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RESEARCH

Ethnobotanical importance of the endemic taxa in the Egyptian flora

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Background: Endemic species are important components in the flora of most world regions. Most of these species have become threatened and exposed to extinction within the last few years. The present study aims to evaluate the ecosystem services offered by the endemic plant taxa in Egypt and the threats that affect them. Twenty-five field visits were conducted during summer 2018 to spring 2022 to several locations all over Egypt. In each location, the main habitats, national distribution, abundance, goods and threats were recorded.
Results: Egypt has 41 endemic taxa belonging to 36 genera and 20 families inhabiting 10 main habitats. Rocky surfaces and sandy formations have the highest number of endemic species. The relation between the number of endemic taxa and the abundance categories indicated that 2 taxa are rare (4.9% of the total taxa), while the remaining were very rare (95%). The most represented offered good was the medicinal uses (32 taxa = 78%), while fuel plants were only represented by 2 taxa (2 taxa = 4.9%). Besides, 14 taxa (34.1% of the total studied taxa) have at least 1 environmental service. Soil fertility (7 taxa = 50%) was the most represented, followed by sand accumulations (6 taxa out of 14 taxa = 43%), while shading plant was the least (1 taxon = 7.1%) (*Rosa arabica*). The most represented threat is over-cutting and over-collecting (38 taxa = 92.7%), while mining and quarrying is the least represented (4 taxa = 9.8%).
Conclusions: The potential and actual goods, services and threats of the endemic taxa were assessed as follows; field observation, information collected from local inhabitants and herbalists, and a literature review. The present study recommended planning a strategy about the importance, threats and conservation of endemic taxa in Egypt that would help in the protection and rescue of these plants and increase awareness about the importance of these plants.

Keywords: ecosystem services, Egyptian flora, endemism, ethnobotanical importance, goods, threats

Introduction

Endemism is a function of the spatial scale used to describe the restriction of certain taxa to a definite sized area (Laffan and Crisp 2003). The majority of endemic taxa are included in the Red Data List as they are potentially threatened due to their narrow and unique distribution ranges and habitat specificity (Crisp et al. 2001). Boulos (2009) reported 60 endemic taxa in Egypt; Hosni et al. (2013) recorded 76, while Abdelaal et al. (2018) recorded 48 taxa and El-Khalafy et al. (2021) recorded 41 endemic taxa belonged to 36 genera and 20 families.

Plants are essential resources and have an immense impact on ecosystems and a vital role in socio-economic conditions of the people (Ahmad et al. 2010; Böcük et al. 2009). Plants were universally recognized as a critical component of biodiversity and global sustainability. For example, plants provide food, fiber, fuel, shelter, and medicine. Healthy ecosystems, based on plant diversity, provide the conditions and processes that sustain life and are essential to the well-being and livelihoods of all humankind (Wilson 1992).

Natural ecosystems provide numerous services and goods that support human well-being and survival (Cos-

tanza et al. 1997; Millennium Ecosystem Assessment 2005). Deserts provide many benefits that can meet the demands of both the local inhabitants and other surrounding communities. These benefits include water, food supply, medicine and raw materials. However, the information available about the services and goods provided by this biome is fragmentary. Consequently, deserts have been over looked in most of ecosystem valuation studies (De Groot et al. 2012). A key component in desert ecosystems is the vegetation. Its structure and dynamics control the provision of ecosystem services (Havstad et al. 2007; Peters et al. 2006). Many plant and animal domestications originally occurred in the Middle-East, and many of the wild relatives of domesticated species are still extant in their centers of origin in desert areas (Batanouny 1999). However, these ancestral forms are gradually disappearing as a result of excessive resource exploitation.

Goods are organisms and their parts and products that grow in the wild and are used directly for human benefit (Daily et al. 1997). Six major categories of goods could be described identified: grazing, medicinal, human food, timber, fuel, and other uses (e.g., chairs, mats, baskets, beach beds, ornamental purposes, oil and dye extraction and soap manufacture) (Shaltout and Ahmed 2012). For example, trade of medicinal plants is an essential source of economic income in different regions of Egypt, such as the northwestern coastal region and South Sinai. The economy of the community in these regions based on this type of trade (Shaltout and Al-Sodany 2002). The respect for natural resources by Elderly people is obvious. Conversely, many of these traditional practices have been lost by the young generation. For example, the collection of fuel wood by older people is focused mainly on the dry and dead plants. In contrast, the young generation and people of the surrounding urban settlements do not differentiate between green and dry plants (Shaltout and Ahmed 2012).

Ecosystem Services are those valuable, ongoing streams of benefits provided by thriving ecosystems (Turner and Daily 2008). Twelve aspects of services could be identified (Heneidy and Bidak 2004): soil fertility, sand accumulation, esthetic concerns, wind-breaking, shading, refuge, salinity tolerance, water storage, water invading, bank retention, water purification, and weed control.

