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Egypt. J. Bot. **Vol. 60**, No. 1, pp. 147-168 (2020)

Egyptian Journal of Botany

http://ejbo.journals.ekb.eg/

Characterization of the Wild Trees and Shrubs in the Egyptian Flora

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THE present study aims to study the floristic characteristics of the native trees and shrubs (with height ≥50cm) in the Egyptian flora. The floristic characteristics include taxonomic diversity, life and sex forms, flowering activity, dispersal types, economic potential, threats and national and global floristic distributions. Nine field visits were conducted to many locations all over Egypt for collecting trees and shrubs. From each location, plant and seed specimens were collected from different habitats. In present study 228 taxa belonged to 126 genera and 45 families were recorded, including 2 endemics (*Rosa arabica* and *Origanum syriacum* subsp. *sinaicum*) and 5 near-endemics. They inhabit 14 habitats (8 natural and 6 anthropogenic). Phanerophytes (120 plants) are the most represented life form, followed by chamaephytes (100 plants). Bisexuals are the most represented. Sarcochores (74 taxa) are the most represented dispersal type, followed by ballochores (40 taxa). April (151 taxa) and March (149 taxa) have the maximum flowering plants. Small geographic range - narrow habitat - non abundant plants are the most represented rarity form (180 plants). Deserts are the most rich regions with trees and shrubs (127 taxa), while Sudano-Zambezian (107 taxa) and Saharo-Arabian (98 taxa) was the most. Medicinal plants (154 taxa) are the most represented good, while salinity tolerance (105 taxa) was the most represented service and over-collecting and over-cutting was the most represented threat. Plants with spiny organs such as spiny stipules, leaves, branches, inflorescences and fruits or woody branches with spine-like terminates are the most represented (64 taxa).

Keywords: Egyptian flora, Good and services, Rarity form, Woody plants.

Introduction

Woody plants are perennials with defined stem and canopy, and clearly formed with secondary growth and lignificated tissues. Woody plants are either trees (e.g. *Salix mucronata*), Shrubs (e.g. *Thymelaea hirsuta*) or lianas (e.g. *Cocculus pendulus*). Trees have one erect perennial stem or trunk at least 25cm in circumference at 137cm above the ground. (Lund, 2015). They also have a define crown of foliage. In contrast, shrubs are small woody plants, usually with several perennial stems branching at the base. However, some trees (e.g. *Quercus* sp. and *Fraxinus* sp.) have multi-trunked forms (Lund, 2015).

Egypt's land (about one million km^2) comprises four geographical units, namely: River Nile (about 35,700km^2) that includes: The Nile Delta, Nile Valley and Nile Fayium; Western Desert (about 681,000km^2); Eastern Desert (about 223,000km^2) and Sinai Peninsula (about 61,000km^2) (Zaharan & Willis, 2009). The climate of Egypt can be divided into two main climatic provinces: arid (including the Mediterranean coast and Gebel Elba area with annual rainfall of 20-100mm) and hyper arid (including the Eastern and Western Deserts with annual rainfall usually less than 20mm) (Ayyad & Ghabour, 1986). Consequently, Egypt is mainly desert (>96%) and its climate does not favour the establishment of real forests with their huge trees and shrubs, so the flora of Egypt comprises, relatively, few trees and shrubs.

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Received 1/1/2019; Accepted 7/9/2019
DOI: 10.21608/ejbo.2019.6982.1276
Edited by: Prof. Dr. Fawzy M. Salama, Faculty of Science, Assuit University, Assuit, Egypt.

These plants show a number of morpho-physiological features that allow them to adapt with the high aridity and low nutrient availability which characterizes the semi-arid environments, such as deep root systems, tolerance to high radiation levels and capacity for clonal spread, presence of thorns and spines and small leaves (Nobel & Franco, 1989; Pugnaire et al., 1996a, b). Many shrubs and trees are of structural and economic importance in the arid regions (Crisp & Lange, 1976). They play an important role in soil protection and stabilization against movement by wind or water, provide a source of forage for animals and fuel for local inhabitants and have medicinal and potential industrial values (Thalen, 1979).

From the view point of the dynamics of semi-desert communities, many shrubs and trees may be considered pioneer species. Their high germinability, elevated growth rates during early stages and tolerance to high radiation levels allow them to colonize open spaces, thus providing microsites for the germination and establishment of many other species under their canopies (Nobel & Franco, 1989; Valiente-Banuet & Ezcurra, 1991; Pugnaire et al., 1996a, b).

These plants are, unfortunately, endangered. Human activities (primarily over-grazing by livestock and related disturbances) are one of the principal influences on woodland species (Oliver, 1980; Agren & Zachrisson, 1990; Skarpe, 1990; Stewart & Rose, 1990; Welden et al., 1991; Veblen, 1992; Lykke, 1998; Sakio et al., 2002; Tanaka et al., 2008). There are many examples of human destructive activities against the woody plants as mortality of *Acacia* trees which mainly associated with charcoal production in eastern desert of Egypt (Andersen & Krzywinski, 2007), over-grazing and over-cutting in Sinai, and aridity conditions and limited surface water availability in Sinai and Negev deserts (Shrestha et al., 2003; Abd El-Wahab et al., 2013). Local populations of *Moringa peregrina* are endangered due to over-cutting, and over-grazing whose effects are magnified by the contemporary prevailing extreme of drought (Zaghloul et al., 2012). Small populations of *Juniperus phonicea* at Gabal El-Maghara and Gabal Yelleq should be considered very important as they are under intensive cutting and burning and are negatively affected by drought (El-Bana et al., 2010).

Early in 1986, a preliminary survey of the threatened plant species in the Flora of Egypt was carried out, and later in 1987 a list of 425 of the flowering plants and vascular cryptogams was assigned in collaboration with the Threatened Plant Unit (TPU) of the IUCN, Kew, England. Among these 190 species are woody perennials (trees, shrubs and under-shrubs), while the rest are annuals, biennials or perennial herbs. The taxa are classified using the categories of The Red Data Book categories prepared by IUCN to indicate the degree of threat to individual species in their wild habitats (Abd El-Ghani & Fahmy, 1994). Checking the Red data list of vascular plants represented in the Flora of Egypt carried out by (El-Hadidi & Hosni, 2000), it was found that 96 threatened trees and shrubs (with mean height ≥50 cm) are among them.

