Boiss., and *Reseda muricata* C. Presl.

VI *Scrophularia deserti* group. This group involved Pakistan, India, and Syria. The most common species among these countries were *Scrophularia deserti* Delile, *Astragalus schimperi* Boiss., *Euphorbia obovata* Decne., and *Agathophora alopecuroides* (Delile) Fenzl ex Bunge.

VII *Astragalus schimperi* group. This group involved Afghanistan, Oman, the United Arab Emirates, and Bahrain. The most common species among these countries were *Astragalus schimperi* Boiss., *Reseda muricata* C. Presl, *Scrophularia deserti* Delile, *Cotoneaster orbicularis* Schldl., and *Silene arabica* F. N. Williams.

Table 6 List of the exclusive Saharo-Arabian endemic plants in Egypt

No.	Endemic species	Family
1	<i>Anarrhinum forskahlii</i> subsp. <i>pubescens</i> D. A. Sutton	Plantaginaceae
2	<i>Astragalus fresenii</i> Decne	Fabaceae
3	<i>Ballota kaiseri</i> Tackh.	Lamiaceae
4	<i>Bellevalia flexuosa</i> var. <i>galalensis</i> Tackh. & Drar	Asparagaceae
5	<i>Bufoia multiceps</i> Decne	Caryophyllaceae
6	<i>Dianthus guessfeldtianus</i> Muschl.	Caryophyllaceae
7	<i>Glinus runkewitzii</i> Tackh. & Boulos	Molluginaceae
8	<i>Helianthemum schweinfurthii</i> Grosser	Cistaceae
9	<i>Hyoscyamus boveanus</i> (Dunal) Asch. & Schweinf	Solanaceae
10	<i>Melilotus serratifolius</i> Tackh. & Boulos	Fabaceae
11	<i>Micromeria serbaliana</i> Danin & Hedge	Lamiaceae
12	<i>Origanum syriacum</i> subsp. <i>sinaicum</i> (Boiss.) Greuter & Burde	Lamiaceae
13	<i>Persicaria obtusifolia</i> (Täckh. & Boulos) Greuter & Burdet	Polygonaceae
14	<i>Polygala sinaica</i> Botsch. var. <i>sinaica</i>	Polygalaceae
15	<i>Primula boveana</i> Decne. ex Duby	Primulaceae
16	<i>Rhazya greissii</i> Tackh. & Boulos	Apocynaceae
17	<i>Rosa arabica</i> (Crép. ex Boiss.) Déségl.	Rosaceae
18	<i>Scorzonera drarii</i> Tackh.	Asteraceae
19	<i>Senecio belbeysius</i> Delile	Asteraceae
20	<i>Silene leucophylla</i> Boiss.	Caryophyllaceae
21	<i>Silene oreosinaica</i> Chowdhuri	Caryophyllaceae
22	<i>Silene schimperiana</i> Boiss.	Caryophyllaceae
23	<i>Silene villosa</i> var. <i>graveolens</i> Sickenb.	Caryophyllaceae
24	<i>Tephrosia kassasii</i> Boulos	Fabaceae
25	<i>Trigonella media</i> Delile ex Urb.	Fabaceae

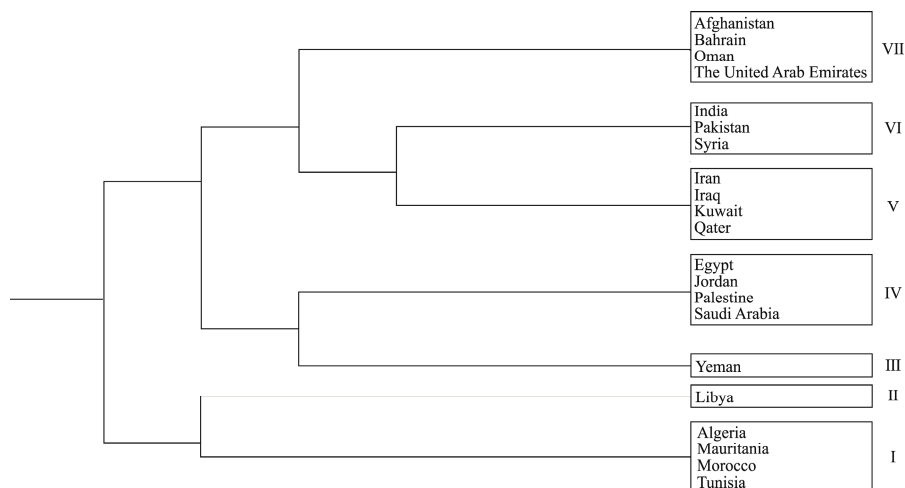


Fig. 3 Dendrogram showing the most representative seven groups produced after using TWINSPLAN classification technique at the fourth level. I, *Asphodelus refractus* group; II, *Agathophora alopecuroides* var. *papillosa* group; III, *Anvillea garcinii* group; IV, *Reseda muricata* group; V, *Agathophora alopecuroides* var. *alopecuroides*; VI, *Scrophularia deserti* group; VII, *Astragalus schimperi* group.

4 Discussion

The results of the current study support the idea that the Saharo-Arabian region is characterized by hot deserts, semi-deserts, and savanna. The Saharo-Arabian countries include Morocco, Mauritania, Western Sahara (not included in this study), Algeria, Tunisia, Libya, Egypt, Palestine, Kuwait, Saudi Arabia, Qatar, Bahrain, the United Arab Emirates, Oman, Yemen, southern Jordan, Syria, Iraq, Iran, Afghanistan, Pakistan, as well as northern India.

A large portion of the flora of the Saharo-Arabian region is shared with the nearby Mediterranean, Irano-Turanian, and Sudano-Zambeian regions of the Palearctic Kingdom and the Holarctic Kingdom (White and Léonard, 1991). The boundary of the Saharo-Arabian region in the Nile Delta starts after an average distance of 15–25 km in north-south direction from the coast (Zahran and Willis, 2009). This distance includes a transition zone between the Mediterranean and the Saharo-Arabian floristic region that is called Mediterranean-Sahara regional transition zone (El Hadidi, 2003). This transition zone extends for an average width ranging 5–10 km in south direction from the coast. The boundary of the Saharo-Arabian region in the Western Desert starts after an average distance of 45–50 km in north-south direction from the coast in which the Mediterranean-Sahara regional transition zone extends for an average width ranging 5–10 km in south direction from the coast (El Hadidi, 2003). The Sinai Peninsula totally lies within the Saharo-Arabian floristic region except the Mediterranean coastal strip of North Sinai (about 13.0% of Sinai Peninsula) (Zahran et al., 1985; White and Léonard, 1991; Heneidak, 2008). Danin and Plitmann (1987) stated that the highlands of the South Sinai are located in the Irano-Turanian chorotype, while the lowlands of South Sinai are located in the Sudano-Zambeian chorotype. Also, Gebel Elba Mountains that are excluded from the Saharo-Arabian floristic region, are located in the Sudano-Zambeian chorotype (Eig, 1931; White and Léonard, 1991).

Regarding the national distribution of the Saharo-Arabian endemic plants in Egypt, Sinai (especially South Sinai) is the richest region, comprising 83 taxa (65.9%) of the total endemic species. Numerous microhabitats can be found in Sinai Peninsula due to the variety of geology and landforms. Each of them has distinct climatic conditions and a flora that is rich in endemic and medicinal plants (Khedr, 2021). The massive mountains in Sinai Peninsula, which limit the dispersion of seeds over long distances, are likely responsible for the region's abundance of endemic species. In particular, the Saint Katherine Protectorate (SKP) in South Sinai is the most

Table 7 Vegetation groups of the 126 Saharo-Arabian endemic plants in Egypt

Vegetation group	Number of species	Distribution country	Percentage of African country (%)	Percentage of Asian country (%)	Dominant species
I <i>Asphodelus refractus</i> group	10	Algeria, Morocco, Mauritania, and Tunisia	100.0	0.0	<i>Asphodelus refractus</i> Boiss., <i>Agathophora alopecuroides</i> (Delile) Fenzl ex Bunge, <i>Anvillea garcinii</i> (Burm. f.) DC., <i>Pseuderucaria teretifolia</i> (Desf.) O. E. Schulz, and <i>Zygophyllum scabrum</i> (Forssk.) Christenh. & Byng.
II <i>Agathophora alopecuroides</i> var. <i>papillosa</i> group	12	Libya	100.0	0.0	<i>Agathophora alopecuroides</i> var. <i>papillosa</i> (Maire) Boulos, <i>Daucus sahariensis</i> Murb., and <i>Anvillea garcinii</i> (Burm. f.) DC.
III <i>Anvillea garcinii</i> group	11	Yemen	0.0	100.0	<i>Anvillea garcinii</i> (Burm. f.) DC., <i>Gomphocarpus sinaicus</i> Boiss., and <i>Launaea spinosa</i> (Forssk.) Sch. Bip. ex Kuntze.
IV <i>Reseda muricata</i> group	126	Egypt, Jordan, Palestine, and Saudi Arabia	25.0	75.0	<i>Reseda muricata</i> C.Presl, <i>Allium sinaiticum</i> Boiss., <i>Agathophora alopecuroides</i> (Delile) Fenzl ex Bunge, <i>Gomphocarpus sinaicus</i> Boiss., and <i>Anthemis scrobicularis</i> Yavin.
V <i>Agathophora alopecuroides</i> var. <i>alopecuroides</i> group	23	Iran, Iraq, Kuwait, and Qatar	0.0	100.0	<i>Agathophora alopecuroides</i> var. <i>alopecuroides</i> , <i>Silene arabica</i> F.N.Williams, <i>Astragalus schimperi</i> Boiss., and <i>Reseda muricata</i> C. Presl
VI <i>Scrophularia deserti</i> group	11	India, Pakistan, and Syria	0.0	100.0	<i>Scrophularia deserti</i> Delile, <i>Astragalus schimperi</i> Boiss., <i>Euphorbia obovata</i> Decne., and <i>Agathophora alopecuroides</i> (Delile) Fenzl ex Bunge
VII <i>Astragalus schimperi</i> group	13	Afghanistan, Bahrain, Oman, and the United Arab Emirates	0.0	100.0	<i>Astragalus schimperi</i> Boiss., <i>Reseda muricata</i> C. Presl, <i>Scrophularia deserti</i> Delile, <i>Cotoneaster orbicularis</i> Schlttdl., and <i>Silene arabica</i> F. N. Williams

important region for endemism in Egypt (Zohary, 1973). Moreover, in Sinai Peninsula, the wadis serve as drainage channels for gathering rainwater from the surroundings and facilitating the growth of plants. Consequently, these wadis are floristically diverse and provide habitat for many wild species (Khedr, 2021). The highest number of the Saharo-Arabian endemic plants in Egypt also distributes in other Saharo-Arabian countries, especially Palestine, Jordan, Saudi Arabia, Iraq, Iran, and Kuwait, and most of them are distributed in Sinai Peninsula. This can be explained by the separation of the Arabian Peninsula and Sinai subplate away from the larger African landmass as a product of a geological "rifting" process. The physical separation caused many species to become physically separated, and several little springs appeared in the limestone and sandstone hills of western Sinai and southwestern Jordan, respectively (Hegazy and Doust, 2016). Moreover, the microhabitats of the deserts of Sinai Peninsula, Palestine, and Jordan support the rarest plant species (Lavergne, 2003).

Multivariate analysis indicated seven vegetation groups, two of them (groups I and II) distributed in the African countries, while the other five (groups III–VII) mainly distributed the Asian countries. This indicates that the topography governs the vegetation distribution. Friis et al. (2005) showed how topography affected plant diversity and distribution in the Horn of Africa, which in turn increased the number of species and endemism by facilitating evolutionary processes and avoiding extinction. According to Irl et al. (2015) and Méndez-Toribio et al. (2016),

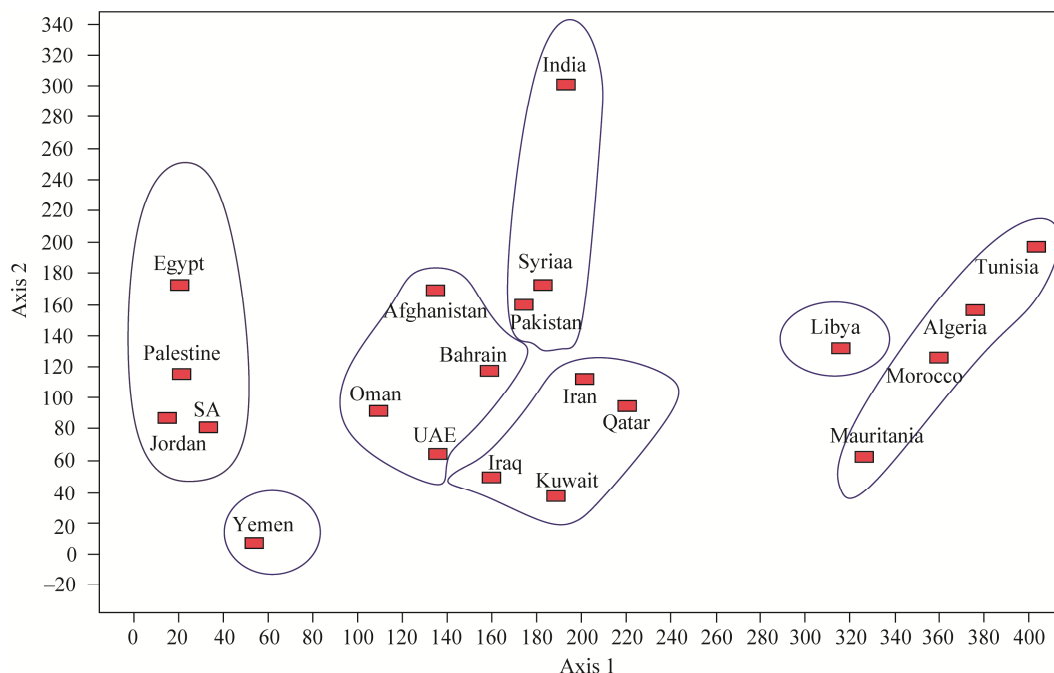


Fig. 4 Detrended correspondence analysis (DECORANA) ordination plot. SA, Saudi Arabia; UAE, the United Arab Emirates.

complex topography affects the richness, speciation process, diversity, and geographical distribution pattern of plant species, however, its influence is the greatest when determining plant endemic richness patterns. Also, due to enhanced habitat diversity and niche space availability, the varied topography may favor the creation of microrefugia (Badgley et al., 2017; Graae et al., 2018), which may have improved the chances of species survival during periods of shifts in the environment (Dobrowski, 2011; Keppel et al., 2012). In addition, topography promotes isolation, which acts as a dispersal restriction between populations (Janzen, 1967), limiting the flow of genes through isolation, promoting divergence, and creating the conditions necessary for allopatry (Coyne and Orr, 2004). In addition, numerous factors, such as climate, geographic barriers, human influences, biotic interactions, and stochastic occurrences, also have an impact on the distribution of endemic organisms (Morrone, 2018). Extreme weather events, such as drought and flooding, extremely high and low temperatures, wind events, and even changes in salinity or pH, are on the rise as a result of climate change. Therefore, it is likely that most organisms are going to face environmental conditions that are outside of their normal historical tolerance range (Cheng et al., 2017).

Some taxa found in the Saharo-Arabian floristic region extend to neighboring areas in other floristic regions because of some factors such as wind, human activities, and climate change. These taxa were excluded from endemism in the present study because of their extension to adjacent regions. For example, *Allium crameri* Asch. & Boiss. and *Allium papillare* Boiss that extend to the Mediterranean coast of Rafah (El-Garf, 2000) and Bardawil Lake (El-Bana, 2009; Nada et al., 2013); and *Anthemis melampodina* subsp. *deserti* (Boiss.) Eig, *Anthemis zoharyana* Eig, *Asphodelus viscidulus* Boiss., *Astragalus camelorum* Barbey, *Astragalus palaestinus* Eig, *Bassia arabica* (Boiss.) Maire & Weiller, *Bellevalia eigii* Feinbrun, *Carduus getulus* Pomel, *Caroxylon tetrandrum* (Forssk.) Akhani & Roalson, *Carthamus eriocephalus* (Boiss.) Greuter, *Colchicum ritchei* R. Br., *Ferula sinaica* Boiss., and *Glaucium arabicum* extend to the Mediterranean region including different adjacent countries (Täckholm, 1974; Squires and Ayoub, 1994; Boulos, 1999–2005; Turk and El Shayeb, 2005; Turki et al., 2006; Galal and Fawzy, 2007;

El-Zanaty et al., 2010; Danin and Fragman-Sapir, 2016; Fakhry and Al-Anazi, 2017; Osman and Abdein, 2019; Mahklouf, 2020). In addition, some species extend to the Irano-Turanian region such as *Caroxylon villosum* (Schult.) Akhani & Roalson (Mosallam, 2007), *Onopordum ambiguum* Fresen. (Rabei and Elgamal, 2021), *Verbascum eremobium* Murb. and *Blepharis attenuata* Napper (Danin and Fragman-Sapir, 2016), *Astragalus bombycinus* Boiss. (Asri, 2004; Osman et al., 2014), and *Stipagrostis multinerva* H. Scholz (GBIF, 2023). Moreover, some species extend to the Sudano-Zambezian region like *Ziziphus nummularia* (Burm. f.) Wight & Arn. (Danin and Fragman-Sapir, 2016), *Cometes surattensis* Burm. f. (Al-Sherif et al., 2013), and *Deverra triradiata* Hochst. ex Boiss. (Abd El-Ghani et al., 2011).