Apart from climatic changes and the loss of natural habitats, excessive human activities (e.g., overexploitation) may cause extinction to the endemic taxa (Thomas et al. 2004). Also, some essential natural threats were recorded, such as the aridity of the area with very scarce precipitation yearround. Animal grazing, human impacts, and traditional plant collection for medicinal uses, further intensify the natural threats of aridity and fragmentation, thus pushing these taxa to the extinction (Mansour et al. 2013; Zaghloul et al. 2006). In recent times, the extinction rate has accelerated, causing hundreds or perhaps thousands of species, subspecies, and varieties to become extinct every year (Cunningham and Cunningham 2006).

Endemic taxa are essential components in the flora of most world regions. Most of these species have become exposed to extinction within the last years as a result of a lot of reasons such as environmental conditions and human activities. Extinction of these species are considered as a major threat to biodiversity; there is an urgent need to assess the goods and services offered by these taxa to prepare conservation strategy for these plants. The present study aims to assess the economic uses of the endemic taxa in Egypt based on the goods (e.g., medicinal, grazing, human food, fuel, and other uses), and services (e.g., sand accumulation, soil fertility, nitrogen fixation, and ruderal weed), which they offer. Besides, the determination of different threats affects them.

Study area

Egypt lies in the northeastern part of Africa and extends to Asia (Sinai Peninsula). Egypt is the aridest country in North Africa in which desert conditions prevail throughout the country (Wickens 1992). Egypt contains four main geographical regions (Fig. 1): the Western Desert, including the Mediterranean coastal belt (681,000 km^2), the Eastern Desert, including the Red Sea coastal belt (223,000 km^2), Nile land (25,000 km^2) and Sinai Peninsula (61,000 km^2). River Nile land includes several islands in its mainstream and the two Delta branches. Fayium depression (1,700 km^2) is connected to the Nile by a principal irrigation canal called the Youssef Sea (Zahran and Willis 2009).

The climate of Egypt is governed by its position in the North-eastern part of Africa between 22°–32° N (El-Hadidi 2000). Its climate is generally moderate, considered as a contest between the hot, dry air masses over the Sahara, and the cooler, damper maritime air masses from the north carried by eastward moving depressions. The hot dry tropical continental air masses dominate throughout most of the year, but during the winter period, air masses of both tropical and polar maritime origin make brief incursions into Egypt from the north, frequently bringing rain with them. A hot and almost rainless climate characterizes it. The key feature of the precipitation in Egypt is very little and the average annual rainfall over the whole country is only about 10 mm. Even along the narrow northern strip of the Mediterranean coastal land, where the precipitation is concentrated, the annual rainfall range between 80–200 mm $year^{-1}$ from 2015 to 2019 (https://power.larc.nasa.gov/), and the amount decreases very rapidly southward.

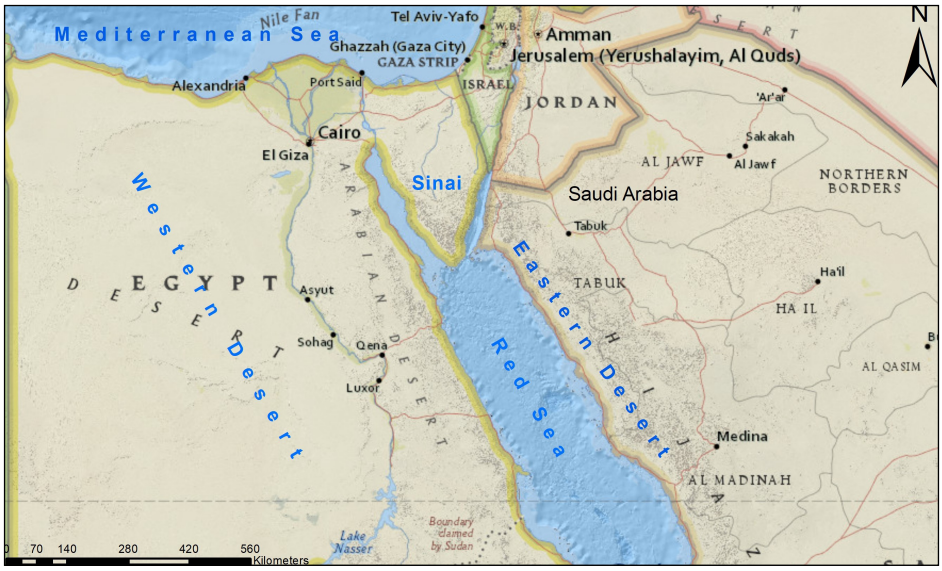

Fig. 1 The main geomorphic regions of Egypt.

Materials and Methods

Twenty-five field visits were conducted during summer 2018 to spring 2022 to several locations all over Egypt, including Saint-Catherine, Matrouh, Alexandria, Aswan and Assiut for collecting the endemic taxa in Egypt (Table 1 and Fig. 2). In each location, specimens of the taxa were collected from different sites. The main habitats in each location were determined through visiting different sites. The available information and data are also collected: coordinates, abundance, uses and threats for taxa through visits. Other notifications were taken into consideration such national phytogeographical distribution.