The present paper aims at the followings: 1- Preparing a list of the trees and shrubs (with mean height ≥ 50cm) in the Egyptian flora (see appendix). 2- Determining the species which are considered alien. 3- Determining if there are endemic or near-endemic species among them. 4- Checklist analysis in terms taxonomic diversity, geographical distribution, life forms, flowering times, sex forms, dispersal types, rarity forms, goods and services, threats and physical defense.

Methods

Fourteen field visits were conducted to many locations all over Egypt during the period from 2017 to 2019 for collecting the trees and shrubs in Egypt. The covered phytogeographical regions are Oases, Mediterranean, Nile region, Red Sea, Eastern desert and Sinai (Table 1). From each location, specimens of plant taxa were collected from different habitats and seed samples representing the recorded taxa were also collected as can as possible. Other notifications were taken into account, if possible, such as sex form, size structure, life form, flowering time and dispersal type of diaspores. The available information and data such as: main habitats, coordinates, uses and threats for taxa were recorded through visiting different locations. Other information was collected from the herbarium of Tanta University (TANE). Information from the available literature was also taken into consideration (Täckholm & Täckholm, 1941; Täckholm & Drar, 1950-1969; Zohary, 1966, 1972; Täckholm, 1956, 1974; Feinbrun-Dothan, 1978, 1986; Boulos, 1999-2009; El-Hadidi & Hosni, 2000; Ahmed, 2009;

Shaltout et al., 2010). The websites in Table 2 were also consulted to collect more information about the recorded plants. The list of families are arranged alphapitically according to APG IV (The Angiosperm Phylogeny Group) system (Byng et al., 2016) (Table 3).

TABLE 1. Field visits during the present study (2017 to 2019).

Trip number	Exact location	Governorate	Latitude (N)	Longitude (E)	Date
1	Siwa Oasis	Matrouh	29.2052	25.5217	2017/1
2	Aswan Botanic Garden	Aswan	-	-	2017/2
3	Wadi Um - Rakham	Matrouh	31.3933	27.0432	4/2017
	Wadi Habis	Matrouh	31.388889	27.053333	4/2017
4	Al-Omayed	Matrouh	30.83555556	29.01833333	11/2017
	Al-Alamein	Matrouh	30.8390	28.9476	11/2017
5	Dafra road, Tanta	Gharbia	31.02216	30.725102	15/1/2018
6	Wadi Degla Protected Area, Al-Maadi	Helwan	31.3865	29.9488	12/2/2018
7	The agricultural new road, Al-Hamoul	Kafr Al-Sheikh	31.4233	30.9660	12/3/2018
	The International Coastal Road, Al-Borlos	Kafr Al-Sheikh	31.1003	31.5855	12/3/2018
8	Al-Alamein	Matrouh	30.8390	28.9476	23/3/2018
9	Cairo-Alexandria desert road, Al-Amereya	Alexandria	31.0731	29.8322	29/3/2018
	Bremly cage near Burg Elarab stadium	Alexandria	30.88074	28.79789	29/3/2018
	Shatea El-Gharam Road, Marsa Matrouh	Matrouh	31.3722	27.1813	30/3/2018
	Wadi Um Al-Rakhm	Matrouh	31.3933	27.0432	31/3/2018
	Ajeeba	Matrouh	31.4141	27.0072	31/3/2018
10	Wadi Al-Hitan, North Fayoum	Fayoum	30.4264	29.2117	13/4/2018
11	El-Mallaha Swamp near Hurghada	Red Sea	33.1676	28.2317	24/4/2018
	Mangrove Forests, Safaga	Red Sea	34.0104	26.6165	25/4/2018
12	Cairo University Herbarium	Cairo	-	-	2019/1/29
13	Ras Sedr Eltoor road	South Sinai	28.90831667	33.19305	2019/4/5
	Wadi El-Arbain, Saint Catherine	South Sinai	28.55347222	33.94791667	2019/4/5
	Wadi Feiran ,Saint Catherine	South Sinai	28.78969444	33.45647222	2019/4/5
	Wadi Tal'a ,Saint Catherine	South Sinai	28.56861111	33.93277778	2019/4/6
	Ras Muhammad Nature Reserve ,Sharm Elsheikh	South Sinai	27.7222	34.2539	2019/4/7
14	El-Gharam region	Matrouh	31.38086	27.00040	2019/4/11
	Marsa Matrouh El-Sallum road	Matrouh	31.3019733	26.8584964	2019/4/12

TABLE 2. Websites that were consulted to collect more information about the recorded plants.

Database name	Link
The Plant List	http://www.theplantlist.org
Kew world checklist of different plant families	http://wcsp.science.kew.org
Catalogue of Life	http://www.catalogueoflife.org
South African national biodiversity institute (SANBI)	http://pza.sanbi.org
PFAF Plant Database	https://pfaf.org/user/Default.aspx
Global Plant Science (JSTOR)	http://plants.jstore.org
Useful tropical plants	http://tropical.theferns.info/
PlantUse	https://uses.plantnet-project.org
Flora of Israel online	http://flora.org.il/en/plants/
Global Biodiversity Information Facility (GBIF)	http://www.gbif.org/occurence
African Plant Database	http://www.villege.ch/musinfo/bd/cjb/africa
Tropicos	http://www.tropicos.prg/Home.aspx
International Plant Name Index (IPNI)	http://www.ipni.org
IUCN	http://www.iucnredlist.org/details/

TABLE 3. Major taxonomic groups of the trees and shrubs in the Egyptian flora.

Taxonomic group	Family (F)	Genus (G)	Species (S)	Subspecies (Sub)	Variety (V)	Sub/S	S/G	G/F
Gymnosperms	2	2	6	1	0	0.2	3	1
Monocots	2	5	6	0	0	0	1.2	2.5
Eudicots	41	119	199	27	21	0.1	1.7	2.9
Total	**45**	**126**	**211**	**28**	**21**	**0.1**	**1.7**	**2.8**

Identification of plant specimens was carried out depending on the previous mentioned literature. Some identification was revised in TANE based on referral materials. The species which were not collected from the field were examined from herbarium sheets deposited in TANE. Life forms of the recorded taxa were assessed using the system of (Raunkiaer, 1937), and dispersal type was assessed using the system of (Dansereau & Lems, 1957).