The distribution of species, genetic diversity, and effective population size can all be impacted by human activity (Zhao et al., 2018, 2019). In many parts of the world, human activities have overtaken climate change in recent centuries as the primary factor influencing species distributions (Li et al., 2015). Anthropogenic disturbances such as livestock grazing and logging have an impact in changing the richness, diversity, distribution pattern, and vegetation structure in an ecosystem. The magnitude of their influence depends on the severity of disturbance (Hogan et al., 2016). Changes in climatic conditions are impacting the distribution and occurrence of natural resources in deserts. Both the timing and the routes of species migrations are predicted to change as a result of altered food distribution and the spatiotemporal unpredictability of water availability, which could adversely affect the dynamics of migratory ungulate populations (Duncan et al., 2012). It is widely acknowledged that human activities play a significant role in dryland climate change. Salinization, desertification, loss of vegetative cover, biodiversity loss, and other forms of environmental degradation are all caused in part by human activities. With rapid economic development, the modern lifestyle has become increasingly reliant on the use of fossil fuels (Barnett and O'Neill, 2010). In addition, the spatial patterns of energy consumption have strongly influenced temperature trends in recent years (Li and Zhao, 2012), especially in developing countries.

5 Conclusions

The current study is considered the pioneer in providing recent and verified checklist of the Saharo-Arabian endemic species in Egypt. A preliminary list of 429 Saharo-Arabian endemics in Egypt was compiled from three available literature. By comparing with three previous studies, this study excluded the species that were recorded in any countries or region outside the Saharo-Arabian region based on different literature, database reviews, and websites in Egypt and other countries, and finally reduced this number to 126 endemics belonging to 87 genera and 37 families. The eudicots had the highest plant diversity including 33 families, 82 genera, and 103 species, the monocots included 3 families, 4 genera, and 6 species, and there was also 1 species of gymnosperm. The most representative family was Asteraceae (17 species). Among the nine phytogeographic regions in Egypt, the South Sinai was the richest region with the Saharo-Arabian endemic species. Moreover, the SS1 subzone had all the 126 endemics, the SS2 subzone owned 79 taxa, and the SS3 subzone distributed 14 endemic plants. Seven groups were recognized at the fourth level of classification as a result of the application of TWINSPAN to the Saharo-Arabian endemics in Egypt, including *Asphodelus refractus* group that involved Tunisia, Algeria, Morocco, and Mauritania; *Agathophora alopecuroides* var. *papillosa* group that included only Libya; *Anvillea garcinii* group that included only Yemen; *Reseda muricata* group that involved Egypt, Saudi Arabia, Palestine, and Jordan; *Agathophora alopecuroides* var. *alopecuroides* group that included Iran, Iraq, Qatar, and Kuwait; *Scrophularia deserti* group that involved Pakistan, India, and Syria; and *Astragalus schimperi* group that involved Afghanistan, Oman, the United Arab Emirates, and Bahrain. The majority of the endemic plants identified in this study are very rare, emphasizing the need for comprehensive planning and conservation efforts, both *in situ* and *ex situ*.

Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Author contributions

Conceptualization and design: Asmaa S ABO HATAB, Kamal H SHALTOUT, Yassin M AL-SODANY, Mohamed M EL-KHALAFY; Material preparation, data collection, and analysis: Asmaa S ABO HATAB, Mohamed M EL-KHALAFY; Writing - original draft preparation: Asmaa S ABO HATAB, Kamal H SHALTOUT, Yassin M AL-SODANY, Mohamed M EL-KHALAFY; Writing - review and editing: Asmaa S ABO HATAB, Kamal H SHALTOUT, Yassin M AL-SODANY, Soliman A HAROUN, Mohamed M EL-KHALAFY; Supervision: Kamal H SHALTOUT, Yassin M AL-SODANY, Soliman A HAROUN. All authors approved the manuscript.

Appendix

Table S1 Updated list of the Saharo-Arabian endemic plants in Egypt

Table S2 Distribution of the Saharo-Arabian endemic plants in the Saharo-Arabian countries

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Table S1 Updated list of the Saharo-Arabian endemic plants in Egypt

No.	Species	Family	Exclusion region	Reference and website	The present study	Bornkamm and Kehl (1990)	Boulos (1999–2005)	Abd El-Ghani et al. (2017)
1	<i>Abutilon pannosum</i> (G.Forst.) Schtdl.	Malvaceae	Angola, Burkina, Cameroon, Cape Verde, and Chad (SZ)	Boulos (1999–2005); GBIF; and POWO	×		×	✓
			Gebel Elba (SZ)	Abutaha et al. (2020)				
2	<i>Aeluropus littoralis</i> (Gouan) Parl.	Poaceae	Baleares, Bulgaria, and France, and Spain (ME)	GBIF and POWO	×		×	✓
			Mediterranean coast in Egypt (ME)	Boulos (1999–2005)				
3	<i>Aerva javanica</i> (Burm.f.) Juss. ex Schult.	Amaranthaceae	Botswana, Burkina, Cameroon, Cape Verde, and Chad (SZ)	GBIF and POWO	×	×	×	✓
			Gebel Elba (SZ)	Boulos (1999–2005)				
4	<i>Agathophora alopecuroides</i> var. <i>alopecuroides</i> (Delile) Fenzl ex Bun	Amaranthaceae			✓		✓	✓
5	<i>Agathophora alopecuroides</i> var. <i>papillosa</i> (Maire) Boulos	Amaranthaceae			✓		✓	✓
6	<i>Allium crameri</i> Asch. & Boiss.	Amaryllidaceae	Bardawil Lake and Mediterranean coast of Rafah (ME)	CAIM (1998); Nada et al. (2013); and El-Khalafy et al. (2021a, b)	●		✓	
7	<i>Allium decaisnei</i> C. Presl	Amaryllidaceae			✓		✓	
8	<i>Allium papillare</i> Boiss.	Amaryllidaceae	Bardawil Lake and Rafah (ME)	CAIM (1928); Boulos (1999–2005); El-Garf (2000); and El-Bana (2009)	●		×	
9	<i>Allium rothii</i> Zucc.	Amaryllidaceae			✓		✓	
10	<i>Allium sinaiticum</i> Boiss.	Amaryllidaceae			✓		✓	
11	<i>Anabasis articulata</i> (Forssk.) Moq.	Amaranthaceae	Spain (ME)	GBIF	×	✓	×	×
			Mediterranean coast in Egypt, Rafah and Sallum (ME)	Boulos (1999–2005); Khafagi et al. (2005); Amer et al. (2020); and Gamal et al. (2022)				
12	<i>Anarrhinum forskaohlii</i> subsp. <i>pubescens</i> D. A. Sutton	Plantaginaceae			✓		✓	
13	<i>Anastatica hierochuntica</i> L.	Brassicaceae	Canary Islands (ME)	POWO	×	✓	×	✓
			Sudan and Eritrea (SZ)	POWO				
			Gebel Elba (SZ)	Boulos (1999–2005)				

To be continued

No.	Species	Family	Exclusion region	Reference and website	The present study	Bornkamm and Kehl (1990)	Boulos (1999–2005)	Abd El-Ghani et al. (2017)
14	<i>Anthemis melampodina</i> subsp. <i>deserti</i> (Boiss.) Eig	Asteraceae	Mediterranean coast in Egypt (ME)	Täckholm (1974); Boulos (1999–2005); Fakhry and Al-Anazi (2017); and Osman and Abdein (2019)	●		×	✓
15	<i>Anthemis melampodina</i> subsp. <i>melampodina</i>	Asteraceae	Mediterranean coast in Egypt (ME)	Täckholm (1974); Boulos (1999–2005); Fakhry and Al-Anazi (2017); and Osman and Abdein (2019)	●		×	✓
16	<i>Anthemis scrobicularis</i> Yavin	Asteraceae			✓		✓	
17	<i>Anthemis zoharyana</i> Eig	Asteraceae	Mediterranean coast in Egypt (ME)	Täckholm (1974)	●		✓	
18	<i>Anvillea garcinii</i> (Burm. f.) DC.	Asteraceae			✓		✓	
19	<i>Argyrolobium saharae</i> Pomel	Fabaceae			✓		✓	
20	<i>Aristida funiculata</i> Trin. & Rupr.	Poaceae	Burkina, Cape Verde, Chad, Eritrea, Ethiopia, Niger, Kenya, Senegal, and Somalia (SZ) Mediterranean coast in Lybia (ME) Gebel Elba (SZ)	Boulos (1999–2005); GBIF; and POWO Al-Sghair et al. (2019) Boulos (1999–2005)	×	✓	×	
21	<i>Arnebia hispidissima</i> (Sieber ex Lehm.) A.DC.	Boraginaceae	Cameroon, Chad, Eritrea, Ethiopia, Somalia, Niger, and Sudan (SZ) Gebel Elba (SZ)	Boulos (1999–2005); GBIF; and POWO Boulos (1999–2005)	×		×	✓
22	<i>Arnebia tinctoria</i> Forssk.	Boraginaceae			✓		✓	
23	<i>Artemisia judaica</i> L.	Asteraceae	Chad (SZ) Gebel Elba (SZ)	GBIF and POWO Boulos (1999–2005)	●		×	✓
24	<i>Artemisia monosperma</i> Delile	Asteraceae	Al-Arish (North Sinai), Burg El-Arab, Burullus Wetland, and Mediterranean coast in Egypt (ME)	Boulos (1999–2005); Al-Sodany (2009); and Badr et al. (2012)	●		×	✓
25	<i>Asphodelus refractus</i> Boiss.	Asphodelaceae			✓		✓	
26	<i>Asphodelus viscidulus</i> Boiss.	Asphodelaceae	El Burullus and Mediterranean coast in Egypt (ME)	Boulos (1999–2005) and Galal and Fawzy (2007)	●		×	

Continued

No.	Species	Family	Exclusion region	Reference and website	The present study	Bornkamm and Kehl (1990)	Boulos (1999–2005)	Abd El-Ghani et al. (2017)
27	<i>Asteriscus graveolens</i> (Forssk.) Less.	Asteraceae	Canary Islands (ME)	GBIF and POWO	×		×	✓
			Chad and Mali (SZ)	GBIF and POWO				
			Mediterranean coast in Egypt (ME)	Boulos (1999–2005)				
28	<i>Astragalus amalecitanus</i> Boiss.	Fabaceae			✓		✓	
29	<i>Astragalus annularis</i> Forssk.	Fabaceae	Lebanon (ME)	GBIF	●	✓	×	×
			Mediterranean coast in Egypt, Rosetta, and Sallum (ME)	Boulos (1999–2005); El-Hawiet et al. (2010); and Amer et al. (2020)				
30	<i>Astragalus arpilobus hauarensis</i> (Boiss.) Podlech subsp.	Fabaceae	North of Iran (IT)	GBIF	●	✓	×	
			Mediterranean coast in Egypt (ME)	Täckholm (1974) and Boulos (1999–2005)				
31	<i>Astragalus bombycinus</i> Boiss.	Fabaceae	North of Iran (IT)	Asri (2004) and Osman et al. (2014)	●		✓	×
32	<i>Astragalus camelorum</i> Barbey	Fabaceae	El-Arish and Mediterranean coast in Egypt (ME)	Täckholm (1974) and CAI (1986)	●		✓	
33	<i>Astragalus caprinus</i> L.	Fabaceae	Cyprus, and Sicilia (ME)	GBIF and POWO	×		×	✓
			Iran and Turkey (IT)	Flora of Libya				
			Mediterranean coast in Egypt (ME)	Boulos (1999–2005)				
34	<i>Astragalus dactylocarpus acinaciferus</i> (Boiss.) E. Ott subsp.	Fabaceae			✓		✓	
35	<i>Astragalus eremophilus</i> Boiss.	Fabaceae	Chad, Eritrea, and Sudan (SZ)	Khderi et al. (2019) and POWO	×	×	×	✓
			Gebel Elba (SZ)	Boulos (1999–2005)				
36	<i>Astragalus fresenii</i> Decne	Fabaceae			✓		✓	
37	<i>Astragalus hispidulus</i> DC.	Fabaceae	Coastal area in Libya (ME)	Baayo (2008)	×	✓	×	✓
			Mediterranean coast in Egypt and Burg el Arab (ME)	Boulos (1999–2005) and GBIF				
38	<i>Astragalus intercedens</i> Sam. ex Rech.f.	Fabaceae			✓		✓	
39	<i>Astragalus kahiricus</i> DC.	Fabaceae	North of Iran, Tadjhikistan, Turkmenistan, and Uzbekistan (IT)	Rahimi and Atri (2013); Flora of Libya; GBIF; and POWO	×		✓	

To be continued

No.	Species	Family	Exclusion region	Reference and website	The present study	Bornkamm and Kehl (1990)	Boulos (1999–2005)	Abd El-Ghani et al. (2017)
40	<i>Astragalus palaestinus</i> Eig	Fabaceae	Mediterranen coast in Egypt (ME)	Danin and Fragman-Sapir (2016)	●		✓	
41	<i>Astragalus peregrinus</i> subsp. <i>peregrinus</i> Vahl.	Fabaceae	Greece and Kriti (ME) El-Arish and Mediterranean coast in Egypt (ME)	Flora of Greece (2023) and POWO Boulos (1999–2005) and Badr and Sharawy (2007)	●	✓	×	✓
42	<i>Astragalus sanctus</i> Boiss.	Fabaceae			✓		✓	
43	<i>Astragalus schimperi</i> Boiss.	Fabaceae			✓		✓	✓
44	<i>Astragalus sieberi</i> DC.	Fabaceae	Alexandria El-Alamein desert road, Burullus Wetland, and Matrouh road (ME)	Al-Sodany (2009) and Abd El-Ghani et al. (2021)	●		✓	✓
45	<i>Astragalus sparsus</i> Decne	Fabaceae			✓		✓	
46	<i>Astragalus trigonus</i> DC	Fabaceae	Chad, Mali, Niger, and Sudan (SZ) Mediterranen coast in Egypt (ME)	GBIF and POWO Boulos (1999–2005)	×	×	×	✓
47	<i>Astragalus vogelii</i> (Webb) Bornm.	Fabaceae	Cape Verde, Eritrea, Ethiopia, Mali, Niger, and Sudan (SZ)	Boulos (1999–2005); GBIF; and POWO	×	×	×	✓
48	<i>Atractylis boulosii</i> Tackh.	Asteraceae			✓		✓	
49	<i>Atractylis carduus</i> (Forssk.) C. Chr.	Asteraceae	Mediterranen coast in Egypt and Turkey (ME) Mediterranen coast in Egypt (ME)	Flora of Libya and POWO Täckholm (1974) and Boulos (1999–2005)	×		×	✓
50	<i>Atractylis mernephtae</i> Asch. & Schweinf. & Letourn.	Asteraceae			✓		✓	✓
51	<i>Atractylis prolifera</i> Boiss.	Asteraceae	Coastal area of Libya and Spain (ME) Mediterranen coast in Egypt, and the northwestern coastal desert of Egypt (ME)	Flora of Libya and GBIF Boulos (1999–2005) and Bidak et al. (2015)	●		×	
52	<i>Atractylis serratuloides</i> Sieber ex Cass.	Asteraceae	Coastal area of Libya (ME) North of Sinai (ME)	Flora of Libya Täckholm (1974)	●		✓	
53	<i>Atraphaxis spinosa</i> var. <i>sinaica</i> (Jaub. & Spach) Boiss.	Polygonaceae			✓		✓	