The identification of collected plants carried by authors and based on different literatures and database reviews and recorded species are arranged alphapitically according to Linear Angiosperm Phylogeny Group (LAPG) III System. These resources include previous floras and available literature: Täckholm et al. (1941), Täckholm and Drar (1950–1969), Andrews (1950–1956), Hassib (1951), Täckholm (1974), El-Hadidi et al. (1992), Boulos (1999, 2000, 2002, 2005, 2009), El-Hadidi and Hosni (2000), Zahram and Willis (2003), Ahmed (2009), Shaltout et al. (2010), Shabana (2013), Zahran et al. (2015), Ibrahim et al. (2016), and El-Khalafy (2018).

Goods and services of the recorded taxa were assessed on three bases; information collected from local inhabitants and herbalists, field observations and the literature reviews. Sixty persons distributed in different regions all over Egypt were interviewed; they are in the age class of 40–60 years old (Table S1). Additional information was collected from herb shops distributed in other regions especially in Matrouh, Siwa, Nile Delta. A literature review was used to fill gaps in the collected information: Boulos (1983), El-Hadidi et al. (1992), Aly (1998), Batanouny (1999, 2005), Shaltout and Al-Sodany (2002), Ali (2004), Ahmed (2009), Shaltout and Ahmed (2012), Shaltout et al. (2010), Hatim (2013), Bidak et al. (2015), Heneidy et al. (2017), El-Khalafy (2018), Ahmed et al. (2023), and El-Khalafy (2023).

All of the endemic taxa were exposed to at least one aspect of threats. The threats are classified into 8 major groups: over-collecting and over-cutting, habitat loss, browsing and over-grazing, clearance for agriculture, mining and quarrying, trampling, urbanization and tourism and climatic changes and environmental conditions. Major threats for each taxon were assessed in the field and by using the website (http://www.iucnredlist.org/technical-documents/classification-schemes/threats-classification-scheme) and depending on the following studies: Hosni et al. (2013), Shabana (2013), Zahran et al. (2015), Rabei et al. (2016), Shaltout et al. (2018), Omar and Nagy (2015), The IUCN Red List of Threatened Species (2017a, 2017b, 2017c), Omar et al. (2017), Omar (2018).

Results

Habitat types and abundance categories

According to the habitats of endemic taxa, the recorded taxa variation revealed that rocky surfaces and sandy formations have the highest number of taxa (Table 2). The relation between the frequencies of endemic taxa in the Egyptian flora in relation to the number of habitats in which they occur, approximates an inverse J-shape distribution. There is a gradual decrease in the number of taxa with an increase in the number of habitats, starting with the taxa that occur in one habitat (34 taxa = 82.9%) and two habitats (6 taxa = 14.6%). *Allium mareoticum* is the only taxon that occurs in four habitats.

In addition, the relation between the number of endemic taxa and the abundance categories indicated that 2 taxa are rare (4.9% of the total taxa), while 39 were very rare (95.1%) (Fig. 3).

Table 1 Field visits during the present study (summer 2018–spring 2022)