Fourteen major habitats are supporting the trees and shrubs in Egypt: eight are natural habitats and six are anthropogenic habitats. The natural habitats are: 1- Sand dunes, 2- Sand flats (i.e., sandy soil, desert plains and sandy plains), 3- Alluvial and loamy soils, 4- Rocky ground, 5- Mountains, hills and ridges, 6- Calcareous ground, 7- Plains, depressions and wadis, 8- Forests (i.e., evergreen, semi-evergreen, dry, mangrove forests and savanna). The anthropogenic habitats are: 1- Saline soils, 2- Salt marshes, 3- Banks of water bodies (i.e., canals, ditches and misqas), 4- Road sides, 5- Waste lands (i.e., ruderal places and fallow fields), 6- Cultivated lands (i.e., fields, gardens, irrigated soil, plantations and farmland). The habitats of the trees and shrubs were recorded during the field trips, while the missing information were recorded according to these references (Boulos, 1999, 2000, 2002, 2005, 2009), (Täckholm, 1974), (Zohary, 1966, 1972), (Ahmed, 2009), (Shaltout et al., 2010), and the phyto-geographical regions were gathered from previous references, while relative magnitude terms, as reported by (Mueller-

Dombois & Ellenberg, 1974) and (Täckholm, 1974), were used to evaluate the abundance categories of the recorded species (very rare, rare, common and very common).

The global distribution (i.e. floristic regions) was assessed according to the system of (Good, 1974), who divided the globe into six kingdoms, three subkingdoms and thirty nine floristic regions., The theoretical framework of (Rabinowitz, 1981) was applied to assess the different types of rarity forms depending on the phyto-geographical range, habitat specificity and local abundance.

Results

Floristic analysis

There are 228 plant taxa recorded in this study (211 species, 28 subspecies and 21 varieties) belonging to 126 genera and 45 families. The most represented genera are: *Acacia* (12 taxa), *Atriplex* (9 taxa), *Tamarix* (6 taxa), *Ephedra, Salsola, Capparis, Euphorbia* and *Lycium* (5 taxa each). Gymnosperms are represented by 2 families (Cupressaceae and Ephedraceae), 2 genera, 6 species and one subspecies. The monocot families are 2 (Asparagaceae and Arecaceae), represented by 5 genera and 6 species. Eudicots are represented by 41 families (Table 3).

The highly represented families are Fabaceae (34 species), Amaranthaceae (25 species), Malvaceae (14 species), Solanaceae (11 species) and both Capparaceae and Apocynaceae (10 species). Twelve families are represented by only one species (Boraginaceae, Ebenaceae, Plantaginaceae, Rubiaceae, Celastraceae, Elatinaceae, Menispermaceae, Moringaceae, Nitrariaceae, Rhizophoraceae, Sapindaceae and Thymeleaceae); 8 by 2 species (Apiaceae, Brassicaceae, Burseraceae, Convolvulaceae, Loranthaceae, Polygonaceae, Resedaceae and Salvadoraceae); 8 by 3 species (Acanthaceae, Oleaceae, Plumbaginaceae, Verbenaceae, Moraceae, Phyllanthaceae, Salicaceae and Zygophyllaceae); 3 by 6 species (Rhamnaceae, Rosaceae and Tamaricaceae); while 2 by 7 species (Anacardiaceae and Euphorbiaceae) (Table 4).

Two endemics are recorded (*Rosa arabica* and *Origanum syriacum* subsp. *sinaicum*) and 5 near-endemics (*Lycium schweinfurthii* var. *aschersohnii, Medemia argun, Pistacia khinjuk* var. *microphylla, Withania obtusifolia* and *Zygophyllum dumosum*)

Habitat

The most represented habitat is sand dunes (116 taxa= 50.9%), followed by saline soils (101 taxa= 44.3%). Whereas calcareous ground is the least represented one (only 6 taxa= 2.6%) (Fig. 1). The species number gradually decreases with the rise in the number of habitats which they occur in (an inverse J-shaped), where the number of taxa that occur in one habitat is (49 taxa= 21.4%), two habitats (123 taxa= 53.9%). Then number of plants gradually decreases with increasing number of habitats. *Tamarix nilotica* is the only species that occurs in eight habitats (Fig. 2.).

Life forms

The life form determination of the recorded species indicated that phanerophytes (120 taxa= 52.6% of the total recorded taxa) are the most represented life form, followed by Suffruticose chamaephytes (100 taxa= 43.9%) (Appendix). Phanerophytes are represented by: nano-phanerophytes (83 taxa= 36.4%), micro-phanerophytes (33 taxa= 14.5%), and meso-phanerophytes (4 taxa= 1.8%). The rest of plants are distributed as follows: 3 taxa (1.3%) are proto-hemicryptophytes. Both *Euphorbia polycantha* and *Euphorbia consobrina* are stem succulents, and *Plicosepalus curviflorus* and *Plicosepalus acaciae* are hemi-parasites, while only *Asparagus stipularis* is geophyte-helophyte.

Sex forms

The sex of trees and shrubs is expressed in the following forms: bisexual (i.e. hermaphrodites), unisexual (either monoecious or dioecious) and polygamous. They are arranged ascendingly as follows: polygamous (7 plants= 3.1%), monoecious (31 plants= 13.6%), dioecious (34 plants= 15%) and bisexual (156 plants= 68.4%) (Appendix).

Dispersal types

Determination of dispersal types indicated that sarcochores (74 taxa= 32.7% of the total plant taxa) are the most represented dispersal type, followed by ballochores (40 taxa= 17.7%), then pogonochores (29 taxa= 12.8%) and microsclerochores (28 taxa= 12.3%) (Appendix).

TABLE 4. Taxic diversity of the trees and shrubs in the Egyptian flora. Ac: actual number and Re: relative number (%). The leading families were underlined.