No.	Species	Family	Exclusion region	Reference and website	The present study	Bornkamm and Kehl (1990)	Boulos (1999–2005)	Abd El-Ghani et al. (2017)
54	<i>Atriplex coriacea</i> Forssk.	Amaranthaceae	Somalia (SZ) Alexandria, Matrouh, and Mediterranean coast in Egypt (ME)	GBIF CAI (1959); Boulos (1999–2005)	●		×	
55	<i>Atriplex dimorphostegia</i> Kar. et Kir.	Amaranthaceae	Kazakhstan, Kirgizstan, Tadzhikistan, Turkmenistan, Uzbekistan, and Xinjiang Uygur Autonomous Region, China (IT)	GBIF and POWO	×	✓	✓	×
56	<i>Atriplex farinosa</i> Forssk.	Amaranthaceae	Eritrea, Kenya, Somalia, and Sudan (SZ)	GBIF and POWO	×		✓	✓
57	<i>Atriplex glauca</i> L.	Amaranthaceae	Canary Islands, Madeira, Portugal, and Spain (ME)	Boulos (1999–2005); GBIF; and POWO	×	✓	×	
58	<i>Atriplex portulacoides</i> L.	Amaranthaceae	Albania, Balears, Belgium, Canary Islands, Cyprus, and Denmark (ME) Mediterranean coast in Egypt (ME)	Abd El-Ghani et al. (2017); GBIF; and POWO Boulos (1999–2005)	×	×	×	✓
59	<i>Atriplex turcomanica</i> (Moq.) Boiss.	Amaranthaceae	Kazakhstan, Transcaucasus, Turkey, Turkmenistan, and Uzbekistan (IT)	Abd El-Ghani et al. (2017); GBIF; and POWO	×	✓	✓	×
60	<i>Avicennia marina</i> (Forssk.) Vierh.	Acanthaceae	Cape Provinces, Eritrea, and Kenya (SZ)	GBIF and POWO	×		×	✓
61	<i>Ballota kaiseri</i> Tackh.	Lamiaceae			✓		✓	
62	<i>Bassia arabica</i> (Boiss.) Maire & Weiller	Amaranthaceae	Mariut and Mediterranean coast in Egypt (ME)	Squires and Ayoub (1994); Boulos (1999–2005); and Turki et al. (2006)	●	✓	×	
63	<i>Bellevalia desertorum</i> Eig & Feinbrun	Asparagaceae			✓		✓	
64	<i>Bellevalia eigii</i> Feinbrun	Asparagaceae	Burg el Arab, Mariut, Mediterranean coast in Egypt, and Sallum (ME)	Boulos (1999–2005); Amer at al. (2020); and GBIF	●		×	
65	<i>Bellevalia flexuosa</i> var. <i>galalensis</i> Tackh. & Drar	Asparagaceae			✓		✓	
66	<i>Bellevalia zoharyi</i> Feinbrun	Asparagaceae			✓		✓	
67	<i>Biarum olivieri</i> Blume	Araceae	Bardawil Lake, Damiette, and Mediterranean coast in Egypt (ME)	Boulos (1999–2005); El-Sheikh (2013); and GBIF	×		✓	

No.	Species	Family	Exclusion region	Reference and website	The present study	Bornkamm and Kehl (1990)	Boulos (1999–2005)	Abd El-Ghani et al. (2017)
68	<i>Blepharis attenuata</i> Napper	Acanthaceae	West and central Jordan (IT)	Danin and Fragman-Sapir (2016)	●		✓	
69	<i>Blepharis edulis</i> (Forssk.) Pers.	Acanthaceae	Angola, Chad, Eritrea, Ethiopia, Kenya, Mali, Niger, Somalia, Sudan, Tanzania, and Uganda (SZ)	Boulos (1999–2005); GBIF; and POWO	×		×	✓
70	<i>Blumea bovei</i> (DC.) Vatke	Asteraceae	Chad, Eritrea, Ethiopia, Somalia, and Sudan (SZ)	Boulos (1999–2005); GBIF; and POWO	×	✓	×	
71	<i>Brassica deserti</i> Danin & Hedge	Brassicaceae	El-Arish and north Sinai (ME)	Boulos (1999–2005) and Shehata and Kamel (2007)	●		✓	
72	<i>Brocchia cinerea</i> (Delile) Vis.	Asteraceae	Ethiopia, Mali, and Sudan (SZ) Mediterranean coast in Egypt (ME)	Boulos (1999–2005); GBIF; and POWO Boulos (1999–2005)	×	✓	×	✓
73	<i>Bufoia multiceps</i> Decne.	Caryophyllaceae			✓		✓	
74	<i>Calendula tripterocarpa</i> Rupr.	Asteraceae	France and Spain (ME)	GBIF and POWO	×		✓	
75	<i>Calotropis procera</i> (Aiton) W. T. Aiton	Apocynaceae	Bangladesh, Benin, Burkina, Cambodia, Cameroon, Canary Islands, Cape Verde, Chad, Congo, Eritrea, and Ethiopia (SZ) Gebel Elba (SZ)	GBIF and POWO Boulos (1999–2005)	×	×	×	✓
76	<i>Campanula dulcis</i> Decne.	Campanulaceae			✓		✓	
77	<i>Capparis cartilaginea</i> Decne.	Capparaceae	Chad, Eritrea, Ethiopia, Kenya, Somalia, Sudan, and Tanzania (SZ) Gebel Elba (SZ)	GBIF and POWO Boulos (1999–2005)	×		×	✓
78	<i>Capparis spinosa</i> var. <i>aegyptia</i> (Lam.) Boiss.	Capparaceae	Greece, Kriti, and Turkey (ME)	GBIF and POWO	×	✓	×	✓
79	<i>Carduus getulus</i> Pomel	Asteraceae	Mediterranean coast in Egypt (ME)	Boulos (1999–2005)	●	✓	×	
80	<i>Caroxylon imbricatum</i> (Forssk.) Moq.	Amaranthaceae	Chad, Eritrea, Gebel Elbar, Senegal, Somalia, and Sudan (SZ) Gebel Elba (SZ)	GBIF and POWO Boulos (1999–2005) and Elkordy et al. (2022)	×	×	×	✓

No.	Species	Family	Exclusion region	Reference and website	The present study	Bornkamm and Kehl (1990)	Boulos (1999–2005)	Abd El-Ghani et al. (2017)
81	<i>Caroxylon tetragonum</i> (Delile) Moq.	Amaranthaceae	Matrouh and Mediterranean coast in Egypt (ME)	Turki (1999) and Boulos (1999–2005)	●	✓	×	
82	<i>Caroxylon tetrandrum</i> (Forssk.) Akhani & Roalson	Amaranthaceae	Canary Islands and Spain (ME)	Boulos (1999–2005) and GBIF	●	✓	×	×
83	<i>Caroxylon villosum</i> (Schult.) Akhani & Roalson	Amaranthaceae	Mediterranean coast in Egypt and north of Syria (ME)	Mosallam (2007) and GBIF	●		✓	×
			The northwestern coastal desert of Egypt (ME)	Bidak et al. (2015)				
84	<i>Caroxylon volkensii</i> (Schweinf. & Asch.) Akhani & Roalson	Amaranthaceae	Mediterranean coast in Egypt (ME)	Boulos (1999–2005); El-Shamy (2016); and Alghanem et al. (2020)	●		×	
85	<i>Carrichtera annua</i> (L.) DC.	Brassicaceae	Canary Islands, Cyprus, Greece, Kriti, and Portugal (ME)	Boulos (1999–2005); GBIF; and POWO	×	×	×	✓
86	<i>Carthamus eriocephalus</i> (Boiss.) Greuter	Asteraceae	Matrouh (ME)	El-Zanaty et al. (2010)	●		×	✓
87	<i>Phonus mareoticus</i> (Delile) G.López	Asteraceae	Alexandria and Sallum (ME)	Boulos (1999–2005) and Salama et al. (2005)	×	✓	×	✓
88	<i>Caudanthera sinaica</i> (Decne.) Plowes	Apocynaceae	South of Yemen and Sudan (SZ)	GBIF and POWO	×		✓	
89	<i>Caylusea hexagyna</i> (Forssk.) M.L. Green	Resedaceae	Cape Verde, Chad, Eritrea, Mali, Niger, Somalia, and Sudan (SZ)	GBIF and POWO	×		×	✓
			Gebel Elba (SZ) and Mediterranean coast in Egypt (ME)	Boulos (1999–2005)				
90	<i>Cenchrus divisus</i> (J.F.Gmel.) Verloove, Govaerts & Buttler	Poaceae	Chad, Eritrea, Niger, and Somalia (SZ)	Boulos (1999–2005); GBIF; and POWO	×		×	✓
91	<i>Centaurea aegyptiaca</i> L.	Asteraceae	Sudan (SZ)	POWO	●		×	✓
			Gebel Elba (SZ)	Boulos (1999–2005)				
92	<i>Centaurea ammocyanus</i> Boiss.	Asteraceae	Lebanon (ME)	Boulos (1999–2005)	●		×	
			North of Iran (IT)	GBIF				

Continued

No.	Species	Family	Exclusion region	Reference and website	The present study	Bornkamm and Kehl (1990)	Boulos (1999–2005)	Abd El-Ghani et al. (2017)
93	<i>Centaurea glomerata</i> Vahl	Asteraceae	Italy and Spain (ME)	GBIF and POWO	×	×	×	✓
			Mediterranean coast in Egypt (ME)	Boulos (1999–2005); Shaltout et al. (2018); and Hamed et al. (2021)				
94	<i>Centaurea pallescens</i> Delile	Asteraceae	Lebanon, France, and Mediterranean coast in Egypt (ME)	Boulos (1999–2005); Hamed et al. (2021); GBIF; Euro+Med); Flora of Lebanon; and GBIF	×	✓	×	
95	<i>Centaurea scoparia</i> Sieber ex Spreng	Asteraceae			✓		✓	✓
96	<i>Centaurea sinaica</i> DC.	Asteraceae			✓		✓	✓
97	<i>Centaurium malzacianum</i> Maire	Gentianaceae			✓		✓	
98	<i>Chiladenus montanus</i> (Vahl) Brullo	Asteraceae			✓		✓	
99	<i>Citrullus colocynthis</i> (L.) Schrad.	Cucurbitaceae	Bangladesh, Benin, Burkina, Cape Verde, Chad, Cyprus, Eritrea, and Ethiopia (SZ) and Canary Islands (ME)	Boulos (1999–2005); GBIF; and POWO	×	×	×	✓
			Mediterranean coast in Egypt (ME)	Abd El-Ghani et al. (2017)				
100	<i>Cleome arabica</i> L.	Cleomaceae	Chad, Eritrea, Ethiopia, Niger, and Sudan (SZ)	GBIF and POWO	×		✓	✓
101	<i>Cleome brachycarpa</i> Vahl ex DC.	Cleomaceae	Cape Verde, Chad, Eritrea, Ethiopia, Kenya, Mali, Niger, Somalia, and Sudan (SZ)	GBIF and POWO	×		×	✓
			Gebel Elba (SZ)	Boulos (1999–2005)				
102	<i>Cleome chrysantha</i> Decne.	Cleomaceae	Sudan and Ethiopia (SZ)	GBIF and POWO	×		×	✓
			Gebel Elba (SZ)	Boulos (1999–2005)				
103	<i>Cleome droserifolia</i> (Forssk.) Delile	Cleomaceae	Eritrea, Somalia, and Sudan (SZ)	GBIF and POWO	×	×	×	✓
			Gebel Elba (SZ)	Boulos (1999–2005)				
104	<i>Cebatha pendula</i> (J. R. Forst. & G. Forst.) Kuntze	Menispermaceae	Cape Verde, Ethiopia, and Somalia (SZ)	GBIF and POWO	×	×	×	✓
			Gebel Elba (SZ)	Boulos (1999–2005)				

To be continued

No.	Species	Family	Exclusion region	Reference and website	The present study	Bornkamm and Kehl (1990)	Boulos (1999–2005)	Abd El-Ghani et al. (2017)
105	<i>Colchicum guessfeldtianum</i> Asch. & Schweinf.	Colchicaceae			✓		✓	
106	<i>Colchicum ritchii</i> R.Br.	Colchicaceae	Mediterranean coast in Egypt (ME)	Boulos (1999–2005) and Flora of Libya	●		×	
107	<i>Colchicum schimperi</i> Janka ex Stef	Colchicaceae	El Arish (ME)	CAI (1965)	●		✓	
108	<i>Cometes surattensis</i> Burm.f.	Caryophyllaceae	South of Oman (SZ), India, Iran, Iraq, and Pakistan (IT)	Al-Sherif et al. (2013) and POWO	●		✓	
109	<i>Commicarpus boissieri</i> (Heimerl) Cufod.	Nyctaginaceae	South of Oman and south of Yemen (SZ)	GBIF	×		✓	
110	<i>Convolvulus fatmensis</i> Kunze	Convolvulaceae	Chad, Mali, and Sudan (SZ) Lebanon and Mediterranean coast in Egypt (ME)	Boulos (1999–2005)	×	✓	×	
111	<i>Convolvulus hystrix</i> Vahl	Convolvulaceae	Eritrea, Ethiopia, Somalia, and Sudan (SZ) Gebel Elba (SZ)	Boulos (1999–2005); GBIF; and POWO Boulos (1999–2005)	×		×	✓
112	<i>Convolvulus lanatus</i> Vahl	Convolvulaceae	Mediterranean coast in Egypt, and Tukey (ME)	Boulos (1999–2005) and POWO	●	✓	×	✓
113	<i>Convolvulus schimperi</i> Boiss.	Convolvulaceae			✓		✓	
114	<i>Convolvulus spicatus</i> Peter ex Hallier f.	Convolvulaceae			✓		✓	
115	<i>Cornulaca monacantha</i> Delile	Amaranthaceae	Chad, Mali, and Niger (SZ) Mediterranean coast in Egypt (ME)	GBIF and POWO Boulos (1999–2005)	×	×	×	✓
116	<i>Cotoneaster orbicularis</i> Schltdl.	Rosaceae			✓		×	
117	<i>Crataegus sinaica</i> Boiss.	Rosaceae	Cyprus and Turkey (ME)	GBIF and POWO	×		✓	
118	<i>Crepis nigricans</i> Viv.	Asteraceae			✓		✓	
119	<i>Crotalaria aegyptiaca</i> Benth.	Fabaceae	Somalia (SZ)	Boulos (1999–2005); GBIF; and POWO	●		✓	✓
120	<i>Crucianella ciliata</i> Lam.	Rubiaceae			✓		✓	×
121	<i>Crucianella membranacea</i> Boiss.	Rubiaceae	Lebanon (ME)	Boulos (1999–2005)	●		×	
122	<i>Crucihimalaya kneuckeri</i> (Bornm.) Al-Shehbaz, O'Kane & R. A. Price	Brassicaceae			✓		✓	

No.	Species	Family	Exclusion region	Reference and website	The present study	Bornkamm and Kehl (1990)	Boulos (1999–2005)	Abd El-Ghani et al. (2017)
123	<i>Cucumis prophetarum</i> L.	Cucurbitaceae	Benin, Burkina, Burundi, Cameroon, Chad, Eritrea, and Ethiopia (SZ)	Boulos (1999–2005); GBIF; and POWO	×		×	✓
124	<i>Cullen plicatum</i> (Delile) C. H. Stirt.	Fabaceae	Chad, Ethiopia, Mali, Sudan, and Somalia (SZ)	Boulos (1999–2005); GBIF; and POWO	×		×	✓
125	<i>Cuprella homalocarpa</i> (Fisch. & C. A. Mey.) Salmerón-Sánchez, Mota & Fuertes	Brassicaceae	North of Sinai (ME)	Täckholm (1974)	●		×	
126	<i>Cuscuta pedicellata</i> Ledeb.	Convolvulaceae	Eritrea, Ethiopia, and Sudan (SZ)	GBIF and POWO	×	✓	×	✓
			Kazakhstan, Kirgizstan, and Russia (IT) and South European (ME)	GBIF and POWO				
			Gebel Elba (SZ) and Mediterranean coast in Egypt (ME)	Boulos (1999–2005)				
127	<i>Cutandia memphitica</i> (Spreng.) K. Richt.	Poaceae	Canary Islands, Cyprus, North Caucasus, Spain, Tadjhikistan, and Transcaucasus (ME)	GBIF and POWO	×	✓	×	×
			Gebel Elba (SZ) and Mediterranean coast in Egypt (ME)	Boulos (1999–2005)				
128	<i>Cymbopogon iwarancusa</i> (Jones ex Roxb.) Schult.	Poaceae	China and Vietnam (IT)	GBIF and POWO	×		✓	
129	<i>Cynanchum acutum</i> L.	Apocynaceae	South Europe, Mediterranean coast in Egypt, Spain, and Ukraine (ME)	Boulos (1999–2005) and GBIF	×	×	×	✓
130	<i>Cyperus capitatus</i> Vand.	Cyperaceae	Bulgaria, Canary Islands, Cape Verde, Cyprus, France, Greece, Italy, and Kriti (ME)	GBIF and POWO	×	✓	×	
131	<i>Cyperus conglomeratus</i> Rottb.	Cyperaceae	Burkina, Central African Republic, Chad, Eritrea, Ethiopia, Gabon, and Kenya (SZ)	GBIF and POWO	×	✓	×	×
			Gebel Elba (SZ) and Mediterranean coast in Egypt (ME)	Boulos (1999–2005)				