Location	Exact place	Date
Elsheikh Mubarak Village	Baltim	08/4/2019
		09/4/2019
		15/2/2021
Alamin	Omayed region	19/4/2019
		20/4/2019
		16/6/2020
		28/3/2022
Saint Catherine Protectorate	Shag Shreg	04/5/2019
		19/5/2020
	Wadi Faraa	04/5/2019
		19/5/2020
	Wadi Garginya	05/5/2019
		19/5/2020
	Wadi El-Arbain	20/5/2020
	Wadi Abo-Welih	20/5/2020
	Wadi Aukdid Eldib	07/5/2019
	Wadi Gebal (Tobok)	07/5/2019
	Wadi Gebal	07/5/2019
	Wadi Zawatine	08/5/2019
	Wadi Rahabet Nada	08/5/2019
	Sheg El Kharaza	09/5/2019
	Sheg.Etlah and W.Etlah	09/5/2019
	ElRasis	10/5/2019
	Wadi Abo-Hamman	10/5/2019
	Eldir Mountain region	11/5/2019
	Wadi Feiran	5/4/2019
	Abu Gifa	4/9/2020
	Main Shikaya	4/9/2020
	Wadi El-Shaq	4/9/2020
	Gebel Azeg	5/9/2020
	Wadi El-Mather	5/9/2020
	El-Mserdy	6/9/2020
	Wadi Abumahshour	6/9/2020
	Gebel Al-Ahmar	7/9/2020
Alamin-Matrouh	Ageeba and Keliopatra	30/3/2018
		13/6/2020
		29/3/2022
		29/5/2022
	El-Gharam region	31/3/2018
		13/6/2020
		29/3/2022
		28/5/2022
	Omayed region	4/6/2018
		13/6/2020
		29/3/2022
		25/5/2022
	Wadi Habis	4/6/2018
		13/6/2020
		29/3/2022
		30/5/2022
	Wadi El-Agol	30/3/2022
	Ras-Elhekhma	5/6/2018
		13/6/2020
		30/3/2022
	Sidi-Abdelrahman	13/6/2020
		5/6/2018
		30/3/2022
		27/5/2022
	Alamin-Sidi Abdelrahman Road	28/3/2022
	Matrouh El-Sallum Road	31/3/2022
Oasis	Siwa Oasis	31/3/2022
Burg Elburullus	Burg Elburullus	6/6/2018
		15/2/2021
El-Sallam Town	El-Tawfiqia	7/5/2022
Alexandria (Mariut)	Bremly cage	29/3/2018
		13/6/2020
		28/3/2022
	Near Burg El-Arab stadium	29/3/2018
		13/6/2020
		28/3/2022
	Mariut entrance	28/3/2022
	Bashari El-kheir	28/3/2022
	Mariut	28/3/2022
	El-Ghabaniat	28/3/2022
	Burg El-Arab	28/3/2022
El-Sharqia	El-Salhia	14/10/2021
		6/5/2022
Baltim–Rashid Road	Baltim–Rashid Road	5/6/2021
Gamasa–Baltim Road	Gamasa–Baltim Road	5/6/2021
		5/5/2022
Fayoum	Wadi Al-Hitan, North Fayoum	5/4/2020
Red Sea	El-Mallaha Swamp	28/3/2020
	Mangrove Forests, Safag	29/3/2020
Sharm Elsheikh	Ras Muhammad Nature Reserve	7/4/2019
Assiut	Wadi Al-Assiuty Protectorate	6/9/2019
El-Beheira	Idku	3/5/2022
Kafrelsheikh	Dessouk	1/2/2020
	Dessouk-Motoubis road	1/2/2020
	Gebel Abu Mandour	2/2/2020
		2/5/2022

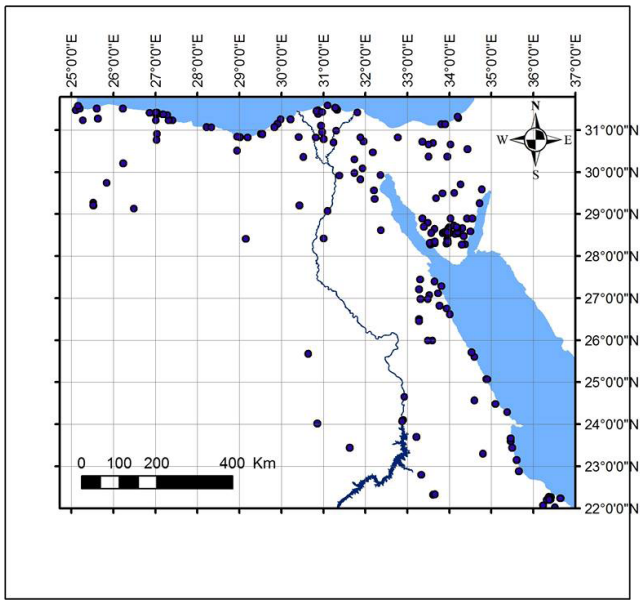

Fig. 2 Map of Egypt indicating the field trips and distribution of endemic taxa.

Goods and services

All the endemic taxa have at least one aspect of the potential or actual economic goods (Table S2). The goods are classified into 5 major groups: medicinal, grazing, human food, fuel and other uses (e.g., esthetic concerns, oil). The offered goods could be arranged descendingly as follows: medicinal (32 taxa = 78%), grazing (19 taxa = 46.3%), human food (9 taxa = 22%), other uses (6 taxa = 14.6%) and fuel (2 taxa = 4.9%) (Fig. 4A). Seventeen taxa have only one good (34.1%), while 21 taxa have two goods (51.2%) and only one taxon has three goods (2.4%) (Fig. 4B). Regarding the habitat's types, medicinal plants had the maximum value in sandy formations, while grazing and human food in rocky surfaces (Table 3).

Regarding the habitats types, medicinal plants had the maximum value in sandy formations, while grazing and human food in rocky surfaces. The variation in relation to national geographical distribution indicated that all goods had the maximum values in Sinai, followed by Mediterranean region (Table 4).

Fourteen species has at least one environmental service. According to the available data in the present study, most services offered by the endemic taxa in Egypt are soil fertility and nitrogen fixation (7 taxa = 50%) and sand accumulation (6 taxa out of 14 taxa = 43% of the total environmental services recorded species), weed (2 taxa = 14.3%) and shading (1 taxon = 7.1%) (Table S2).