Family	Genus		Species		Subspecies		Variety	
	Ac	Re	Ac	Re	Ac	Re	Ac	Re
Gymnosperms								
Cupressaceae	1	0.8	1	0.5	-	-	-	-
Ephedraceae	1	0.8	5	2.4	1	3.4	-	-
Angiosperms								
A. Monocots								
Arecaceae	3	2.4	3	1.4	-	-	-	-
Asparagaceae	2	1.6	3	1.4	-	-	-	-
B. Eudicots								
Amaranthaceae	12	9.5	25	11.8	2	6.9	4	19
Acanthaceae	3	2.4	3	1.4	-	-	-	-
Anacardiaceae	2	1.6	7	3.3	-	-	2	9.5
Apiaceae	1	0.8	2	0.9	-	-	-	-
Apocynaceae	8	6.3	10	4.7	2	6.9	-	-
Asteraceae	5	4	6	2.8	-	-	-	-
Boraginaceae	1	0.8	1	0.5	-	-	-	-
Brassicaceae	2	1.6	2	0.9	2	6.9	-	-
Burseraceae	2	1.6	2	0.9	-	-	-	-
Capparaceae	4	3.2	10	4.7	-	-	3	14.3
Celastraceae	1	0.8	1	0.5	-	-	-	-
Convolvulaceae	2	1.6	2	0.9	-	-	-	-
Ebenaceae	1	0.8	1	0.5	-	-	-	-
Elatinaceae	1	0.8	1	0.5	-	-	-	-
Euphorbiaceae	3	2.4	7	3.3	-	-	-	-
Fabaceae	17	13.5	34	16.1	9	31	2	9.5
Lamiaceae	5	4	5	2.4	3	10.3	-	-
Loranthaceae	1	0.8	2	0.9	-	-	-	-
Malvaceae	8	6.3	14	6.6	-	-	-	-
Menispermaceae	1	0.8	1	0.5	-	-	-	-
Moraceae	1	0.8	3	1.4	1	3.4	-	-
Moringaceae	1	0.8	1	0.5	-	-	-	-
Nitrariaceae	1	0.8	1	0.5	-	-	-	-
Oleaceae	2	1.6	3	1.4	4	13.8	2	9.5
Phyllanthaceae	2	1.6	3	1.4	1	3.4	2	9.5
Plantaginaceae	1	0.8	1	0.5	-	-	-	-
Plumbaginaceae	2	1.6	3	1.4	-	-	-	-
Polygonaceae	2	1.6	2	0.9	2	6.9	-	-
Resedaceae	2	1.6	2	0.9	-	-	-	-
Rhamnaceae	3	2.4	6	2.8	1	3.4	-	-
Rhizophoraceae	1	0.8	1	0.5	-	-	-	-
Rosaceae	4	3.2	6	2.8	-	-	-	-
Rubiaceae	1	0.8	1	0.5	-	-	-	-

TABLE 4. Cont.

Family	Genus		Species		Subspecies		Variety	
	Ac	Re	Ac	Re	Ac	Re	Ac	Re
Salicaceae	2	1.6	3	1.4	-	-	-	-
Salvadoraceae	2	1.6	2	0.9	-	-	2	9.5
Sapindaceae	1	0.8	1	0.5	-	-	-	-
Solanaceae	5	4	11	5.2	-	-	4	19
Tamaricaceae	1	0.8	6	2.8	-	-	-	-
Thymeleaceae	1	0.8	1	0.5	-	-	-	-
Verbenaceae	2	1.6	3	1.4	-	-	-	-
Zygophyllaceae	2	1.6	3	1.4	-	-	-	-
Total	**126**	**100**	**211**	**100**	**28**	**100**	**21**	**100**

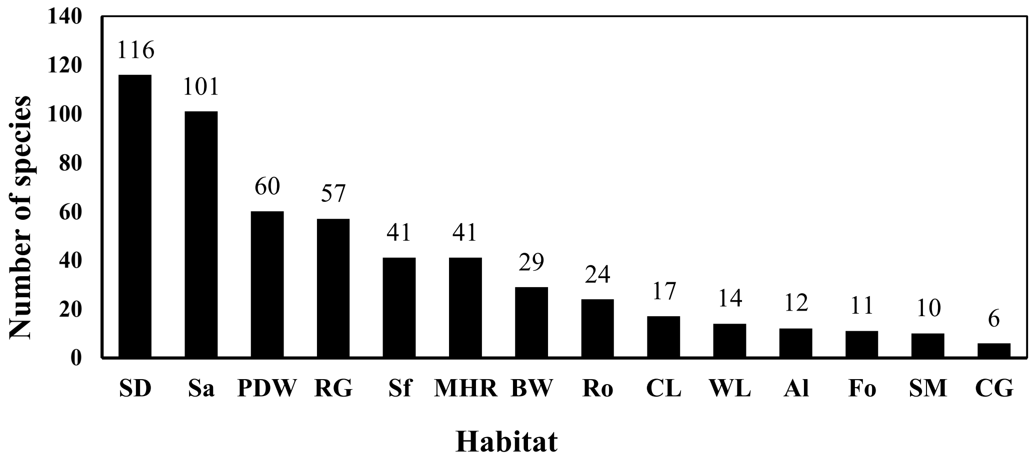

Fig. 1. Number of trees and shrubs in the Egyptian flora in relation to their habitat [Habitats are abbreviated as follows: SD: Sand dunes, Sa: Saline soils, PDW: Plains, depressions and wadis, RG: Rocky ground, SF: Sand flats, MHR: Mountains, hills and ridges, BW: Banks of water bodies, Ro: Road sides, CL: Cultivated lands, WL: Waste lands, Al: Alluvial and loamy soils, Fo: Forests, SM: Salt marshes and CG: Calcareous ground].