No.	Species	Family	Exclusion region	Reference and website	The present study	Bornkamm and Kehl (1990)	Boulos (1999–2005)	Abd El-Ghani et al. (2017)
132	<i>Cyperus laevigatus</i> L.	Cyperaceae	Angola, Botswana, Burundi, and Cape Verde (SZ)	GBIF and POWO	×	✓	×	
			Canary Islands (ME)	GBIF and POWO				
			Gebel Elba (SZ) and Mediterranean coast in Egypt (ME)	Boulos (1999–2005)				
133	<i>Daucus sahariensis</i> Murb.	Apiaceae			✓		✓	
134	<i>Delphinium bovei</i> Decne.	Ranunculaceae	Eastern Mediterranean coastal region (ME)	Täckholm (1974)	●		✓	
135	<i>Desmostachya bipinnata</i> (L.) Stapf.	Poaceae	Cambodia, Central African Republic, Chad, Eritrea, and Ethiopia (SZ)	GBIF and POWO	×	✓	✓	✓
136	<i>Deverra tortuosa</i> (Desf.) DC.	Apiaceae	Coastal area of Libya and Mediterranean coast in Egypt (ME)	Boulos (1999–2005) and Flora of Libya	●	✓	×	✓
137	<i>Deverra triradiata</i> Hochst. ex Boiss.	Apiaceae	West of Iraq (IT)	Abd El-Ghani et al. (2011)	●		✓	✓
138	<i>Dianthus guessfeldianus</i> Muschl.	Caryophyllaceae			✓		✓	
139	<i>Dianthus monadelphus</i> subsp. <i>judaicus</i> (Boiss.) Greuter & Burdet	Caryophyllaceae			✓		✓	
140	<i>Dianthus sinaicus</i> Boiss.	Caryophyllaceae			✓		✓	
141	<i>Diplotaxis acris</i> (Forssk.) Boiss.	Brassicaceae	Turkey and Spain (ME)	Boulos (1999–2005) and POWO	×	✓	×	✓
			Chad (SZ)	POWO				
142	<i>Diplotaxis harra</i> (Forssk.) Boiss.	Brassicaceae	Sicilia and Spain (ME)	Boulos (1999–2005); GBIF; and POWO	×		×	✓
			Somalia (SZ)	Boulos (1999–2005); GBIF; and POWO				
143	<i>Ducrosia ismaelis</i> Asch.	Apiaceae			✓		✓	
144	<i>Echinops glaberrimus</i> DC.	Asteraceae			✓		✓	
145	<i>Echinops taeckholmianus</i> Amin	Asteraceae	Baltim and Rosetta (ME)	CAI (1987) and El-Khalafy et al. (2021 a, b, 2004)	×		✓	×
146	<i>Echiochilon fruticosum</i> Desf.	Boraginaceae	Mediterranean coast in Egypt (ME) and east of Lebanon (IT)	Boulos (1999–2005) and Hamed et al. (2021)	×	×	×	✓

No.	Species	Family	Exclusion region	Reference and website	The present study	Bornkamm and Kehl (1990)	Boulos (1999–2005)	Abd El-Ghani et al. (2017)
147	<i>Echium angustifolium</i> Mill.	Boraginaceae	Cyprus, Greece, Kriti, and Turkey (ME)	GBIF and POWO	×		×	✓
			Mediterranean coast in Egypt (ME)	Boulos (1999–2005)				
148	<i>Echium horridum</i> Batt.	Boraginaceae	Canary Islands (ME)	GBIF and POWO	×		×	✓
			Mali and Sudan (SZ)	GBIF and POWO				
			Gebel Elba (SZ)	Boulos (1999–2005)				
149	<i>Echium longifolium</i> Delile	Boraginaceae	Ethiopia and Sudan (SZ)	CAI (1973) and GBIF	×		✓	
			Gebel Elba (SZ) and Mediterranean coast in Egypt (ME)	Täckholm (1974)				
150	<i>Echium rauwolfii</i> Delile	Boraginaceae	Sudan (SZ)	POWO	×		×	✓
			Cyprus (ME)	POWO				
			Mediterranean coast in Egypt (ME)	Boulos (1999–2005)				
151	<i>Echium rubrum</i> Forssk.	Boraginaceae	Russia and Spain (ME)	GBIF	×	✓	×	
			Mediterranean coast in Egypt (ME)	Boulos (1999–2005)				
152	<i>Enarthrocarpus strangulatus</i> Boiss.	Brassicaceae	The western Mediterranean coastal land in Egypt (ME)	Boulos (1999–2005) and Turki and El Shayeb (2005)	●	✓	×	
153	<i>Ephedra alata</i> Decne.	Ephedraceae	Chad and Mali (SZ)	GBIF and POWO	×	✓	×	×
			Mediterranean coast in Egypt (ME)	Boulos (1999–2005) and Abd El-Ghani et al. (2017)				
154	<i>Ephedra aphylla</i> Forssk.	Ephedraceae	Cyprus (ME)	POWO	●	✓	×	✓
			Mediterranean coast in Egypt and Rosetta (ME)	Boulos (1999–2005) and Abdel-Kader et al. (2003)				
155	<i>Ephedra pachyclada</i> subsp. <i>sinaica</i> (Riedl) Freitag & Maier-St.	Ephedraceae			✓		✓	
156	<i>Eragrostis aegyptiaca</i> (Willd.) Delile	Poaceae	Burkina, Chad, Mali, Niger, Senegal, and Sudan (SZ)	GBIF and POWO	×	✓	×	
			Gebel Elba (SZ) and Mediterranean coast in Egypt (ME)	Boulos (1999–2005)				

Continued

No.	Species	Family	Exclusion region	Reference and website	The present study	Bornkamm and Kehl (1990)	Boulos (1999–2005)	Abd El-Ghani et al. (2017)
157	<i>Eremobium aegyptiacum</i> subsp. <i>aegyptiacum</i> (Spreng.) Asch. ex Boiss.	Brassicaceae	Chad (SZ) Arish, Burg El Arab, and Mediterranean coast in Egypt (ME)	Khalik (2005) Boulos (1999–2005); CAI (2004); and TANE (2010)	×	✓	×	✓
158	<i>Eremobium aegyptiacum</i> var. <i>lineare</i> (Delile) Zohary	Brassicaceae			✓		✓	
159	<i>Eremogone sinaica</i> (Boiss.) Dillenb. & Kadereit	Caryophyllaceae			✓		✓	
160	<i>Erigeron bonariensis</i> L.	Asteraceae	South of America and Western Europe (ES)	Boulos (1999–2005)	×	✓	×	×
161	<i>Erodium arborescens</i> (Desf.) Willd.	Geraniaceae	Mediterranean coast in Egypt (ME)	Mahklouf (2020)	●	✓	✓	✓
162	<i>Erodium crassifolium</i> L'Hér.	Geraniaceae	Cyprus and Kriti (ME)	Boulos (1999–2005); GBIF; and POWO	●	✓	×	✓
163	<i>Erodium glaucophyllum</i> (L.) L'Hér.	Geraniaceae	Italy (ME)	POWO	×		×	✓
			Sudan (SZ)	POWO				
			Mediterranean coast in Egypt (ME)	Täckholm (1974) and Boulos (1999–2005)				
			Northwestern of Jordan (IT)	Flora of Libya				
164	<i>Erodium oxyrhinchum</i> M.Bieb.	Geraniaceae	Turkey, Turkmenistan, Uzbekistan, and Xinjiang Uygur Autonomous region, China (IT)	GBIF and POWO	×		×	✓
			Southwest of Saudi Arabia (SZ)	Danin and Fragman-Sapir (2016)				
165	<i>Erodium pulverulentum</i> (Boiss.) Batt.	Geraniaceae	Eritrea (SZ)	POWO	×	✓	×	✓
			Spain (ME)	POWO				
			Mediterranean coast in Egypt (ME)	Boulos (1999–2005)				
			North of Iran (IT)	Abd El-Ghani et al. (2017)				
166	<i>Erodium touchyanum</i> Delile ex Godr.	Geraniaceae	Canary Islands and Cyprus (ME)	POWO	●		✓	✓
167	<i>Erucaria pinnata</i> (Viv.) Täckh. & Boulos	Brassicaceae	Burg Elarab, Matrouh, and Mediterranean coast in Egypt (ME)	CAI (1979); Boulos (1999–2005); and TANE (2006)	●		×	

To be continued

No.	Species	Family	Exclusion region	Reference and website	The present study	Bornkamm and Kehl (1990)	Boulos (1999–2005)	Abd El-Ghani et al. (2017)
168	<i>Euphorbia granulata</i> Forssk	Euphorbiaceae	Chad, Eritrea, Ethiopia, Kazakhstan, and Kenya (SZ) Gebel Elba (SZ)	GBIF and POWO Boulos (1999–2005)	×		×	✓
169	<i>Euphorbia grossheimii</i> (Prokh.) Prokh.	Euphorbiaceae	Transcaucasus (ME)	Boulos (1999–2005); GBIF; and POWO	●		×	
170	<i>Euphorbia obovata</i> Decne.	Euphorbiaceae			✓		✓	
171	<i>Euphorbia retusa</i> Forssk.	Euphorbiaceae	France (ME) Mediterranen coast in Egypt (ME)	GBIF Boulos (1999–2005)	●	✓	×	✓
172	<i>Farsetia aegyptia</i> Turra	Brassicaceae	Chad, Mali, and Sudan (SZ) Mediterranen coast in Egypt (ME)	Danin and Fragman-Sapir (2016) and POWO Boulos (1999–2005)	×	×	×	✓
173	<i>Farsetia stylosa</i> R. Br.	Brassicaceae	Cameroon, Chad, Djibouti, Eritrea, Ethiopia, Kenya, and Mali (SZ)	Boulos (1999–2005); Abd El-Ghani et al. (2017); GBIF; and POWO	×	✓	×	×
174	<i>Ferula sinaica</i> Boiss.	Apiaceae	Mediterranen coast in Egypt (ME)	Täckholm (1974)	●		✓	
175	<i>Ficus palmata</i> Forssk.	Moraceae	Eritrea, Ethiopia, Somalia, and Sudan (SZ)	Boulos (1999–2005); GBIF; and POWO	×		×	✓
176	<i>Galium aparine</i> L.	Rubiaceae	Belgium, Bulgaria, Cyprus, Denmark, Finland, France, Gebel Elbarmany, Greece, and Ireland (ME)	Boulos (1999–2005); GBIF; and POWO	×		×	✓
177	<i>Galium ceratopodum</i> Boiss.	Rubiaceae	Tadzhikistan, Turkmenistan, Uzbekistan, Russia, and other places of Central Asia (IT)	Boulos (1999–2005); GBIF; and POWO	×		×	✓
178	<i>Galium sinaicum</i> (Delile ex Decne) Boiss.	Rubiaceae			✓		✓	
179	<i>Galium tricornutum</i> Dandy	Rubiaceae	Albania, Bulgaria, Cyprus, France, Gebel Elbarmany, Greece, and Italy (ME) Central Asia (IT) and Mediterranean coast in Egypt (ME)	GBIF and POWO Boulos (1999–2005)	×		×	✓

Continued

No.	Species	Family	Exclusion region	Reference and website	The present study	Bornkamm and Kehl (1990)	Boulos (1999–2005)	Abd El-Ghani et al. (2017)
180	<i>Glaucium arabicum</i> Fresen.	Papaveraceae	Mediterranen coast in Egypt (ME)	Boulos (1999–2005)	●		×	
181	<i>Glinus runkewitzii</i> Tackh. & Boulos	Molluginaceae			✓		✓	
182	<i>Gymnocarpus decander</i> Forssk.	Caryophyllaceae	Canary Islands (ME)	POWO				
			Mediterranen coast in Egypt (ME)	Boulos (1999–2005) and Abd El-Ghani et al. (2017)	●	×	×	✓
183	<i>Gymnocarpus sclerocephalus</i> (Decne.) Dahlgren & Thulin	Caryophyllaceae	Chad, Djibouti, and Eritrea (SZ)	GBIF and POWO	×		×	✓
			Gebel Elba (SZ)	Boulos (1999–2005)				
184	<i>Gomphocarpus sinaicus</i> Boiss.	Apocynaceae			✓		✓	
185	<i>Gypsophila capillaris</i> (Forssk.) C.Chr.	Caryophyllaceae	North of Syria (IT)	Danin and Fragman-Sapir (2016) and GBIF	●		×	✓
			Mediterranen coast in Egypt (ME)	Abd El-Ghani et al. (2017)				
186	<i>Halopeplis perfoliata</i> (Forssk.) Bunge ex Ung.-Sternb.	Amaranthaceae	Eritrea and Sudan (SZ)	POWO	×		×	✓
			Mediterranen coast in Egypt (ME)	Boulos (1999–2005)				
187	<i>Haloxylon negevensis</i> (Iljin & Zohary) L.Boulos	Amaranthaceae			✓		✓	
188	<i>Haplophyllum poorei</i> C.C.Towns.	Rutaceae			✓		✓	
189	<i>Haplophyllum tuberculatum</i> (Forssk.) A. Juss.	Rutaceae	Chad, Somalia, and Sudan (SZ)	GBIF and POWO	×	✓	×	✓
			Gebel Elba (SZ) and Mediterranean coast in Egypt (ME)	Boulos (1999–2005)				
190	<i>Helianthemum kahiricum</i> Delile	Cistaceae	Cyprus (ME)	POWO	×	✓	×	✓
			Mediterranen coast in Egypt (ME)	Boulos (1999–2005) and Makhlof (2020)				
191	<i>Helianthemum lippii</i> (L.) Dum.Cours.	Cistaceae	Italy and Kriti (ME)	GBIF and POWO				
			Chad and Sudan (SZ)	GBIF and POWO	×	×	×	✓
			Mediterranen coast in Egypt (ME)	Boulos (1999–2005)				

To be continued

No.	Species	Family	Exclusion region	Reference and website	The present study	Bornkamm and Kehl (1990)	Boulos (1999–2005)	Abd El-Ghani et al. (2017)
192	<i>Helianthemum sancti-antoni</i> Schweinf. ex Boiss.	Cistaceae			✓		✓	
193	<i>Helianthemum schweinfurthii</i> Grosser	Cistaceae			✓		✓	✓
194	<i>Helianthemum stipulatum</i> (Forssk.) C. Chr.	Cistaceae	Djibouti and Somalia (SZ)	GBIF and POWO	×	✓	×	
			Cyprus, Greece, and Turkey (ME)	GBIF and POWO				
			Mediterranean coast in Egypt (ME)	Boulos (1999–2005)				
195	<i>Helianthemum ventosum</i> Boiss.	Cistaceae			✓		✓	
196	<i>Heliotropium arbainense</i> Fresen.	Boraginaceae	Ethiopia and Sudan (SZ)	Boulos (1999–2005); GBIF; and POWO	×		×	✓
197	<i>Heliotropium bacciferum</i> Forssk.	Boraginaceae	Chad, Comoros, Djibouti, Eritrea, and Ethiopia (SZ)	GBIF and POWO	×	×	×	✓
			Gebel Elba (SZ)	Boulos (1999–2005)				
198	<i>Heliotropium digynum</i> (Forssk.) Asch. ex C. Chr.	Boraginaceae	The western Mediterranean coastal land (ME)	Turki and El Shayeb (2005)	×		×	✓
			Mediterranean coast in Egypt (ME)	Boulos (1999–2005)				
			West of Iraq (IT)	Abd El-Ghani et al. (2017)				
199	<i>Herniaria hemistemon</i> J. Gay	Caryophyllaceae	Mediterranean coast in Egypt and Sallum (ME)	Boulos (1999–2005) and Amer et al. (2020)	×	✓	×	✓
			North of Syria (IT)	Makhlouf (2020) and GBIF (2023)				
200	<i>Heteroderis pusilla</i> (Boiss.) Boiss.	Asteraceae	Kazakhstan, Kirgizstan, Tadjikistan, Turkmenistan, and Uzbekistan (IT)	GBIF and POWO	×		✓	
201	<i>Hippocrepis areolata</i> Desv.	Fabaceae	France and Mediterranean coast (ME)	Boulos (1999–2005) and POWO	●	✓	×	
202	<i>Hippocrepis constricta</i> Kunze	Fabaceae	Chad, Sudan, and Tanzania (SZ)	GBIF and POWO	×		✓	×
203	<i>Hyoscyamus boveanus</i> (Dunal) Asch. & Schweinf.	Solanaceae			✓		✓	✓
204	<i>Hyoscyamus desertorum</i> (Asch. ex Boiss.) Täckh.	Solanaceae	Arish and Mediterranean coast in Egypt (ME)	Boulos (1999–2005) and GBIF	●		×	×