Threats

The threats upon the endemic taxa could be arranged descendingly as follows: over-collecting and over-cutting (33 taxa = 80.5%), climatic changes and environmental conditions (22 taxa = 53.6%), urbanization and tourism (19 taxa = 46.3%), browsing and over-grazing (20 taxa = 48.8%), clearance for agriculture (16 taxa = 39%), habitat loss (14 taxa = 34.1%), mining and quarrying (7 taxa = 17%) (Fig. 5A). The variation according to the number of threats indicated that 4 taxa are exposed to one threat, 7 to 2 threats, 14 to 3 threats (34.1%), 11 to 4 threats (26.9%), 4 to 5 threats (9.6%) and only one taxon (*Hyoscyamus boveanus*) exposed to 6 threats (2.4%) (Fig. 5B and Table S3).

Discussion

Endemism is the restriction of occurrence of a taxon to a defined country (Gaston 1994). The narrow-distributed taxa restricted to a limited area in the country are steno-endemics (Gaston 1994). Forty-one endemic taxa of vascular plants belonged to 36 genera and 20 families were recorded in the present study. All of the endemics had at least one aspect of the potential or actual economic goods. The most represented offered good was the medicinal uses (78%), while fuel plants were only represented by 2 taxa (4.9%). The results of the present study are similar to that of other studies in different countries. For example, El-Darier and El-Mogaspi (2009) recorded 44 endemic species belonging to 28 families and 41 genera in El-Jabal El-Akhdar Region (Libya). The most represented goods were medicinal uses. Twenty one medicinal uses were recorded for 12 species mentioned in the present study and 7 non-medicinal uses were also mentioned. Most cited plant parts

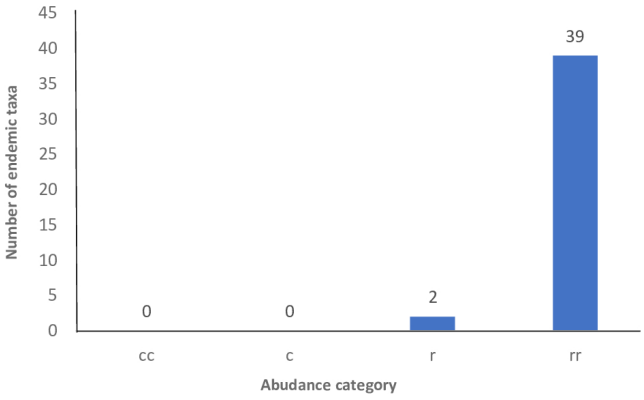

Fig. 3 Number of endemic taxa in the Egyptian flora in relation to their abundance categories (magnitude terms). cc: very common; c: common; r: rare; rr: very rare.

Table 2 Taxonomic diversity of the endemic taxa in Egypt in relation to their habitats

Habitat	Taxonomic category				
	Family	Genus	Species	Subspecies	variety
Banks of water bodies	5	5	4	1	-
Desert plains, depressions, and wadis	4	6	4	1	1
Sandy formations	7	12	11	1	3
Alluvial and loamy soils	1	1	1	-	-
Cultivated fields	4	4	4	-	-
Mountains and hills	4	4	4	-	-
Rocky surfaces	7	9	9	1	2
Well surroundings	2	3	1	1	-
Road sides	1	1	1	-	-
Calcareous ground	2	2	1	-	1

-: not applicable.

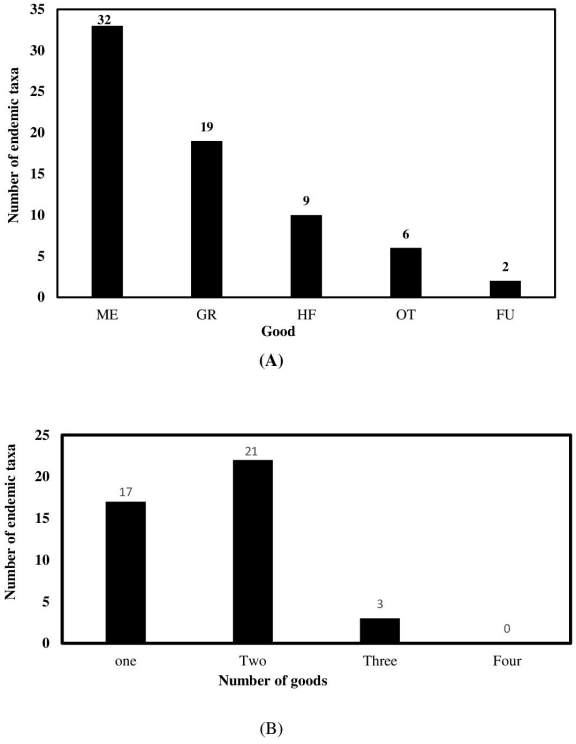

Fig. 4 Descending arrangement of the goods of the endemic taxa in the Egyptian flora (A) and the number of goods offered by endemic taxa (B). ME: medicinal; GR: grazing; HF: human food; OT: other uses; FU: fuel.