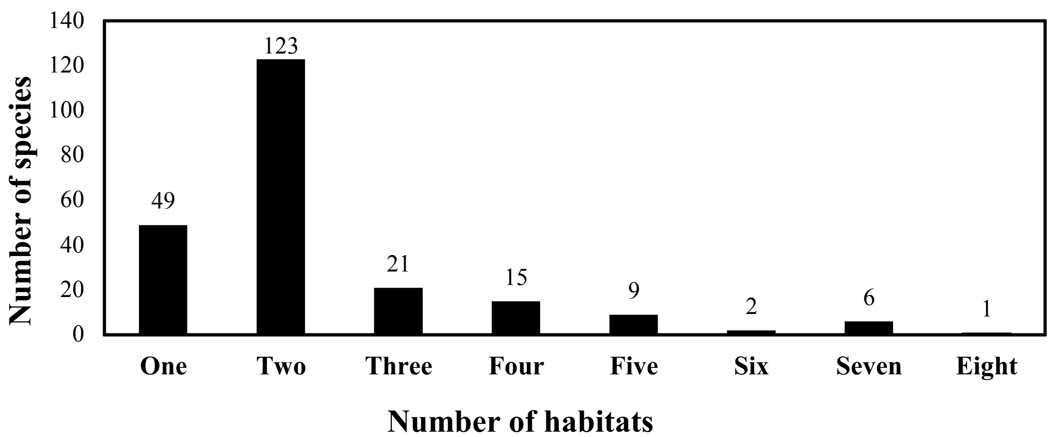

Fig. 2. Number of trees and shrubs in the Egyptian flora in relation to the number of habitats in which they occur.

Flowering time

Analysis of the flowering times of the recorded species indicated that there was a gradual increase in the frequency of the flowered species from December (36 taxa= 15.8%) till reaching a maximum in April (151 taxa= 66.2%) and March (149 taxa= 65.4%) forming positively skewed curve (Fig. 3). Generally, the period from March to May is characterized by the highest flowering activity, while the period from September to December is characterized by the lowest. Regarding the number of months in which the plants are in the flowering stage, it was found that the highest percentage of plants stay flowered in three months of the year (78 plants= 34.2%), followed by the plants that flower in two months (38 plants= 16.7%). There are 7 plants that give flowers all the year (they are *Lycium schweinfurthii, Salsola villosa, Ecbolium viride, Delonix elata, Bergia suffruticosa* and *Boscia angustifolia*), wherease only one species flowers in eleven months (*Capparis decidua*).

Rarity forms

The relation between the number of trees and shrubs and the rarity forms indicated that SNN (small geographic range – narrow habitat – non abundant plants) was the most represented (180 taxa= 78.9%), followed by LNA (large geographic range – narrow habitat – abundant) (23 taxa= 10.1%), LNN (large geographic range – narrow habitat – non abundant) (21 taxa= 9.2%), and LWA (large geographic range – wide habitat – abundant) (6 taxa= 2.6%) (Appendix). *Thymelaea hirsuta* is the only species that is SWN (small geographic range – wide habitat – non abundant) constituting 0.4% of the total trees and shrubs.

Global distribution

The chorology of the recorded species revealed that the Sudano-Zambezian element is the most represented by 107 taxa (46.9% of the total trees and shrubs). This element includes strictly Sudano-Zambezian (monoregional with about 64.5%), biregional (28.1%) and pluriregional taxa (21.5%). Followed by the Saharo-Arabian element that is represented by 98 taxa (43%) including 38.8% monoregional, 51% biregional and 10.2% pluriregional. Then Mediterranean element that is represented by 45 taxa (19.7%) including 31.1% monoregional, 48.9 % biregional and 20% pluriregional. and the Irano-Turanian element is represented by 34 taxa (14.9%) including 29.4% monoregional, 47% biregional and 23.5 pluriregional (Fig. 4).

Local distribution

Ninety two trees and shrubs (40.4%) occur in only one phyto-geographical region. In addition, 26 taxa occur in 2 regions (11.4%), 25 in 3 regions (11%) and 85 taxa occur in more than 3 regions. The Egyptian deserts are the most rich regions with trees and shrubs, comprising 127 taxa (55.8%) of the total trees and shrubs followed by Gebel Elba region (100 taxa = 43.9 %). Red Sea region has the least number of trees and shrubs (53 taxa= 23.2%) (Appendix).

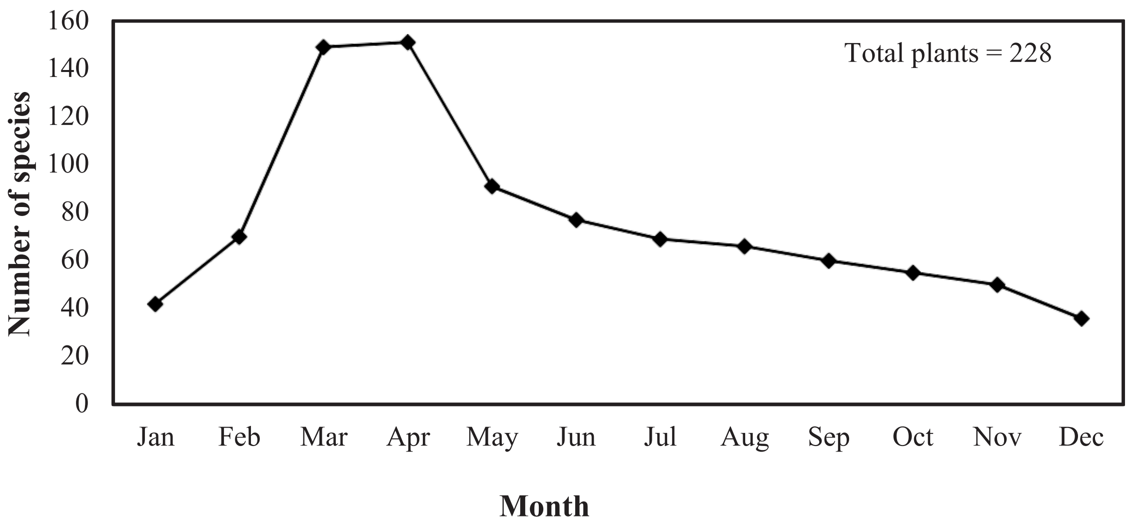

Fig. 3. Number of trees and shrubs in the Egyptian flora in relation to their flowering time.