No.	Species	Family	Exclusion region	Reference and website	The present study	Bornkamm and Kehl (1990)	Boulos (1999–2005)	Abd El-Ghani et al. (2017)
205	<i>Hyoscyamus pusillus</i> L.	Solanaceae	Central Asia, and south European Russia, Turkey, Turkmenistan, Uzbekistan, and Xinjiang Uygur Autonomous Region, China (IT)	Boulos (1999–2005); GBIF; and POWO	×		×	✓
206	<i>Hyecoum aegyptiacum</i> (Forssk.) Asch. & Schweinf.	Papaveraceae	El Kawm El Akhdar Island and Mediterranean coast in Egypt (ME)	Boulos (1999–2005) and TANE (2000)	●		×	
207	<i>Hyecoum aequilobum</i> Viv.	Papaveraceae	Mediterranean coast in Egypt (ME)	Boulos (1999–2005)	●		×	
208	<i>Hypericum sinaicum</i> Hochst. ex Boiss.	Hypericaceae			✓		✓	
209	<i>Iflogia spicata</i> subsp. <i>hadidii</i> (Fayed & Zareh) Greuter	Asteraceae	Arish and Mediterranean coast in Egypt (ME)	Boulos (1999–2005) and GBIF	●	✓	×	
210	<i>Iphiona mucronata</i> (Forssk.) Asch. & Schweinf.	Asteraceae			✓		✓	✓
211	<i>Iphiona scabra</i> DC. ex Decne.	Asteraceae	Djibouti, Eritrea, Ethiopia, and Sudan (SZ) Gebel Elba (SZ)	Boulos (1999–2005); GBIF; and POWO Boulos (1999–2005)	×		×	✓
212	<i>Iris mariae</i> Barbey	Iridaceae	Bardawil Lake and Rafah (ME)	El Banna (2009) and GBIF	×		✓	
213	<i>Isatis microcarpa</i> J. Gay ex Boiss.	Brassicaceae	Mediterranean coast in Egypt (ME)	Boulos (1999–2005)	●		×	
214	<i>Kickxia aegyptiaca</i> subsp. <i>aegyptiaca</i> (L.) Nábělek	Plantaginaceae	Chad and Sudan (SZ) Mediterranean coast in Egypt (ME)	POWO Boulos (1999–2005) and Danin and Fragman-Sapir (2016)	×	×	×	✓
215	<i>Kickxia floribunda</i> (Boiss.) Täckh. & Boulos	Plantaginaceae	Arish (ME)	Täckholm (1974); El-Hadidi et al. (1999); and GBIF	●		✓	
216	<i>Lasiurus scindicus</i> Henrard	Poaceae	Chad, Djibouti, Eritrea, Ethiopia, Mali, Niger, Somalia, and Sudan (SZ) Gebel Elba (SZ) and Mediterranean coast in Egypt (ME)	GBIF and POWO Boulos (1999–2005)	×		×	✓
217	<i>Lathyrus hirsutus</i> L.	Fabaceae	France, Greece, Poland, and Portugal (ME)	Boulos (1999–2005); GBIF; and POWO	×	✓	×	

No.	Species	Family	Exclusion region	Reference and website	The present study	Bornkamm and Kehl (1990)	Boulos (1999–2005)	Abd El-Ghani et al. (2017)
218	<i>Lathyrus sphaericus</i> Retz.	Fabaceae	France, Greece, and Hungary (ME)	Boulos (1999–2005); GBIF; and POWO	×	✓	×	
			Eritrea and Ethiopia (SZ)	Boulos (1999–2005); GBIF; and POWO				
219	<i>Launaea amal-aminiae</i> N. Kilian	Asteraceae	Gebel Elba and Halayeb Triangle (SZ)	Zareh et al. (2016) and Marzouk et al. (2021)	●		✓	✓
220	<i>Launaea angustifolia</i> (Desf.) Kuntze	Asteraceae	Mediterranean coast in Egypt (ME)	Täckholm (1974)	●		✓	
221	<i>Launaea capitata</i> (Spreng.) Dandy	Asteraceae	Chad, Eritrea, and Sudan (SZ)	Boulos (1999–2005); GBIF; and POWO	×	✓	×	✓
			Canary Islands (ME)	Boulos (1999–2005); GBIF; and POWO				
222	<i>Launaea mucronata</i> (Forssk.) Muschl	Asteraceae	Chad, Eritrea, and Sudan (SZ)	Boulos (1999–2005); GBIF; and POWO	×	✓	×	✓
223	<i>Launaea mucronata</i> subsp. <i>cassiniana</i> (Jaub. & Spach) N. Kilian	Asteraceae	Chad and Sudan (SZ)	Boulos (1999–2005); GBIF; and POWO	×	✓	×	✓
224	<i>Launaea spinosa</i> (Forssk.) Sch. Bip. Ex Kuntze	Asteraceae			✓		✓	✓
225	<i>Lavandula atriplicifolia</i> Benth.	Lamiaceae			✓		✓	
226	<i>Lavandula coronopifolia</i> Poir.	Lamiaceae	Cape Verde, Chad, and Djibouti (SZ)	Boulos (1999–2005); GBIF; and POWO	×		×	✓
227	<i>Lepidium niloticum</i> (Delile) Sieber ex Steud.	Brassicaceae	Chad and Sudan (SZ)	GBIF and POWO	×	✓	✓	
228	<i>Leptadenia arborea</i> (Forssk.) Schweinf	Apocynaceae	Burkina, Cameroon, Chad, and Djibouti (SZ)	Boulos (1999–2005); GBIF; and POWO	×		×	✓
229	<i>Leptadenia pyrotechnica</i> (Forssk.) Decne	Apocynaceae	Burkina, Cameroon, Chad, Djibouti, and Eritrea (SZ)	Boulos (1999–2005); GBIF; and POWO	×		×	✓
230	<i>Leobordea platycarpa</i> (Viv.) B. E. van Wyk & Boatwr.	Fabaceae	Angola, Botswana, Chad, and Central African Republic (SZ)	GBIF and POWO	×		✓	×
231	<i>Limonium axillare</i> (Forssk.) Kuntze	Plumbaginaceae	Djibouti, Eritrea, Somalia, and Sudan (SZ)	Boulos (1999–2005); GBIF; and POWO	×		×	✓
232	<i>Limonium pruinatum</i> (L.) Chaz.	Plumbaginaceae	El Alamein, north coast of the Nile Delta in Egypt, and Mediterranean coast in Egypt (ME)	Boulos (1999–2005); El-Amier et al. (2014); and GBIF	×	✓	×	✓

No.	Species	Family	Exclusion region	Reference and website	The present study	Bornkamm and Kehl (1990)	Boulos (1999–2005)	Abd El-Ghani et al. (2017)
233	<i>Lindenbergia indica</i> (L.) Vatke	Orobanchaceae	Djibouti, Eritrea, and Ethiopia (SZ)	Boulos (1999–2005); GBIF; and POWO	×		×	✓
			Greece (ME)	El-Amier (2016) and Flora of Greece				
234	<i>Lobularia arabica</i> (Boiss.) Muschl.	Brassicaceae	Deltaic Mediterranean coast and Mediterranean coast in Egypt (ME)	Boulos (1999–2005)	×	✓	×	
235	<i>Lotus hebranicus</i> Hochst. ex Brand	Fabaceae	Sudan (SZ)	Sokoloff (2001) and POWO	●		×	✓
236	<i>Lotus glinoides</i> Delile	Fabaceae	Chad, Eritrea, and Sudan (SZ)	Boulos (1999–2005); GBIF; and POWO	×	✓	×	✓
237	<i>Lotus lanuginosus</i> Vent.	Fabaceae			✓	✓	✓	
238	<i>Lupinus digitatus</i> Forssk.	Fabaceae	Senegal (SZ)	GBIF and POWO	●		✓	×
			Botswana, Djibouti, Eritrea, and Ethiopia (SZ)	GBIF and POWO				
239	<i>Lycium shawii</i> Roem. & Schult.	Solanaceae	Gebel Elba (SZ)	Boulos (1999–2005)	×		×	✓
240	<i>Lygeum spartum</i> Loefl. ex L.	Poaceae	Italy, Kriti, Mediterranean coast in Libya, and Spain (ME)	Boulos (1999–2005); GBIF; Flora of Libya; and POWO	×	×	×	✓
241	<i>Malcolmia pygmaea</i> (DC.) Boiss.	Brassicaceae	Alexandria, El Arish, and Mediterranean coast in Egypt (ME)	CAI (1992); Boulos (1999–2005); and GBIF	×	✓	×	
			Mediterranean coast (ME)	Asri (2004)				
242	<i>Malva ludwigii</i> (L.) Soldano, Banfi & Galasso	Malvaceae	Tadzhikistan, Turkmenistan, and Uzbekistan (IT)	POWO	×	×	×	✓
243	<i>Matthiola arabica</i> Boiss.	Brassicaceae			✓		✓	✓
			Mariut (ME)	GBIF				
244	<i>Matthiola longipetala</i> subsp. <i>hirta</i> (Conti) Greuter & Burdet	Brassicaceae	Turkey (IT)	POWO	×	✓	×	
			Mediterranean coast in Libya (ME)	Flora of Libya				
			Canary Islands (ME)	POWO				
245	<i>Matthiola longipetala</i> subsp. <i>livida</i> (Delile) Maire	Brassicaceae	Burg el arab and Mediterranean coast in Egypt (ME)	Boulos (1999–2005) and Marzouk et al. (2010)	×	✓	×	✓

No.	Species	Family	Exclusion region	Reference and website	The present study	Bornkamm and Kehl (1990)	Boulos (1999–2005)	Abd El-Ghani et al. (2017)
246	<i>Matthiola longipetala</i> subsp. <i>longipetala</i> (Vent.) DC.	Brassicaceae	Cyprus, Turkey, and Uzbekistan (IT)	GBIF and POWO	×	✓	✓	×
247	<i>Medicago laciniata</i> (L.) Mill.	Fabaceae	Botswana, Djibouti, and Ethiopia (SZ)	POWO	×	✓	×	✓
			Canary Islands (ME)	POWO				
			Mediterranean coast in Egypt (ME)	Boulos (1999–2005)				
248	<i>Melilotus serratifolius</i> Tackh. & Boulos	Fabaceae			✓		✓	
249	<i>Mesembryanthemum cryptanthum</i> Hook.f.	Aizoaceae	Angola, Cape Verde, and Namibia (SZ)	Danin and Fragman-Sapir (2016) and POWO	×	×	×	✓
			Mediterranean coast in Egypt (ME)	Boulos (1999–2005)				
250	<i>Micromeria serbaliana</i> Danin & Hedge	Lamiaceae			✓		✓	
251	<i>Micromeria sinaica</i> Benth.	Lamiaceae			✓		✓	
252	<i>Microparacaryum intermedium</i> (Fresen.) Hilger & Podlech	Boraginaceae	Kazakhstan, Tadjikistan, Uzbekistan, and West Himalaya (IT)	GBIF and POWO	×		✓	×
			Eritrea (SZ)	GBIF and POWO				
253	<i>Monsonia heliotropioides</i> (Cav.) Boiss.	Geraniaceae	Chad, NiGebel Elbar, and Sudan (SZ)	Boulos (1999–2005); GBIF; and POWO	×		×	✓
254	<i>Monsonia nivea</i> (Decne.) Webb	Geraniaceae	Chad, NiGebel Elbar, and Sudan (SZ)	Boulos (1999–2005); Danin and Fragman-Sapir (2016); GBIF; and POWO	×	✓	×	✓
255	<i>Morettia canescens</i> Boiss.	Brassicaceae	Chad, Mali, and Niger (SZ)	GBIF and POWO	×		✓	
256	<i>Morettia parviflora</i> Boiss.	Brassicaceae	South of Yemen (SZ)	GBIF	●		✓	
257	<i>Morettia philaeana</i> (Delile) DC.	Brassicaceae	Chad, Mali, NiGebel Elbar, and Sudan (SZ)	Boulos (1999–2005); GBIF; and POWO	×	×	×	✓
258	<i>Moricandia nitens</i> (Viv.) E. A. Durand & Barranté	Brassicaceae	Alamein, Burg El arab, and Mediterranean coast in Egypt (ME)	Boulos (1999–2005); Marzouk et al. (2010); and GBIF	×	×	×	✓
259	<i>Moricandia sinaica</i> (Boiss.) Boiss.	Brassicaceae	Somalia (SZ)	Abdullah and Al-Dosari (2022); GBIF; and POWO	●		✓	✓

No.	Species	Family	Exclusion region	Reference and website	The present study	Bornkamm and Kehl (1990)	Boulos (1999–2005)	Abd El-Ghani et al. (2017)
260	<i>Muscari eburneum</i> (Eig & Feinbrun) D.C.Stuart	Lamiaceae	Mediterranen coast in Egypt (ME)	Täckholm (1974)	●		✓	
261	<i>Muscari longipes</i> subsp. <i>negevense</i> (Feinbrun & Danin) Hosni	Lamiaceae			✓		✓	
262	<i>Najas pectinata</i> (Parl.) Magnus	Hydrocharitaceae	Chad, Guinea, Mali, and Senegal (SZ)	GBIF and POWO	×		✓	
263	<i>Nanorrhinum acerbianum</i> (Boiss.) Betsche	Plantaginaceae	Gebel Elba (SZ)	Boulos (1999–2005)	●		×	✓
264	<i>Nanorrhinum macilentum</i> (Decne.) Betsche	Plantaginaceae	Chad and Sudan (SZ)	Brundu and Camarda (2013) and POWO	●		✓	
265	<i>Nasturtiopsis integrifolia</i> (Boulos) Abdel Khalik & F.T.Bakker	Brassicaceae	El Arish (ME)	GBIF	●		✓	
266	<i>Nepeta septemcrenata</i> Ehrenb. ex Benth.	Lamiaceae			✓		✓	
267	<i>Neurada procumbens</i> L.	Neuradaceae	Chad, Eritrea, Mali, Niger, and Sudan (SZ)	GBIF and POWO	×	×	×	✓
			Cyprus (ME)	GBIF and POWO				
			Gebel Elba (SZ) and Mediterranean coast in Egypt (ME)	Boulos (1999–2005)				
268	<i>Nidorella aegyptiaca</i> (L.) J. C. Manning & Goldblatt	Asteraceae	Benin, Botswana, Burundi, Cambodia, Cameroon, Chad, Congo, Eritrea, Ethiopia, Ghana, and Guinea (SZ)	Boulos (1999–2005); GBIF; and POWO	×	✓	×	
269	<i>Nitraria retusa</i> (Forssk.) Asch.	Nitrariaceae	Senegal and Sudan (SZ)	GBIF and POWO	×	×	×	✓
			Gebel Elba (SZ) and Mediterranean coast in Egypt (ME)	Boulos (1999–2005)				
270	<i>Ochradenus baccatus</i> Delile	Resedaceae	Chad, Djibouti, Eritrea, and Ethiopia (SZ)	GBIF and POWO	×	×	×	✓
			Gebel Elba (SZ) and Mediterranean coast in Egypt (ME)	Boulos (1999–2005)				
271	<i>Ogastemma pusillum</i> (Coss. & Durieu ex Bonnet & Barratte) Brummitt	Boraginaceae	Canary Islands (ME)	POWO	●		✓	

No.	Species	Family	Exclusion region	Reference and website	The present study	Bornkamm and Kehl (1990)	Boulos (1999–2005)	Abd El-Ghani et al. (2017)
272	<i>Oligomeris linifolia</i> (Vahl ex Hornem.) J. F. Macbr.	Resedaceae	Canary Islands and Kriti (ME)	Boulos (1999–2005); GBIF; and POWO	×	✓	×	✓
			Chad (SZ)	Boulos (1999–2005); GBIF; and POWO				
			China (IT)	Boulos (1999–2005); GBIF; and POWO				
273	<i>Onobrychis ptolemaica</i> (Delile) DC.	Fabaceae	Turkey (IT)	GBIF and TÜBİVES (2023)	●		✓	
274	<i>Onopordum ambiguum</i> Fresen.	Asteraceae	Centre of Jordan (IT)	Rabei et al. (2021)	●	×	✓	
275	<i>Origanum isthmicum</i> Danin	Lamiaceae			✓		✓	
276	<i>Origanum syriacum</i> subsp. <i>sinaicum</i> (Boiss.) Greuter & Burdet	Lamiaceae			✓		✓	
277	<i>Pallenis hierichuntica</i> (Michon) Greuter	Asteraceae	Mediterranean coast in Egypt (ME)	Boulos (1999–2005)	×	×	×	✓
			Canary Islands (ME)	Boulos (1999–2005) and POWO				
			East Iran (IT)	Flora of Libya				
278	<i>Pancreatium sickenbergeri</i> Asch. & Schweinf.	Amaryllidaceae	Bardawil Lake, El Borollos, and Omayed (ME), and Elba Mountain (SZ)	TANE (2000) and El-Bana (2009)	×		✓	
279	<i>Panicum turgidum</i> Forssk.	Poaceae	Benin, Burkina, Chad, Congo, Djibouti, Eritrea, and Ethiopia (SZ)	Danin and Fragman-Sapir (2016); GBIF; and POWO	×	✓	×	×
280	<i>Papaver decaisnei</i> (Elkan) Hochst. & Steud. ex Boiss.	Papaveraceae	Burg El-Arab and Mersa Matruh (ME)	Taia (2009)	×		✓	
			Russia (IT)	GBIF				
281	<i>Paronychia arabica</i> subsp. <i>arabica</i> (L.) DC.	Caryophyllaceae	Chad (SZ)	POWO	●	×	×	✓
			Mediterranean coast in Egypt (ME)	Boulos (1999–2005)				
282	<i>Paronychia sinaica</i> Fresen.	Caryophyllaceae			✓		✓	
283	<i>Pergularia tomentosa</i> L.	Apocynaceae	Benin, Burkina, Chad, Djibouti, Ethiopia, Mali, and Niger (SZ)	GBIF and POWO	×	×	×	✓
			Gebel Elba (SZ)	Boulos (1999–2005)				