used for medicinal purposes were flowers, leaves and tubers. Majid et al. (2019) recorded 38 endemic plant species belonging to nineteen families which were utilized by the local inhabitants in Lesser Himalayan region of Pakistan. The highest number of endemics was with medicinal uses. The highest number of endemics was used in fever, wound healing, throat infection and tonic (4 species each). Root was the most widely used part (36.17%) in cure of diseases and the leading mode administered was decoction (25.49%). Heneidy et al. (2017) showed ethnobotanical importance and conservation value of native plants in eastern Arabian Peninsula. Their results showed that native plants provide many ecological and socioeconomic services, including the provisioning of food, medicine, and energy. The native species (>77%) were reported to potentially be used for more than 170 therapeutic applications and for curing various human ailments. The prevailing habitats, namely coastal plains, saline flats, rocky ground and non-saline inlands, were generally characterized by low vegetation cover and low species richness. These native species has high ecological value, providing many ecological services. The most prominent of the recorded ecological services provided by the native plants in the region included sand fixation (68%), salt tolerance (30.7%), contribution to soil fertility (25.3%), water storage (20%), and refuge (9.3%). In

Table 3 Goods offered by the endemic taxa in the Egyptian flora in relation to their habitats

Habitat	Goods				
	ME	GR	HF	FU	OT
Sandy formations	17[a]	9	2	-	2[a]
Rocky surfaces	5	4[a]	2	2[a]	-
Mountains and hills	4	2	1	-	1
Calcareous ground	2	1	1	-	-
Desert plains, depressions, and wadis	5	2	3[a]	-	2[a]
Cultivated fields	1	2	3[a]	-	1
Banks of water bodies	4	2	1	-	-
Alluvial soils	1	-	-	-	-
Road sides	1	1	2	-	-
Well surroundings	2	1	-	-	1

ME: medicinal; GR: grazing; HF: human food; FU: fuel; OT: other uses; -: not applicable.
[a]Maximum values.

Table 4 Goods offered by the endemic taxa in the Egyptian flora in relation to their phytogeographical region

Geographic region	Goods				
	ME	GR	HF	FU	OT
Sinai	16[a]	10[a]	4[a]	2[a]	1
Mediterranean	8	5	4[a]	-	2[a]
Eastern desert	3	2	2	-	2[a]
Western desert	1	1	-	-	-
Nile	7	5	3	-	-
Gebel Elba	2	2	-	-	1
Oases	2	-	1	-	-
Red Sea coastal strip	1	-	-	-	-

ME: medicinal; GR: grazing; HF: human food; FU: fuel; OT: other uses; -: not applicable.
[a]Maximum values.

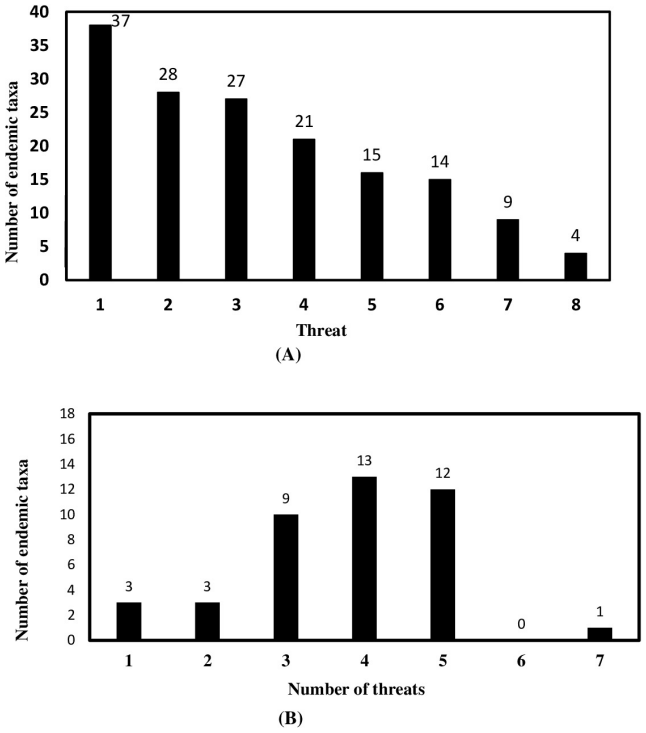

Fig. 5 Descending arrangement of the threats affect on the endemic taxa in the Egyptian flora (A) and the number of threats affects endemic taxa (B). 1: overcutting and over-collecting; 2: climatic changes and environmental conditions; 3: browsing and overgrazing; 4: urbanization and tourism; 5: clearance for agriculture; 6: habitat loss; 7: trampling; 8: mining and quarrying.

addition, the majority of the species recorded are used as grazing plants (96%). A considerable proportion of the species (33%) are consumed by local inhabitants either cooked, as condiments, or added as greens to salads. Moreover, about 25% of the plant species recorded were reported as of value as a fuel-wood. Finally, out of the 75 native plants species recorded, 60 species were reported to be of medicinal value. The medicinal plants were reported to be used for more than 170 therapeutic uses and for curing different kinds of human ailments. In addition, Baydoun et al. (2017) revealed that 130 plant species provide the local community with a breadth of wood and non-wood products in Jabal Moussa Bioreserve, Lebanon. Medicinal species ranked highest contributing to 33% of reported use followed by food and beverage (15%), fuel (12%), environmental uses (10%) and materials (8%), while the remaining 22% was shared between other uses (bee plants, poisons, cosmetics, and social uses).