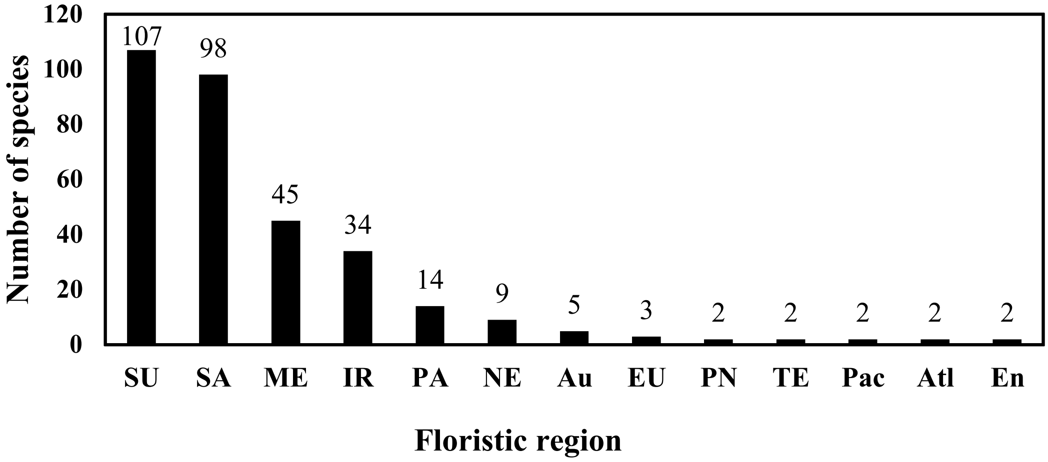

Fig. 4. Number of trees and shrubs in the Egyptian flora in relation to their floristic regions [SU: Sudano-Zambezian, SA: Saharo-Arabian, ME: Mediterranean, PAL: Paleotropical, NE: Neotropical, Au: Australian, EU: Euro-Siberian, PN: Pantropical, TE: Temperate, Pac: Pacific N. American, Atl: Atlantic N. American and En: Endemic].

Goods and services

All the trees and shrubs have at least one aspect of the potential or actual economic goods. The goods are classified into 5 major groups: grazing, medicinal, human food, fuel, timber and other uses (e.g. esthetic concerns, oil, ornamental, breeding work, antimicrobial activity, cosmetics). The offered goods could be arranged descendingly as follows: medicinal (154 taxa= 70.6%) > grazing (76 taxa= 34.9%) > other uses (76 taxa= 34.9%) > fuel (70 taxa= 32.1%) > human food (59 taxa= 27.1%) > timber (53 taxa= 24.3%) (Fig. 5).

One hundred and eighty six trees and shrubs in the Egyptian flora (81.6% of the total species) have at least one aspect of the environmental services. The environmental role of the recorded species could be arranged descendingly as follows: Salinity tolerance (105 taxa) > shading (77 taxa) > soil stabilization (70 taxa) > wind breaks (40 taxa) > sand accumulator (36 taxa) > refuge (33 taxa) > soil fertility (32 taxa) > water storage (14 taxa) > esthetic concerns (14 taxa) > ruderals (9 taxa) > bank retention (7 taxa) > drought resistance (7 taxa) > poisonous plants (6 taxa) > phytoremediator (5 taxa) (Fig. 6).

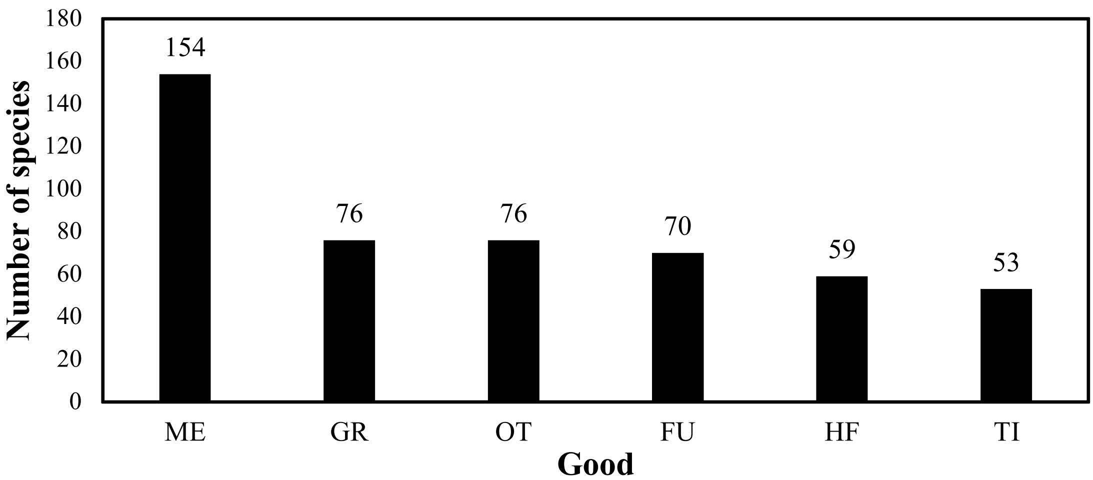

Fig. 5. Descending arrangement of the goods of the trees and shrubs in the Egyptian flora [Goods are coded as: ME: Medicinal, OT: Other uses, GR: Grazing, FU: Fuel, HF: Human food and TI: Timber].