No.	Species	Family	Exclusion region	Reference and website	The present study	Bornkamm and Kehl (1990)	Boulos (1999–2005)	Abd El-Ghani et al. (2017)
284	<i>Periploca aphylla</i> subsp. <i>aphylla</i> Decne.	Apocynaceae	South of Yemen and South of Oman (SZ)	Danin and Fragman-Sapir (2016) and GBIF	×		✓	
285	<i>Persicaria obtusifolia</i> (Täckh. & Boulos) Greuter & Burdet	Polygonaceae			✓		✓	
286	<i>Petrorhagia arabica</i> (Boiss.) P. W. Ball & Heywood	Caryophyllaceae			✓		✓	
287	<i>Phagnalon barbeyanum</i> Asch. & Schweinf.	Asteraceae	Matrouh and Mediterranean coast in Egypt (ME)	Täckholm (1974); Sabri et al. (1992); and Boulos (1999–2005)	×	✓	×	✓
288	<i>Phagnalon nitidum</i> Fresen.	Asteraceae	Ethiopia (SZ)	GBIF	●		✓	
289	<i>Phagnalon sinaicum</i> Bornm. & Kneuck.	Asteraceae			✓		✓	
290	<i>Phlomis aurea</i> Decne.	Lamiaceae			✓		✓	
291	<i>Phoenix dactylifera</i> L.	Arecaceae	Canary Islands (ME)	Boulos (1999–2005); GBIF; and POWO	×	×	×	✓
			Benin, Cape Verde, and Chad (SZ)	Boulos (1999–2005); GBIF; and POWO				
			China (IT)	Boulos (1999–2005); GBIF; and POWO				
292	<i>Picris cyanocarpa</i> Boiss.	Asteraceae	Mediterranean coast in Egypt (ME)	Täckholm (1974)	●		✓	✓
293	<i>Picris sulphurea</i> Delile	Asteraceae			✓		✓	
294	<i>Pimpinella schweinfurthii</i> Asch.	Apiaceae			✓		✓	
295	<i>Pistacia khinjuk</i> Stocks	Anacardiaceae			✓		✓	
296	<i>Plantago amplexicaulis</i> subsp. <i>bauphula</i> (Edgew.) Rech.f.	Plantaginaceae	Spain (ME)	Boulos (1999–2005) and POWO	●		×	×
297	<i>Plantago cylindrica</i> Forssk.	Plantaginaceae	El Arish, Mediterranean coast in Egypt, and the way between Burg El Arab and El Alamin (ME)	CAI (1964) and Boulos (1999–2005)	×		×	✓
298	<i>Plantago sinaica</i> (Barneoud) Decne.	Plantaginaceae			✓		✓	
299	<i>Plicosepalus acaciae</i> (Zucc.) Wiens & Polhill	Loranthaceae	Chad, Eritrea, and Ethiopia (SZ)	Boulos (1999–2005); GBIF; and POWO	×		×	✓

No.	Species	Family	Exclusion region	Reference and website	The present study	Bornkamm and Kehl (1990)	Boulos (1999–2005)	Abd El-Ghani et al. (2017)
300	<i>Plicosepalus curviflorus</i> (Benth. exoliv.) Tiegh	Loranthaceae	Djibouti, Eritrea, Ethiopia, Kenya, Somalia, Sudan, Tanzania, and Uganda (SZ)	GBIF and POWO	×		×	✓
			Gebel Elba (SZ)	Boulos (1999–2005)				
301	<i>Pluchea dioscoridis</i> (L.) DC.	Asteraceae	Angola, Botswana, Burundi, Chad, Djibouti, Eritrea, Ethiopia, Kenya, and Sudan (SZ)	GBIF and POWO	×	✓	×	×
			Lebanon (ME)	Boulos (1999–2005)				
302	<i>Podonosma galalensis</i> Schweinf. ex Boiss.	Boraginaceae			✓		✓	
303	<i>Polycarpaea repens</i> (Forssk.) Asch. & Schweinf.	Caryophyllaceae	Chad, Niger, and Sudan (SZ)	Boulos (1999–2005) and POWO	×	×	×	✓
			Gebel Elba (SZ)	Boulos (1999–2005)				
304	<i>Polycarpaea robbairea</i> (Kuntze) Greuter & Burdet	Caryophyllaceae	Chad, Djibouti, Eritrea, Mali, Niger, Somalia, and Sudan (SZ)	GBIF and POWO	×		×	✓
			Gebel Elba (SZ)	Boulos (1999–2005)				
305	<i>Polycarpon succulentum</i> J.Gay	Caryophyllaceae	Bardawil Lake and Sallum (ME)	El Bana (2009) and Amer et al. (2020)	×	✓	×	
			Lebanon (ME)	Boulos (1999–2005)				
306	<i>Polygala sinaica</i> var. <i>glabrescens</i> (Zohary) Boulos	Polygalaceae			✓		✓	
307	<i>Polygala sinaica</i> var. <i>sinaica</i> Botsch.	Polygalaceae			✓		✓	
308	<i>Evotrochis involucrata</i> Raf.	Primulaceae			✓		✓	
309	<i>Pseuderucaria clavata</i> (Boiss. & Reut.) O.E. Schulz	Brassicaceae	Mediterranean coast in Egypt (ME)	Boulos (1999–2005)	●		×	✓
310	<i>Pseuderucaria teretifolia</i> (Desf.) O. E. Schulz	Brassicaceae			✓	✓	✓	
311	<i>Pteranthus dichotomus</i> Forssk.	Caryophyllaceae	Canary Islands, Cyprus, and Sicilia (ME)	Boulos (1999–2005); GBIF; and POWO	×	×	×	✓
312	<i>Pterocephalus arabicus</i> Boiss.	Caprifoliaceae			✓		✓	
313	<i>Pterocephalus sanctus</i> Decne.	Caprifoliaceae			✓		✓	

No.	Species	Family	Exclusion region	Reference and website	The present study	Bornkamm and Kehl (1990)	Boulos (1999–2005)	Abd El-Ghani et al. (2017)
314	<i>Pulicaria incisa</i> (Lam.) DC.	Asteraceae	Benin, Burkina, Chad, Djibouti, Eritrea, and Ethiopia (SZ) Gebel Elba (SZ)	GBIF and POWO Boulos (1999–2005)	×	×	×	✓
315	<i>Pulicaria sicula</i> (L.) Moris	Asteraceae	Albania, Cyprus, France, Greece, Italy, and Sicilia (ME)	GBIF and POWO	×		✓	
316	<i>Pulicaria undulata</i> (L.) C. A. Mey.	Asteraceae	Benin, Burkina, Cameroon, Cape Verde, Chad, Djibouti, Eritrea, and Ethiopia (SZ)	Boulos (1999–2005); GBIF; and POWO	×	✓	×	✓
317	<i>Pycnocycla tomentosa</i> Decne.	Apiaceae			✓		✓	
318	<i>Reaumuria hirtella</i> Jaub. & Spach	Tamariaceae	Mediterranean coast in Egypt and the northern coastal region of Egypt (ME)	Boulos (1999–2005) and Abozeed (2014)	×	×	×	✓
319	<i>Reaumuria hirtella</i> var. <i>palaestina</i> (Boiss.) Zohary & Danin	Tamariaceae	North of Syria (ME)	GBIF	●		✓	
320	<i>Reaumuria negevensis</i> Zohary & Danin	Tamariaceae			✓		✓	
321	<i>Reseda alba</i> L.	Resedaceae	Albania, Cyprus, France, and Greece (ME) Eritrea (SZ)	Boulos (1999–2005); GBIF; and POWO Boulos (1999–2005); GBIF; and POWO	×		×	✓
322	<i>Reseda arabica</i> Boiss.	Resedaceae	Burg El Arab, El Arish, and Mediterranean coast in Egypt (ME)	Boulos (1999–2005); CAI (2012); and El-Ahmir et al. (2020)	×		×	✓
323	<i>Reseda decursiva</i> Forssk.	Resedaceae	Chile and Spain (ME) Mediterranean coast in Egypt (ME)	GBIF and POWO Boulos (1999–2005)	×	✓	×	✓
324	<i>Reseda muricata</i> C. Presl	Resedaceae			✓		✓	
325	<i>Reseda pruinosa</i> Delile	Resedaceae	Ethiopia and Sudan (SZ) Gebel Elba (SZ) and Mediterranean coast in Egypt (ME)	GBIF and POWO Boulos (1999–2005)	×	✓	×	✓
326	<i>Reseda stenostachya</i> Boiss.	Resedaceae			✓		✓	

No.	Species	Family	Exclusion region	Reference and website	The present study	Bornkamm and Kehl (1990)	Boulos (1999–2005)	Abd El-Ghani et al. (2017)
327	<i>Retama raetam</i> (Forssk.) Webb & Berthel.	Fabaceae	Greece and Sicilia (ME)	GBIF and POWO	×	✓	×	✓
			Sudan (SZ)	GBIF and POWO				
			Mediterranen coast in Egypt (ME)	Boulos (1999–2005)				
328	<i>Rhamnus disperma</i> Ehrenb. ex Boiss.	Rhamnaceae			✓		×	
329	<i>Rhamphospermum arvense</i> (L.) Besser	Brassicaceae	Ibania, Altay, Cyprus, Denmark, France, Gebel Elbarmany, and Greece (ME)	GBIF and POWO	×	✓	×	
			Mediterranen coast in Egypt (ME)	Boulos (1999–2005)				
330	<i>Rhazya greissii</i> Tackh. & Boulos	Apocynaceae			✓		✓	
331	<i>Rhazya stricta</i> Decne.	Apocynaceae	South of Yemen (SZ)	GBIF	●		✓	
332	<i>Rhynchosia minima</i> (L.) DC.	Fabaceae	Angola, Benin, and Botswana (SZ)	Boulos (1999–2005); GBIF; and POWO	×		×	✓
333	<i>Robeschia schimperi</i> (Boiss.) O. E. Schulz	Brassicaceae	Central Iran and Syria (IT)	GBIF	×		✓	
334	<i>Rosa arabica</i> (Crép. ex Boiss.) Déségl.	Rosaceae			✓		✓	
335	<i>Rostraria rohlfsii</i> (Asch.) Holub	Poaceae	Chad and Niger (SZ)	GBIF and POWO	×		✓	
336	<i>Rumex aegyptiacus</i> L.	Polygonaceae	France (ME)	GBIF	×		✓	
			Burg El Arab and Mediterranean coast in Egypt (ME)	El-Khalafy et al. (2021 a, b) and Balah and Hozyan (2022)				
337	<i>Rumex cyprius</i> Murb	Polygonaceae	Cyprus (ME)	Boulos (1999–2005); GBIF; and POWO	×	×	×	✓
			Mediterranen coast in Egypt (ME)	Boulos (1999–2005)				
338	<i>Rumex dentatus</i> L.	Polygonaceae	Albania, Bulgaria, Cyprus, and Greece (ME)	GBIF and POWO	×	×	×	✓
			China (IT)	GBIF and POWO				
			Mediterranen coast in Egypt (ME)	Boulos (1999–2005)				
339	<i>Rumex pictus</i> Forssk.	Polygonaceae	Mediterranen coast in Egypt and Rosetta (ME)	Danin and Fragman-Sapir (2016); Abd El-Aal et al. (2019); and GBIF	×		✓	

No.	Species	Family	Exclusion region	Reference and website	The present study	Bornkamm and Kehl (1990)	Boulos (1999–2005)	Abd El-Ghani et al. (2017)
340	<i>Rumex simpliciflorus</i> Murb.	Polygonaceae	Chad and Sudan (SZ)	GBIF and POWO	×		×	✓
			Gebel Elba (SZ)	Boulos (1999–2005)				
341	<i>Salvadora persica</i> L.	Salvadoraceae	Angola, Botswana, Burkina, Chad, Djibouti, Eritrea, Ethiopia, Kenya, Malawi, Mali, Mozambique, Namibia, and Niger (SZ)	GBIF and POWO	×		×	✓
			Gebel Elba (SZ)	Boulos (1999–2005) and Abd El-Ghani et al. (2017)				
342	<i>Salvia aegyptiaca</i> L.	Lamiaceae	Chad, Eritrea, Mali, and Niger (SZ)	Boulos (1999–2005); GBIF; and POWO	×	✓	×	×
			Canary Islands (ME)	Boulos (1999–2005); GBIF; and POWO				
			Gebel Elba (SZ) and Mediterranean coast in Egypt (ME)	Boulos (1999–2005) and Abd El-Ghani et al. (2017)				
343	<i>Salvia deserti</i> Decne.	Lamiaceae			✓		✓	
344	<i>Savignya parviflora</i> (Delile) Webb	Brassicaceae	El Dabaa (ME)	CAI (2021)	●		✓	✓
			East of Iran (IT)	Osman et al. (2014) and Flora of Libya				
345	<i>Scabiosa eremophila</i> Boiss.	Caprifoliaceae	Mediterranean coast in Egypt and Omayed (ME)	Boulos (1999–2005) and Ahmed et al. (2015)	●		×	
346	<i>Schimpera arabica</i> Hochst. & Steud.	Brassicaceae			✓	✓	✓	✓
347	<i>Schouwia purpurea</i> (Forssk.) Schweinf.	Brassicaceae	Burkina, Chad, Djibouti, Ethiopia, Mali, and Niger (SZ)	Alyasi (2020); GBIF; and POWO (2023)	×	✓	×	✓
			Gebel Elba (SZ) and Mediterranean coast in Egypt (ME)	Boulos (1999–2005)				
348	<i>Scorzonera drarii</i> V.Tackh.	Asteraceae			✓		✓	
349	<i>Scorzonera schweinfurthii</i> Boiss.	Asteraceae			✓		✓	
350	<i>Scrophularia deserti</i> Delile	Scrophulariaceae			✓		✓	✓

Continued

No.	Species	Family	Exclusion region	Reference and website	The present study	Bornkamm and Kehl (1990)	Boulos (1999–2005)	Abd El-Ghani et al. (2017)
351	<i>Scrophularia hypericifolia</i> Wydler	Scrophulariaceae	North of Iran (IT)	Feyzi et al. (2014); Veiskarami and Sharifi-Tehrani (2017); and GBIF	×		✓	
352	<i>Senecio aegyptius</i> L.	Asteraceae	Ethiopia and Sudan (SZ)	Boulos (1999–2005); GBIF; and POWO	×	✓	×	
			Cyprus (ME)	Boulos (1999–2005); GBIF; and POWO				
353	<i>Senecio belbeysius</i> Delile	Asteraceae			✓		✓	
354	<i>Senecio flavus</i> (Decne.) Sch. Bip	Asteraceae	Canary Islands and Spain (ME)	Boulos (1999–2005); GBIF; and POWO	×		×	✓
			Chad, Namibia, and Sudan (SZ)	Boulos (1999–2005); GBIF; and POWO				
			Gebel Elba (SZ)	Boulos (1999–2005)				
355	<i>Senna holosericea</i> (Freseu) Greuter	Fabaceae	Chad, Djibouti, Eritrea, Ethiopia, Somalia, and Sudan (SZ)	Boulos (1999–2005); GBIF; and POWO	×		×	✓
			Gebel Elba (SZ)	Boulos (1999–2005)				
356	<i>Senna italica</i> Mill.	Fabaceae	Benin (SZ)	Boulos (1999–2005); GBIF; and POWO	×	×	×	✓
			Colombia and Jamaica (ES)	Boulos (1999–2005); GBIF; and POWO				
			Gebel Elba (SZ)	Boulos (1999–2005) and Abd El-Ghani et al. (2017)				
357	<i>Setaria verticillata</i> (L.) P.Beauv.	Poaceae	Angola, Bangladesh, Benin, Botswana, Bulgaria, Burkina, Burundi, Cambodia, and Cameroon (SZ)	Boulos (1999–2005); GBIF; and POWO	×	✓	×	×
358	<i>Silene arabica</i> Boiss.	Caryophyllaceae			✓		✓	×
359	<i>Silene hussonii</i> Boiss.	Caryophyllaceae			✓		✓	
360	<i>Silene leucophylla</i> Boiss.	Caryophyllaceae			✓		✓	
361	<i>Silene linearis</i> Decne.	Caryophyllaceae			✓		✓	✓
362	<i>Silene odontopetala</i> var. <i>congesta</i> Boiss.	Caryophyllaceae			✓		✓	
363	<i>Silene oreosinaica</i> Chowdhuri	Caryophyllaceae			✓		✓	
364	<i>Silene schimperiana</i> Boiss.	Caryophyllaceae			✓		✓	