Medicinal goods

Thirty-three endemics (79% of the total good taxa) are of medicinal uses. For example, the leaves and flowering tops of *Origanum syriacum* var. *synaicum* were collected and used to treat pulmonary diseases, ease sore throats and treat asthma and bronchitis (Batanouny 1999). The flowers and leaves of *Rosa arabica* were used as an analgesic for menstrual pain; it also has an ethno-veterinary use; the whole plant was used for treatment of some reproductive disorders in sheep, goats and camels (Pieroni et al. 2006). N-hexane and ethylacetate extract of aerial parts of *Silene schimperiana* showed significant cytotoxicity against colon carcinoma and liver carcinoma cells (Hussein et al. 2017). Six metabolites were extracted from the aerial parts of *Anarrhinum pubescens* which show cytotoxic activity the human lung carcinoma cell line (Mahran et al. 2019). Several iridoids were isolated from *A. pubescens*. These iridoids were considered as natural curatives for neurodegenerative disorders like Alzheimer's disease (Mahran et al. 2020). In addition, the methanol extracts of this plant have shown slight cytotoxic activities against numerous diseases like breast, colon, hepatocellular and lung tumor cell lines (Moustafa et al. 2014). It has been found that *Buffonia multiceps* has an ethnoveterinary use. The whole plant of *B. multiceps* used for treatment of digestive problems in sheep, goats and equines (Pieroni et al. 2006). The flowers of *H. boveanus* are mixed with tobacco (*Nicotiana* sp.) and smoked for its intoxicating effects (Omar et al. 2017). *Silene leucophylla* is used to treat leprosy, diarrhea, heal cuts and inflamed wounds; root show hepato-protective function (Omar et al. 2017). *Ballota* species have been used in Turkish folk medicine as antiulcer, antispasmodic, diuretic, choleretic, anti haemorrhoidal, and sedative agent (Omar et al. 2017). Sesquiterpene lactones were isolated from *Sonchus macrocarpus* which have medical importance (Mahmoud et al. 1984). Moreover, *Fumaria* species have Anti-inflammatory, antibacterial, antifungal, antinematode and antinociceptive effects (Gupta et al. 2012). Antiviral, antibacterial, antifungal, antidiabetic, anticarcinogenic, antiplatelet, antispasmodic, antiseptic, antihelminthic, antithrombotic, anti-asthmatic, anti-carminative, anti-oxidant, anti-inflammatory, antihypertensive, hypoglycemic, hypotensive, lithontripic, and hypocholesterolemic properties are just a few of the health benefits that *Allium* species reported to provide (Najeebullah et al. 2021). Further, roots and bulbs of *Bellevalia* species stated to have anti-rheumatic and anti-inflammatory effects (Savio et al. 2019). Furthermore, *P. arabicum* contains Steroids. This phytochemical group has anti-microbials, detoxifyingagents, strengthners, anti-rheumatics and anti-malarial,hepaticidal activities (Koche et al. 2016). Indeed, the reason for the linkage between tannins, carbohydrates, and resins in *P. arabicum* is that they can form reversible and irreversible complexes with each other. Plant extracts with tannins are used as astringents to treat and prevent diarrhoea, as well as diuretics that are effective against stomach and duodenal cancers and pharmaceuticals that are anti-inflammatory, antiseptic, antioxidant, and homeostatic pharmaceuticals (Bruyne et al. 1999).

Grazing goods

Silene oreosinaica was exposed to grazing by domestic and wild animals (Rabei et al. 2016). *Buffonia muticeps* was exposed to destructive overgrazing, causing loss of reproductive organs (The IUCN Red List of Threatened Species 2017b). Also, has economic importance in grazing processes as a pastoral plant (Khafagi et al. 2012; Omar et al. 2013). *Anarrhinum pubescens* considere as a pastoral plant (Khafagi et al. 2012; Omar et al. 2013; The IUCN Red List of Threatened Species 2017a). *Micromeria serbaliana* has grazing economic use (Omar et al. 2017). *Silene leucophylla* is highly grazed by domestic animals (Omar et al. 2017). *Polygala sinaica* var. *sinaica* has economic importance in grazing processes as a pastoral plant (Khafagi et al. 2012; Omar et al. 2013). *Veronica anagalloides* subsp. *taeckholmiorum*, and *Atractylis carduus* var. *marmarica*, *Bromus aegyptiacus*, and *S. macrocarpus* have economic importance in grazing processes (Ahmed 2009).