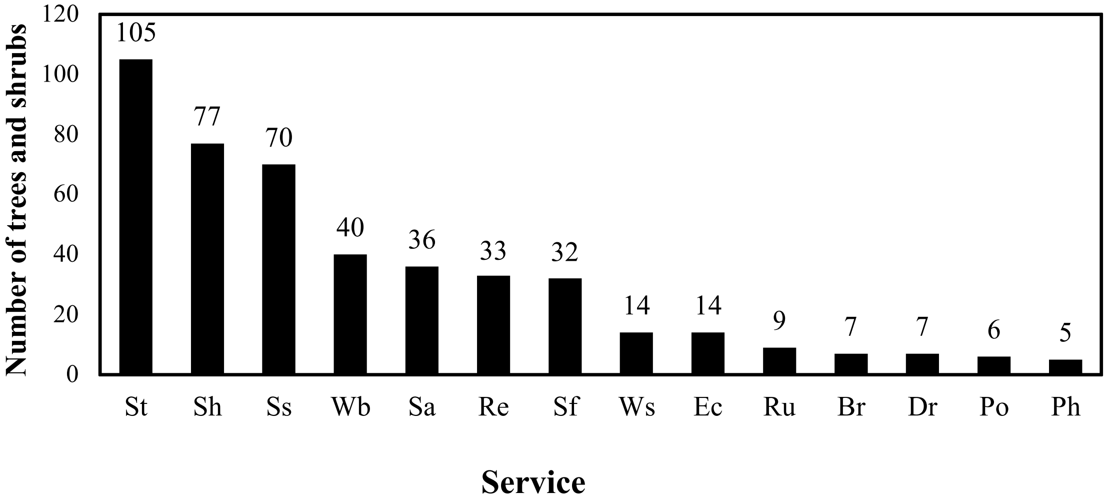

Fig. 6. Number of trees and shrubs in the Egyptian flora in relation to their environmental services. Services are coded as: St: salinity tolerance, Sh: shading, Ss: soil stabilization, Wb: wind breaks, Sa: sand accumulator, Re: refuge, Sf: soil fertility, Ws: water storage, Ec: esthetic concerns, Ru: ruderals, Br: bank retention, Dr: drought resistance, Po: poisonous plants and Ph: phytoremediator.

Threats

Most of the recorded species are 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, disturbance by cars or trampling, urbanization, tourism, climatic changes and environmental conditions. The threats upon trees and shrubs are: over-collecting and over-cutting (180 taxa= 78.9%) > climate changes and environmental conditions (121 taxa= 53.1%) > browsing and over grazing (75 taxa= 33%) > clearance for agriculture (71 taxa= 31.1%) > habitat loss (67 taxa= 29.4%) > urbanization and tourism (59 taxa= 25.9%) > mining and quarrying (31 taxa= 13.6%) > disturbance by cars or trampling (11 taxa= 4.8%) (Fig. 7). The variation according to the number of threats illustrated that 57 taxa are exposed to one threat (25% of the total threatened taxa), 67 to 2 threats (29.4%), 37 to 3 threats (16.2%), 33 to 4 threats (14.5%), 22 to 5 threats (9.6%), 8 to 6 threats (3.5%), 2 (*Anabasis articulata* and *Withania somnifera*) to 7 threats (0.9%). *Suaeda pruinosa* is the only species that is exposed to all the 8 threats.

Physical defense

There are 110 trees and shrubs that have sort of physical defense (48.2% of the total plant taxa). These species were sorted into 4 groups according to their mode of defense. Group I includes 44 taxa (40% of taxa that have physical defense) that have hairy leathery leaves and hairy stems; sometimes the hairs become stiff or rough and irritating (e.g. *Atriplex glauca, Salsola villosa* and *Haloxylon persicum*). Group II comprises 64 taxa (58.2%) with spiny organs such as spiny stipules, leaves, branches, inflorescences and fruits or woody branches with spine-like terminates (e.g. *Atraphaxis spinosa, Salsola spinescens* and *Zilla spinosa* subsp. *spinosa*). Group III includes 5 taxa (4.5%) that have sticky latex and are with unpleasant taste and odour (*Pistacia lenticus, Gomphocarpus sinaicus, Solenostemma arghel* and *Salsola imbricata*). Group IV includes 4 taxa (3.6%) that are covered with scales, dots or spots (*Deverra triradiata, D. tortuosa, Limoniastrum monopetalum* and *Datura metel*) (Fig. 8).

Discussion

The flora of Egypt comprises 2145 species, related to 744 genera and 129 families (Boulos, 2009). This means that trees and shrubs (with mean height ≥ 50cm) represented only 9.9% of the total species, 17% of the total genera and 37.2% of the total families. This agree to some extent with the study of Zahran & El-Ameir (2012) who reported that the natural wealth of the flora of Egypt comprised few trees and shrubs. This may due to almost Egypt was mainly desert (96% of its total area) and it was an arid and hyper arid country.

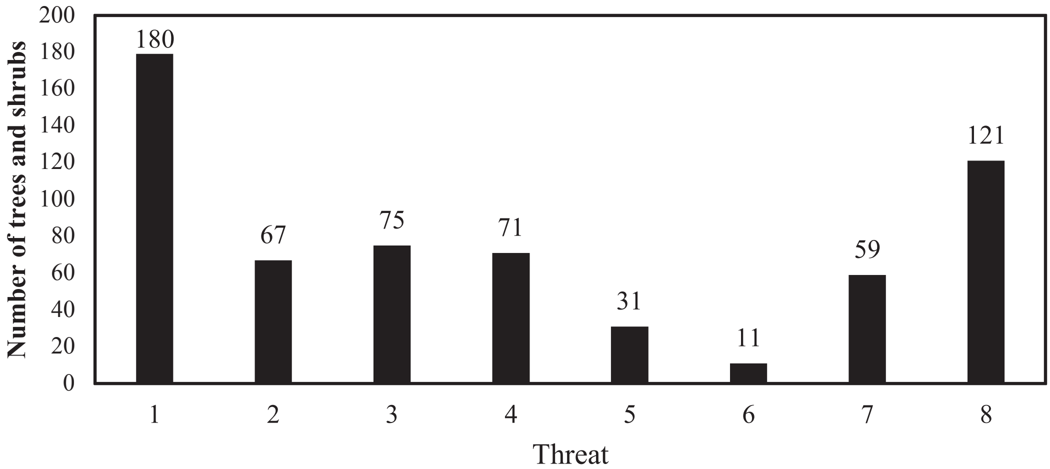

Fig. 7. Arrangement of the threats upon the trees and shrubs in the Egyptian flora [Threat groups are coded as: 1- Over-collecting and over cutting, 2- Habitat loss, 3- Browsing and over-grazing, 4- Clearance for agriculture, 5- Mining and quarrying, 6- Disturbance by cars or trampling, 7- Urbanization and tourism, 8- Climatic changes and environmental conditions].