To be continued

No.	Species	Family	Exclusion region	Reference and website	The present study	Bornkamm and Kehl (1990)	Boulos (1999–2005)	Abd El-Ghani et al. (2017)
365	<i>Silene villosa</i> var. <i>graveolens</i> Sickenb.	Caryophyllaceae			✓		✓	
366	<i>Silene vivianii</i> subsp. <i>viscida</i> (Boiss.) Boulos	Caryophyllaceae			✓		✓	
367	<i>Silene vivianii</i> subsp. <i>vivianii</i> Steud.	Caryophyllaceae	Mediterranean coast in Egypt (ME)	Boulos (1999–2005)	×		×	✓
368	<i>Sida schweinfurthii</i> (Solms) Akhani	Amaranthaceae	Mediterranean coast in Egypt (ME)	Boulos (1999–2005)	●	✓	×	
369	<i>Solenostemma oleifolium</i> (Nectoux) Bullock & E. A. Bruce	Apocynaceae	Chad, Mali, Niger, and Sudan (SZ)	GBIF and POWO	×		×	✓
370	<i>Sporobolus spicatus</i> (Vahl) Kunth	Poaceae	Angola, Botswana, Burundi, Chad, Djibouti, Eritrea, and Ethiopia (SZ) Mediterranean coast in Egypt (ME) and SZ	Boulos (1999–2005); GBIF; and POWO Abd El-Ghani et al. (2017)	×	✓	×	×
371	<i>Stachys aegyptiaca</i> Pers.	Lamiaceae			✓		✓	✓
372	<i>Stipagrostis drarii</i> (Tackh.) de Winter	Poaceae			✓		✓	
373	<i>Stipagrostis multinerva</i> H. Scholz	Poaceae	East of Iran (IT)	GBIF	●		✓	
374	<i>Stipagrostis plumosa</i> (L.) Munro ex T. Anderson	Poaceae	Chad, Cyprus, Mali, and Niger (SZ) Gebel Elba (SZ) and Mediterranean coast in Egypt (ME)	GBIF and POWO Boulos (1999–2005)	×	✓	×	×
375	<i>Stipagrostis vulnerans</i> (Trin. & Rupr.) De Winter	Poaceae	Chad, Mali, Niger, and Sudan (SZ)	Boulos (1999–2005); GBIF; and POWO	×	✓	×	
376	<i>Suaeda aegyptiaca</i> (Hasselq.) Zohary	Amaranthaceae	Djibouti and Eritrea (SZ) Cyprus (ME)	Boulos (1999–2005); GBIF; and POWO Boulos (1999–2005); GBIF; and POWO	×	✓	×	✓
377	<i>Suaeda fruticosa</i> Forssk. ex J. F. Gmel.	Amaranthaceae	Italy (ME) Somalia (SZ) Mexico (ES)	GBIF GBIF GBIF	×	✓	×	
378	<i>Suaeda monoica</i> Forssk. ex J. Gmelin	Amaranthaceae	Botswana, Chad, Djibouti, Eritrea, and Ethiopia (SZ)	Boulos (1999–2005); GBIF; and POWO	×	✓	×	×

No.	Species	Family	Exclusion region	Reference and website	The present study	Bornkamm and Kehl (1990)	Boulos (1999–2005)	Abd El-Ghani et al. (2017)
379	<i>Suaeda vermiculata</i> Forssk. ex J.F.Gme	Amaranthaceae	Chad, Djibouti, and Eritrea (SZ)	GBIF and POWO	×	×	×	✓
			Mediterranen coast in Egypt (ME)	Boulos (1999–2005)				
380	<i>Tamarix amplexicaulis</i> Ehrenb.	Tamaricaceae	Chad, Mali, and Sudan (SZ)	Boulos (1999–2005); GBIF; and POWO	×	✓	×	
381	<i>Tamarix aphylla</i> (L.) H. Karst	Tamaricaceae	Chad, Djibouti, Eritrea, Ethiopia, and Niger (SZ)	GBIF and POWO	×	✓	×	✓
			Gebel Elba (SZ) and Mediterranean coast in Egypt (ME)	Boulos (1999–2005)				
382	<i>Tamarix nilotica</i> (Ehrenb.) Bunge	Tamaricaceae	Chad, Djibouti, Eritrea, and Ethiopia (SZ)	GBIF and POWO	×	✓	×	×
			Greece (ME)	GBIF and POWO				
			Gebel Elba (SZ) and Mediterranean coast in Egypt (ME)	Boulos (1999–2005)				
383	<i>Tamarix passerinoides</i> Delile ex Decne.	Tamaricaceae	Turkmenistan and Russia (IT)	Boulos (1999–2005); GBIF; and POWO	×	✓	×	
			Sudan (SZ)	GBIF and POWO				
			Mediterranen coast in Egypt (ME)	Boulos (1999–2005)				
384	<i>Tamarix tetragyna</i> Ehrenb.	Tamaricaceae	Cyperus (ME)	POWO	×	✓	×	×
			Mediterranen coast in Egypt (ME)	Boulos (1999–2005)				
			Russia (IT)	Abd El-Ghani et al. (2017)				
385	<i>Tanacetum sinaicum</i> (Fresen.) Delile ex K.Bremer & Humphries	Asteraceae			✓		✓	
386	<i>Taverniera aegyptiaca</i> Boiss.	Fabaceae	Eritrea and Sudan (SZ)	GBIF and POWO	×		✓	✓
			Mediterranen coast in Egypt (ME)	Täckholm (1974)				
387	<i>Telephium sphaerospermum</i> Boiss.	Caryophyllaceae	Somalia, South of Yemen (SZ)	GBIF and POWO	●	✓	✓	
388	<i>Tephrosia kassasii</i> Boulos	Fabaceae			✓		✓	
389	<i>Tephrosia purpurea</i> subsp. <i>apollinea</i> (Delile) Hosni & El-Karemy	Fabaceae	Chad, Djibouti, Eritrea, and Somalia (SZ)	GBIF and POWO	×	✓	×	✓
			Gebel Elba (SZ)	Boulos (1999–2005)				

No.	Species	Family	Exclusion region	Reference and website	The present study	Bornkamm and Kehl (1990)	Boulos (1999–2005)	Abd El-Ghani et al. (2017)
390	<i>Tephrosia purpurea</i> subsp. <i>leptostachya</i> (DC.) Brummitt	Fabaceae	Angola, Benin, Botswana, Burkina, Burundi, Cameroon, Tropical Africa (SZ)	Boulos (1999–2005); GBIF; and POWO	×		×	✓
391	<i>Teucrium decaisnei</i> C. Presl	Lamiaceae			✓		✓	
392	<i>Teucrium leucocladum</i> Boiss.	Lamiaceae			✓		✓	
393	<i>Teucrium polium</i> L.	Lamiaceae	France, Morocco, and Spain (ME)	GBIF and POWO	×	×	×	✓
			Mediterranen coast in Egypt (ME)	Boulos (1999–2005)				
394	<i>Thymelaea hirsuta</i> (L.) Endl	Thymelaeaceae	Balears, Cyprus, France, Greece, and Italy (ME)	GBIF and POWO	×	×	×	✓
			Mediterranen coast in Egypt (ME)	Abd El-Ghani et al. (2017)				
395	<i>Thymus bovei</i> Benth.	Lamiaceae			✓		✓	
396	<i>Thymus decussatus</i> Benth.	Lamiaceae			✓		✓	
397	<i>Traganum nudatum</i> Delile	Amaranthaceae	Matrouh and Mediterranean coast in Egypt (ME)	Boulos (1999–2005) and El-Bassossy (2022)	●	✓	×	✓
398	<i>Tragopogon collinus</i> DC.	Asteraceae	Armenia and Kazakhstan (IT)	GBIF and POWO	×		✓	
399	<i>Tribulus kaiseri</i> Hosni	Zygophyllaceae			✓		✓	
400	<i>Tribulus megistopterus</i> Kralik	Zygophyllaceae	Chad and Sudan (SZ)	GBIF and POWO	×		×	✓
			Gebel Elba (SZ)	Boulos (1999–2005)				
401	<i>Trifolium alexandrinum</i> L	Fabaceae	Bulgaria, Greece, Hungary, and Kriti (ME) and Nepal and China (IT)	GBIF and POWO	×		×	✓
			Mediterranen coast in Egypt (ME)	Boulos (1999–2005)				
402	<i>Trigonella glabra</i> Thunb.	Fabaceae	Djibouti and Sudan (SZ)	GBIF and POWO	×	✓	×	
			Mediterranen coast in Egypt (ME)	Boulos (1999–2005)				
403	<i>Trigonella media</i> Delile ex Urb.	Fabaceae			✓		✓	
404	<i>Trigonella schlumbergeri</i> Boiss.	Fabaceae			✓		×	

No.	Species	Family	Exclusion region	Reference and website	The present study	Bornkamm and Kehl (1990)	Boulos (1999–2005)	Abd El-Ghani et al. (2017)
405	<i>Tripleurospermum auriculatum</i> (Boiss.) Rech.f.	Asteraceae	West of Syria and west of Lebanon (IT)	Boulos (1999–2005) and GBIF	●		×	
406	<i>Vachellia flava</i> (Forssk.) Kyal. & Boatwr.	Fabaceae	Benin, Burkina, Cameroon, Central African Republic, and Chad (SZ)	Boulos (1999–2005); GBIF; and POWO	×	×	×	✓
407	<i>Vachellia gerrardi</i> var. <i>najdensis</i> (Chaudhary) Ragup., Seigler, Ebinger & Maslin	Fabaceae	South of Yemen and south of Oman (SZ)	GBIF	●		✓	
408	<i>Vachellia tortilis</i> subsp. <i>raddiana</i> (Savi) Kyal. & Boatwr	Fabaceae	Burkina, Chad, Eritrea, Ethiopia, and Kenya (SZ)	Boulos (1999–2005); GBIF; and POWO	×	×	×	✓
409	<i>Verbascum decaisneanum</i> Kuntze	Scrophulariaceae			✓		✓	
410	<i>Verbascum eremobium</i> Murb.	Scrophulariaceae	Centre of Jordan (IT)	Danin and Fragman-Sapir (2016)	●		✓	
411	<i>Verbascum fruticosum</i> Post & Autran	Scrophulariaceae			✓		✓	
412	<i>Verbascum schimperianum</i> Boiss.	Scrophulariaceae			✓		✓	
413	<i>Veronica anagalloides</i> subsp. <i>taeckholmiorum</i> Chrtek & Osb.-Kos.	Plantaginaceae	El Beheira, El-Mahmudia, and Egypt (ME)	CAI (1970)	●		✓	
414	<i>Veronica kaiseri</i> Tackh.	Plantaginaceae			✓		✓	
415	<i>Vicia sinaica</i> Boulos	Fabaceae	Arish (ME)	El-Khalafy et al. (2021 a, b, 2024) and Bedair et al. (2023)	×		✓	
416	<i>Volutaria sinaica</i> (DC.) Wagenitz	Asteraceae	Chad (SZ) Gebel Elba (SZ)	GBIF and POWO Boulos (1999–2005)	●		×	
417	<i>Zilla spinosa</i> subsp. <i>biparmata</i> (O.E.Schulz) Maire & Weiller	Brassicaceae	Mediterranean coast in Egypt (ME)	Greuter et al. (1984, 1986, 1989); Boulos (1999–2005); and Greuter and von Raab-Straube (2008)	●	✓	×	✓
418	<i>Zilla spinosa</i> subsp. <i>spinosa</i> (L.) Prantl	Brassicaceae	Gebel Elba (SZ)	Boulos (1999–2005)	●	✓	×	✓
419	<i>Ziziphus nummularia</i> (Burm.f.) Wight & Arn.	Rhamnaceae	Southwest of Saudi Arabia (SZ) North of Pakistan, centre of Iran (IT)	Danin and Fragman-Sapir (2016) Rauf et al. (2016)	●		✓	

No.	Species	Family	Exclusion region	Reference and website	The present study	Bornkamm and Kehl (1990)	Boulos (1999–2005)	Abd El-Ghani et al. (2017)
420	<i>Ziziphus spina-christi</i> (L.) Desf.	Rhamnaceae	Burkina, Cameroon, Chad, Cyprus, Djibouti, Eritrea, Ethiopia, and Ghana (SZ)	GBIF and POWO	×		×	✓
			Gebel Elba (SZ) and Mediterranean coast in Egypt (ME)	Boulos (1999–2005)				
421	<i>Zygophyllum arabicum</i> (L.) Christenh. & Byng	Zygophyllaceae	Chad, Mali, Niger, and Sudan (SZ)	Baayo (2008); GBIF; and POWO	×		×	✓
422	<i>Zygophyllum bruguieri</i> (DC.) Christenh. & Byng	Zygophyllaceae	Chad, Eritrea, Mali, Niger, Senegal, Somalia, and Sudan (SZ)	GBIF and POWO	×		×	✓
			Gebel Elba (SZ) and Mediterranean coast in Egypt (ME)	Boulos (1999–2005)				
423	<i>Zygophyllum coccineum</i> L.	Zygophyllaceae	Eritrea and Sudan (SZ)	Boulos (1999–2005); GBIF; and POWO	●		×	✓
424	<i>Zygophyllum decumbens</i> Delile	Zygophyllaceae	Namibia, Somalia, south of Oman, Sudan (SZ)	Boulos (1999–2005); GBIF; and POWO	×		×	✓
425	<i>Zygophyllum dumosum</i> Boiss.	Zygophyllaceae			✓		✓	
426	<i>Zygophyllum glutinosum</i> (Delile) Christenh. & Byng	Zygophyllaceae	Chad, Mali, NiGebel Elbar, and Sudan (SZ)	Flora of Libya and POWO	×		×	✓
			Mediterranean coast in Egypt (ME)	Boulos (1999–2005)				
427	<i>Zygophyllum indicum</i> (Burm.f.) Christenh. & Byng	Zygophyllaceae	Chad, Djibouti Eritrea, Ethiopia, Kenya, Mali, and Niger (SZ)	Boulos (1999–2005); GBIF; and POWO	×		×	✓
428	<i>Zygophyllum molle</i> (Delile) Christenh. & Byng	Zygophyllaceae			✓		✓	✓
429	<i>Zygophyllum scabrum</i> (Forssk.) Christenh. & Byng	Zygophyllaceae			✓		✓	✓

Note: × refers to the excluded species (surely non-Saharo-Arabian endemics), ✓ refers to the included species (surely Saharo-Arabian endemics), and ● refers to the extended species (species mainly distributed in Saharo-Arabian region but having extensions to neighbouring areas). SA, Saharo-Arabian region; IT, Irano-Turanian region; ME, Mediterranean region; SZ, Sudano-Zambezian region; ES, Euro-Siberian region. The manuscript also referred to Cairo University Herbarium (CAI), Agriculture Museum Herbarium (CAIM), and Tanta University Herbarium (TANE).