Human food and fuel goods

Anarrhinum pubescens is collected for traditional treatment and fuel by local communities on a small scale (Moustafa et al. 2014). Also, *R. arabica* is over cutting for fuel (The IUCN Red List of Threatened Species 2017c). *Allium mareoticum*, *Melilotus serratifolius*, and *S. macrocarpus* are used as human food by local inhabitants (Ahmed 2009). In addition, *A. carduus* var. *marmarica* was collected for traditional treatment and fuel by local communities (Shaltout and Ahmed 2012). Common garlic and onions, two economically major *Allium* crop species, play a large role in the daily diet as vegetables and for therapeutic purposes (Najeebullah et al. 2021).

Threats

Habitat destruction is one of the major threats which threatened many endemics in the Egyptian Flora, especially in the Mediterranean region (Shaltout and Ahmed 2012). Fifteen endemics in the present study (e.g., *A. mareoticum*, *Pancratium arabicum*, and *S. macrocarpus*) were exposed to habitat loss due to urbanization and tourism, clearance for agriculture and construction processes. These activities have not only led to the destruction of the habitats, but also the degradation of vast areas of habitat surrounding them. Also, 4 endemics (e.g., *Dianthus guessfeldtianus*, *Helianthemum schweinfurthii*, and *H. boveanus*) were damaged during mining and quarrying; one of the significant processes causing degradation in the ecosystems of many Egyptian regions due to destruction of plant cover. Besides, 22 endemics were threatened as a result of climatic changes in the form of hyper-aridity of most of the Egyptian Deserts (Bidak et al. 2015).

In the present study, it was observed that *B. multiceps* and *A. pubescens* are among the highly grazed endemic taxa in Saint Kathrine Protectorate. *Silene leucophylla*is exposed to grazing by sheep and goats, as well as over-collection for scientific research (Saker et al. 2011). *Bufonia multiceps* is stressed by over grazing due to their high palatability by domestic animals (El-Husseini et al. 2008).

Thirty-seven endemics are subjected to over-cutting and over-collecting by local inhabitants, herbalists, and scientific researchers. The collection of wild native medicinal plants for commercial trade has no regulation. The most serious aspect of this practice is that it usually targets rare and localized flora leading to damage them further (Ahmed 2009; Bidak et al. 2015).

The vegetation within the saint Katrine protectorate area has been subjected to disturbance through human activities including "overgrazing, uprooting" (Khafagi et al. 2012; Mosallam 2007). The threat from feral donkeys causes destruction to numerous plant species through trampling (Khafaja et al. 2006). Also, plant taxa in this region are severely affected by climatic changes, specifically through the destructive effect of sudden flooding (uprooting), and the long term drought impact. In general, these taxa are severely threatened by both natural (aridity of the area and climate change) and human factors (over-grazing: domestic animals & feral donkeys, over collection, unmanaged scientific research). These threats impact numerous plants like (*A. pubescens*, *B. muticeps*, *H. boveanus*, *B. kaiseri*, *Micromeria serbaliana*, *O. syriacum* subsp. *sinaicum*, *P. sinaica* var. *sinaica*, *Primula boveana*, *S. leucophylla*, *S. oreosinaica*, *S. shimperiana*, and *R. arabica* (Omar 2014, 2018; Omar et al. 2017; The IUCN Red List of Threatened Species 2017a, 2017b, 2017c).

Also some endemic taxa have difficulties in reproducing a new generation. Overgrazing cause destruction of the reproductive organs of *A. pubescens* and decrease the opportunity for the possibility of producing new generation (Omar and Nagy 2015).

Conclusions

This study was based entirely upon the economic use of endemic plants in Egypt. In the present study, data were categorized into five categories based on the uses of plants. The medicinal category was the most represented (32 taxa), followed by grazing (19 taxa), human food (9 taxa), other uses (6 taxa = 14.6 %) and fuel (2 taxa = 4.9 %). According to the habitats of endemic taxa, the recorded taxa variation revealed that rocky surfaces and sandy formations have the highest number of taxa. Fourteen species has at least one environmental service. According to the available data, most services offered by the endemic taxa in Egypt are soil fertility, nitrogen fixation and sand accumulation. The threats upon the endemic taxa could be arranged descendingly as follows: over-collecting and over-cutting (33 taxa), climatic changes and environmental conditions (22 taxa),

urbanization and tourism (19 taxa), browsing and overgrazing (20 taxa), clearance for agriculture (16 taxa), habitat loss (14 taxa), mining and quarrying (7 taxa). The useful plants in Egyptian Flora need urgent attention especially endemic species.

Supplementary Information

Supplementary information accompanies this paper at https://doi.org/10.5141/jee.23.044.

Table S1. Example of inquiry sample about the goods of endemic taxa in Egypt. **Table S2.** Characteristics of the endemic taxa in the Egyptian flora. **Table S3.** Type of threats upon the endemic taxa in the Egyptian flora.

Abbreviations
Not applicable.

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Authors' contributions
MMEK, DAEAA, KHS, YMAS involved in conception and design, acquisition, analysis, statistical analysis and interpretation of results, drafting the article and revising it, and approved the final version to be submitted for publication. SAH involved in conception and interpretation of results, revising the article and approved the final version to be submitted for publication.

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The authors declare that they have no competing interests.

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