Table S2 Distribution of the Saharo-Arabian endemic plants in the Saharo-Arabian countries

Species	Country																				Total	Disrtibution area		
	Eg	SA	Ku	Ba	Qa	UAE	Ye	Om	Irq	Irn	Pak	Af	Jo	Pal	Sy	Li	Tu	Al	Mo	Ma			In	
Amaranthaceae																								
<i>Agathophora alopecuroides</i> var. <i>alopecuroides</i> (Delile) Fenzl ex Bunge	✓	✓	✓		✓					✓	✓	✓		✓	✓	✓	✓	✓	✓				14	SS1, SS2, and SS3
<i>Agathophora alopecuroides</i> var. <i>papillosa</i> (Maire) Boulos	✓	✓	✓		✓					✓	✓	✓		✓	✓	✓	✓	✓	✓				14	SS1, SS2, and SS3
<i>Haloxylon negevensis</i> (Ijtin & Zohary) Boulos	✓													✓									2	SS1 and SS2
Amaryllidaceae																								
<i>Allium decaisnei</i> C.Presl	✓																						2	SS1 and SS2
<i>Allium rothii</i> Zucc.	✓													✓	✓								3	SS1 and SS2
<i>Allium sinaïticum</i> Boiss.	✓	✓												✓	✓								4	SS1 and SS2
Anacardiaceae																								
<i>Pistacia khinjuk</i> Stocks	✓	✓																					2	SS1 and SS2
Apiaceae																								
<i>Daucus sahariensis</i> Murb.	✓																✓	✓	✓	✓			5	SS1
<i>Ducrosia ismaelis</i> Asch.	✓	✓																					2	SS1 and SS2
<i>Pimpinella schweinfurthii</i> Asch.	✓	✓				✓		✓															4	SS1 and SS2
<i>Pycnocycla tomentosa</i> Decne.	✓	✓																					3	SS1 and SS2
Apocynaceae																								
<i>Gomphocarpus sinaicus</i> (Boiss.)	✓	✓					✓							✓	✓								5	SS1 and SS2
<i>Rhazya greissii</i> Tackh. & Boulos	✓																						1	SS1

To be continued

Continued

Species	Country																				Total	Distrtbution area		
	Eg	SA	Ku	Ba	Qa	UAE	Ye	Om	Irq	Irn	Pak	Af	Jo	Pal	Sy	Li	Tu	Al	Mo	Ma			In	
Asparagaceae																								
<i>Bellevalia desertorum</i> Eig & Feinbrun	✓													✓	✓								3	SS1 and SS2
<i>Bellevalia flexuosa</i> var. <i>galalensis</i> Tackh. & Drar	✓																						1	SS1
<i>Bellevalia zoharyi</i> Feinbrun	✓													✓	✓								3	SS1 and SS2
<i>Muscari longipes</i> subsp. <i>negevense</i> (Feinbrun & Danin)	✓													✓	✓								3	SS1 and SS2
Asphodelaceae																								
<i>Asphodelus refractus</i> Boiss.	✓	✓												✓	✓		✓	✓	✓	✓	✓		9	SS1 and SS2
Asteraceae																								
<i>Anthemis scrobicularis</i> Yavin	✓	✓												✓	✓								4	SS1 and SS2
<i>Anvillea garcinii</i> (Burm.f.) DC.	✓	✓	✓			✓	✓		✓	✓				✓	✓		✓		✓	✓	✓		13	SS1, SS2, and SS3
<i>Atractylis boulosii</i> Tackh.	✓														✓								2	SS1 and SS2
<i>Atractylis mernepthae</i> Asch. & Schweinf. & Letourn.	✓	✓							✓					✓	✓			✓	✓				7	SS1 and SS2
<i>Centaurea scoparia</i> Sieber ex Spreng	✓	✓												✓	✓								4	SS1 and SS2
<i>Centaurea sinaica</i> DC.	✓	✓	✓			✓	✓		✓	✓				✓	✓	✓							10	SS1 and SS2
<i>Chiliadenus montanus</i> (Vahl) Brullo	✓	✓										1		✓	✓								5	SS1, SS2, and SS3
<i>Crepis nigricans</i> Viv.	✓																✓	✓	✓				4	SS1
<i>Echinops glaberrimus</i> DC.	✓	✓												✓	✓								4	SS1 and SS2

To be continued

Continued

Species	Country																				Total	Disrtibution area		
	Eg	SA	Ku	Ba	Qa	UAE	Ye	Om	Irq	Irn	Pak	Af	Jo	Pal	Sy	Li	Tu	Al	Mo	Ma			In	
<i>Iphiona mucronata</i> (Forssk.) Asch. & Schweinf.	✓	✓												✓	✓								4	SS1 and SS2
<i>Launaea spinosa</i> (Forssk.) Sch. Bip. Ex Kuntze	✓	✓					✓	✓						✓	✓								6	SS1 and SS2
<i>Phagnalon sinaicum</i> Bornm. & Kneuck.	✓	✓												✓	✓								4	SS1 and SS2
<i>Picris sulphurea</i> Delile	✓	✓																					2	SS1 and SS2
<i>Scorzonera drarii</i> Tackh.	✓																						1	SS1
<i>Scorzonera schweinfurthii</i> Boiss.	✓	✓							✓					✓	✓								5	SS1 and SS2
<i>Senecio belbeysius</i> Delile	✓																						1	SS1
<i>Tanacetum sinaicum</i> (Fresen.) Delile ex K. Bremer & Humphries	✓	✓												✓	✓								4	SS1 and SS2
Boraginaceae																								
<i>Arnebia tinctoria</i> (Forssk.)	✓	✓	✓						✓					✓	✓			✓					7	SS1 and SS2
<i>Podonosma galalensis</i> Schweinf. ex Boiss.	✓													✓	✓								3	SS1 and SS2
Brassicaceae																								
<i>Crucihimalaya kneuckeri</i> (Bornm.) Al-Shehbaz, O'Kane & R. A. Price	✓	✓																					2	SS1 and SS2
<i>Eremobium aegyptiacum</i> var. <i>lineare</i> (Delile) Zohary	✓	✓												✓	✓								4	SS1 and SS2
<i>Matthiola arabica</i> Boiss.	✓	✓	✓											✓	✓								5	SS1 and SS2
<i>Pseuderucaria teretifolia</i> (Desf.) O. E. Schulz	✓																✓	✓	✓	✓			5	SS1
<i>Schimpera arabica</i> Hochst. & Steud.	✓	✓	✓			✓			✓	✓				✓	✓	✓							9	SS1, SS2, and SS3

To be continued

Continued

Species	Country																			Total	Distrtbution area		
	Eg	SA	Ku	Ba	Qa	UAE	Ye	Om	Irq	Irn	Pak	Af	Jo	Pal	Sy	Li	Tu	Al	Mo			Ma	In
Campanulaceae																							
<i>Campanula dulcis</i> Decne.	✓	✓					✓						✓									4	SS1 and SS2
Caprifoliaceae																							
<i>Pterocephalus arabicus</i> Boiss.	✓												✓									2	SS1 and SS2
<i>Pterocephalus sanctus</i> Decne.	✓	✓											✓	✓								4	SS1 and SS2
Caryophyllaceae																							
<i>Bufonia multiceps</i> Decne.	✓																					1	SS1
<i>Dianthus guessfeldtianus</i> Muschl.	✓																					1	SS1
<i>Dianthus monadelphus</i> subsp. <i>judaicus</i> (Boiss.) Greuter & Burdet	✓	✓							✓				✓	✓								5	SS1 and SS2
<i>Dianthus sinaicus</i> Boiss.	✓	✓											✓	✓								4	SS1 and SS2
<i>Eremogone sinaica</i> (Boiss.) Dillenb. & Kadereit	✓													✓								2	SS1 and SS2
<i>Paronychia sinaica</i> Fresen.	✓	✓											✓	✓								4	SS1 and SS2
<i>Petrorhagia arabica</i> (Boiss.) P.W. Ball & Heywood	✓												✓	✓								3	SS1 and SS2
<i>Silene arabica</i> Boiss.	✓	✓	✓		✓	✓	✓		✓	✓		✓	✓	✓								11	SS1, SS2, and SS3
<i>Silene hussonii</i> Boiss.	✓	✓											✓	✓								4	SS1 and SS2
<i>Silene leucophylla</i> Boiss.	✓																					1	SS1
<i>Silene linearis</i> Decne.	✓	✓				✓			✓				✓	✓								6	SS1 and SS2
<i>Silene odontopetala</i> var. <i>congesta</i> Boiss.	✓									✓												2	SS1 and SS3
<i>Silene oreosinaica</i> Chowdhuri	✓																					1	SS1

To be continued

Continued

Species	Country																				Total	Distribution area	
	Eg	SA	Ku	Ba	Qa	UAE	Ye	Om	Irq	Irn	Pak	Af	Jo	Pal	Sy	Li	Tu	Al	Mo	Ma			In
<i>Silene schimperiana</i> Boiss.	✓																					1	SS1
<i>Silene villosa</i> var. <i>graveolens</i> Sickenb.	✓																					1	SS1
<i>Silene vivianii</i> subsp. <i>viscida</i> (Boiss.) Boulos	✓								✓	✓												3	SS1, SS2, and SS3
Cistaceae																							
<i>Helianthemum sancti-antoni</i> Schweinf. ex Boiss.	✓	✓												✓	✓							4	SS1 and SS2
<i>Helianthemum schweinfurthii</i> Grosser	✓																					1	SS1
<i>Helianthemum ventosum</i> Boiss.	✓	✓												✓	✓							4	SS1 and SS2
Colchicaceae																							
<i>Colchicum guessfeldtianum</i> Asch. & Schweinf.	✓	✓																				2	SS1 and SS2
Convolvulaceae																							
<i>Convolvulus schimperi</i> Boiss.	✓													✓								2	SS1 and SS2
<i>Convolvulus spicatus</i> Peter ex Hallier f.	✓	✓											✓	✓	✓							5	SS1, SS2, and SS3
Ephedraceae																							
<i>Ephedra pachyclada</i> subsp. <i>sinaica</i> (Riedl) Freitag & Maier-St	✓	✓						✓						✓	✓							5	SS1 and SS2
Euphorbiaceae																							
<i>Euphorbia obovata</i> Decne.	✓									✓					✓						✓	4	SS1, SS2, and SS3
Fabaceae																							
<i>Argyrolobium saharae</i> Pomel	✓																		✓	✓		3	SS1

To be continued

Continued

Species	Country																				Total	Distribution area			
	Eg	SA	Ku	Ba	Qa	UAE	Ye	Om	Irq	Irn	Pak	Af	Jo	Pal	Sy	Li	Tu	Al	Mo	Ma			In		
<i>Astragalus amalecitanus</i> Boiss.	✓													✓									2	SS1 and SS2	
<i>Astragalus dactylocarpus</i> subsp. <i>acinaciferus</i> (Boiss.) E. Ott	✓	✓	✓						✓	✓		✓	✓	✓									8	SS1, SS2, and SS3	
<i>Astragalus fresenii</i> Decne	✓																						1	SS1	
<i>Astragalus intercedens</i> Sam. ex Rech.f.	✓	✓												✓	✓								5	SS1 and SS2	
<i>Astragalus sanctus</i> Boiss.	✓													✓	✓	✓							4	SS1 and SS2	
<i>Astragalus schimperi</i> Boiss.	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓						15	SS1, SS2, and SS3	
<i>Astragalus sparsus</i> Decne	✓	✓						✓						✓	✓								5	SS1 and SS2	
<i>Lotus lanuginosus</i> Vent.	✓	✓							✓					✓	✓	✓							6	SS1 and SS2	
<i>Melilotus serratifolius</i> Tackh. & Boulos	✓																						1	SS1	
<i>Tephrosia kassasii</i> Boulos	✓																						1	SS1	
<i>Trigonella media</i> Delile ex Urb.	✓																						1	SS1	
<i>Trigonella schlumbergeri</i> Boiss.	✓																						1		
Gentianaceae																									
<i>Centaurium malzacianum</i> Maire	✓	✓																					2	SS1 and SS2	
Hypericaceae																									
<i>Hypericum sinaicum</i> Hochst. ex Boiss.	✓	✓												✓	✓								4	SS1 and SS2	
Lamiaceae																									
<i>Ballota kaiseri</i> Tackh.	✓																						1	SS1	
<i>Lavandula atriplicifolia</i> Benth.	✓	✓						✓															3	SS1 and SS2	

To be continued

Continued

Species	Country																			Total	Disrtibution area				
	Eg	SA	Ku	Ba	Qa	UAE	Ye	Om	Irq	Irn	Pak	Af	Jo	Pal	Sy	Li	Tu	Al	Mo			Ma	In		
<i>Micromeria serbaliana</i> (Danin & Hedge)	✓																						1	SS1	
<i>Micromeria sinaica</i> (Benth.) Briq.	✓													✓	✓									3	SS1 and SS2
<i>Nepeta septemcrenata</i> Ehrenb. ex Benth.	✓	✓												✓	✓									4	SS1 and SS2
<i>Origanum isthmicum</i> Danin	✓														✓									2	SS1 and SS2
<i>Origanum syriacum</i> subsp. <i>sinaicum</i> (Boiss.) Greuter & Burdet	✓																							1	SS1
<i>Phlomis aurea</i> Decne.	✓													✓										2	SS1 and SS2
<i>Salvia deserti</i> Decne.	✓	✓												✓	✓									4	SS1 and SS2
<i>Stachys aegyptiaca</i> Pers.	✓	✓												✓	✓									4	SS1 and SS2
<i>Teucrium decaisnei</i> C. Presl	✓														✓		✓							3	SS1 and SS2
<i>Teucrium leuocladum</i> Boiss.	✓	✓												✓	✓									4	SS1 and SS2
<i>Thymus bovei</i> Benth.	✓	✓												✓	✓									4	SS1 and SS2
<i>Thymus decussatus</i> Benth.	✓	✓													✓									3	SS1 and SS2
Molluginaceae																									
<i>Glinus runkewitzii</i> Tackh. & Boulos	✓																							1	SS1
Plantaginaceae																									
<i>Anarrhinum forskaohlii</i> subsp. <i>pubescens</i> D.A.Sutton	✓																							1	SS1
<i>Plantago sinaica</i> (Barneoud) Decne.	✓													✓	✓									3	SS1 and SS2
<i>Veronica kaiseri</i> Tackh.	✓													✓										2	SS1 and SS2

To be continued

Continued

Species	Country																				Total	Distribution area		
	Eg	SA	Ku	Ba	Qa	UAE	Ye	Om	Irq	Irn	Pak	Af	Jo	Pal	Sy	Li	Tu	Al	Mo	Ma			In	
Poaceae																								
<i>Stipagrostis drarii</i> (Tackh.) De Winter	✓	✓	✓				✓	✓	✓					✓	✓								8	SS1 and SS2
Polygalaceae																								
<i>Polygala sinaica</i> var. <i>glabrescens</i> (Zohary) Boulos	✓	✓												✓	✓								4	SS1 and SS2
<i>Polygala sinaica</i> var. <i>sinaica</i> Botsch.	✓																						1	SS1
Polygonaceae																								
<i>Atraphaxis spinosa</i> var. <i>sinaica</i> (Jaub. & Spach) Boiss.	✓	✓																					3	SS1 and SS2
<i>Persicaria obtusifolia</i> (Täckh. & Boulos) Greuter & Burdet	✓																						1	SS1
Primulaceae																								
<i>Evotrochis involucrata</i> Raf.	✓																						1	SS1
Resedaceae																								
<i>Reseda muricata</i> C. Presl	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓								12	SS1, SS2, and SS3
<i>Reseda stenostachya</i> Boiss.	✓													✓	✓								3	SS1 and SS2
Rhamnaceae																								
<i>Rhamnus disperma</i> Ehrenb. ex Boiss.	✓	✓												✓	✓								4	SS1 and SS2
Rosaceae																								
<i>Cotoneaster orbicularis</i> Schltld.	✓	✓						✓					✓										4	SS1, SS2, and SS3
<i>Rosa arabica</i> (Crép. ex Boiss.) Déségl.	✓																						1	SS1

To be continued

Continued

Species	Country																				Total	Distrtibution area		
	Eg	SA	Ku	Ba	Qa	UAE	Ye	Om	Irq	Irn	Pak	Af	Jo	Pal	Sy	Li	Tu	Al	Mo	Ma			In	
Rubiaceae																								
<i>Crucianella ciliata</i> Lam.	✓	✓							✓	✓			✓	✓									6	SS1, SS2, and SS3
<i>Galium sinaicum</i> (Delile ex Decne) Boiss.	✓	✓											✓	✓									4	SS1 and SS2
Rutaceae																								
<i>Haplophyllum poorei</i> C. C. Towns.	✓												✓	✓									3	SS1 and SS2
Scrophulariaceae																								
<i>Scrophularia deserti</i> Delile	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓	16	SS1, SS2, and SS3
<i>Verbascum decaisneanum</i> Kuntze	✓	✓											✓	✓									4	SS1 and SS2
<i>Verbascum fruticosum</i> Post & Auran	✓												✓	✓									3	SS1 and SS2
<i>Verbascum schimperianum</i> Boiss.	✓	✓											✓	✓									4	SS1 and SS2
Solanaceae																								
<i>Hyoscyamus boveanus</i> (Dunal) Asch. & Schweinf.	✓																						1	SS1
Tamaricaceae																								
<i>Reaumuria negevensis</i> Zohary & Danin	✓													✓									2	SS1 and SS2
Zygophyllaceae																								
<i>Tribulus kaiseri</i> Hosni	✓	✓								✓													3	SS1, SS2, and SS3
<i>Zygophyllum dumosum</i> Boiss.	✓												✓	✓									3	SS1 and SS2
<i>Zygophyllum molle</i> (Delile) Christenh. & Byng	✓	✓											✓	✓									4	SS1 and SS2

To be continued

Continued

Species	Country																				Disrtibution area		
	Eg	SA	Ku	Ba	Qa	UAE	Ye	Om	Irq	Irn	Pak	Af	Jo	Pal	Sy	Li	Tu	Al	Mo	Ma		In	Total
<i>Zygophyllum scabrum</i> (Forssk.) Christenh. & Byng	✓													✓		✓	✓	✓	✓			6	SS1 and SS2
Total	126	67	13	3	7	9	11	8	19	14	6	5	72	79	9	12	7	10	9	2	2	490	

Note: Eg, Egypt; SA, Saudi Arabia; Ku, Kuwait; Ba, Bahrain; Qa, Qatar; UAE, the United Arab Emirates; Ye, Yemen; Om, Oman; Irq, Iraq; Irn, Iran; Pak, Pakistan; Af, Afghanistan; Jo, Jordan; Pal, Palestine; Sy, Syria; Li, Libya; Tu, Tunisia; Al, Algeria; Mo, Morocco; Ma, Mauritania; In, India; SS1, Sahara regional subzone; SS2, Saharo-Arabian subzone; SS3, Nubo-Sindian subzone. Note that the Saharo-Arabian floristic region zoning is based on the White and Léonard (1991), of which SS1 subzone includes Morocco, Mauritania, Algeria, Tunisia, Libya, and Egypt, SS2 subzone includes Palestine, Kuwait, Saudi Arabia, Qatar, Bahrain, the United Arab Emirates, Oman, Yemen, and southern Jordan, Syria, and Iraq, and SS3 subzone includes southern Iran, Afghanistan, and Pakistan and northern India.