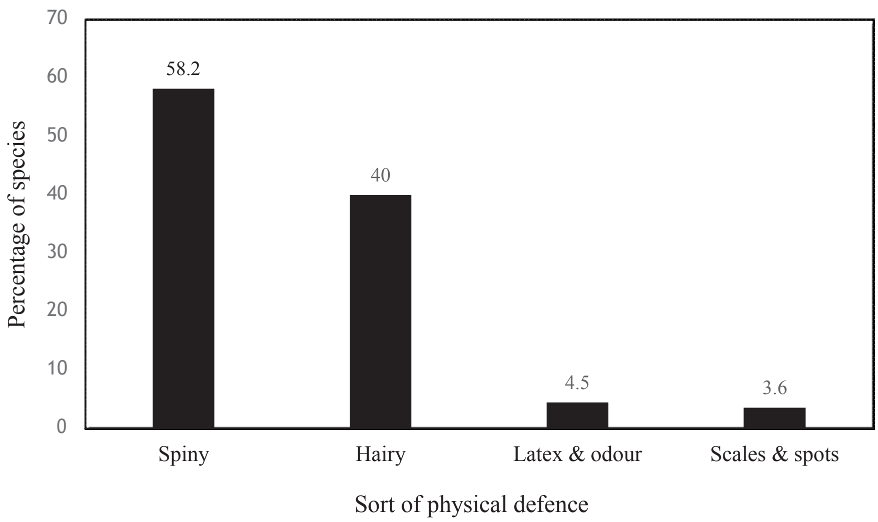

Fig. 8. Physical defence of the trees and shrubs in the Egyptian flora.

Shaltout et al. (2014) reported that there were 14 alien trees and shrubs (13 naturalized and 1 invasive species). The naturalized species were represented as follows: 9 intentionally introduced (*Datura metel, Ficus carica, Lantana camara, Populus euphratica, Ricinus communis, Rubus sanctus, Salix tetrasperma, Sesbania sesban* and *Ziziphus spina-christi*) and 4 accidentally introduced (*Atriplex canescens, A. nummularia, Euphorbia mauritanica* and *Nicotiana glauca*). *Ipomoea carnea* was the only invasive exotic shrub that was introduced into Egypt in 1930 as an ornamental plant. It was native to South America. It grows in dense populations along river beds, banks and canals and may contribute to mosquito nuisance (Eid, 2002). The rapid spread from aquatic to xerophytic habitats indicate that this plant may become an ecological disaster like water hyacinth (Eid, 2002; Shaltout et al., 2010). Regarding the endemism of the recorded species, there are 2 endemics (*Rosa arabica* and *Origanum syriacum* subsp. *sinaicum*) and 5 near-endemics (*Lycium schweinfurthii* var. *aschersohnii, Medemia argun, Pistacia khinjuk* var. *microphylla, Withania obtusifolia* and *Zygophyllum dumosum*) (El-Khalafy, 2018; Shaltout et al., 2018).

Most of the recorded life forms were phanerophytes (120 taxa) whose permanent buds borne at height > 25cm followed by chamaephytes (100 taxa) whose permanent buds borne above the soil surface till a height < 25cm. Phanerophytes are represented by 3 types: nano-phanerophytes, under 2m, micro-phanerophytes, 2-8m and meso-phanerophytes, 8-30m. The only represented chamaephyte was suffruticose chamaephytes in which the permanenting parts remain on the surface of the ground after the herbaceous parts had died away oil the approach of the critical season. There were 2 hemiparasite species (*Plicosepalus curviflorus* and *P. acacia*) on *Acacia* trees and can do photosynthesis at the same time. *Ononis natrix* and *Crotalaria aegyptiaca* were protohemicryptophytes whose permanent buds borne close to soil surface and have only stem leaves. *Euphorbia polycantha* and *E. consobrina* were stem succulents having stems without proper foliage leaves. *Asparagus stipularis* was the only geophyte-helophyte whose permanent buds borne under soil surface or in the mud overlain by water.

In general, the period from March to May (i.e., spring season) was characterized by the highest number of flowered trees and shrubs, while the period from August to January had the lowest number. In Egypt the highest humid period of the year extended from November to April which was associated with low temperatures and evaporation; therefore, much favorable soil moisture. During this period, the plants start their growth activity reaching to the flowering and fruiting stages in March, April and May (Boulos & Hadidi, 1986; Griffiths, 1992; Bircher, 1998; Burnie et al., 2004; Heneidy, 2010). Neverthless, phanerophytes (e.g. *Calotropis procera, Ficus palmata* and *Leptadenia arborea*) flower from May to August. This totally agrees with El-Khalafy (2018) who reported that most species flowered from March to May, except phanerophytes from May to August. Also with Raunkiaer (1937) who reported that phanerophytes flower in dry periods.

Flowering plants exhibit unparalleled diversity of sexual systems, or gamete packaging within and among individuals (Barrett, 2002). This diversity mostly involves monomorphic populations with only hermaphroditic individuals, as only 6% of angiosperm species have polymorphic sexual systems with mixtures of hermaphroditic, female and/or male individuals (Tomaszewski et al., 2018). In present study, most of the recorded species were bisexual. The preponderance of the hermaphroditic species was a common feature in most floras of the world (Lewis, 1941). The eco-evolution of hermaphroditic flowers with animal pollination might be an important advancement by early angiosperms since pollen-producing and pollen-receiving organs in the same flower allowed for efficient simultaneous deposition and removal of pollen (Baker & Hurd, 1968).

In the present study, the dioecious species (15%) were as low as monoecious species (13.6%). Unisexuality was considered as an adaptation to undergo only cross pollination, which was beneficial over the self-pollination (Panawala, 2017). Bram & Quinn (2000) reported that the percentage of dioecious angiosperms have been reported to be low. Queenborough et al. (2009) reported that the low number of dioecious species may be due to that these species suffer a reproductive handicap because populations of dioecious species contain fewer seed-producing individuals. In the presented study, most of dioecious species were phanerophytes (82.3%), which coincided with the theory that assumes an increase in the frequency of dioecy was correlated with an increase in the plant size (Senarath, 2008). A recent study found that in habitats with high levels of light, plants were more likely to change their sexual expression and reproductive output (Varga, 2016). There were 7 polygamous sex-labile species in the present study. One of them was *Thymelaea hirsuta* that had 7 sex states: Male, female, monoecious unisexual, hermaphrodite, andromonoecious (male and hermaphrodite flower), gynomonoecious (female and hermaphrodite flower) and trimonoecious (male, female and hermaphrodite flower) (Shaltout & El-Keblawy, 1992). This could be affected by the age of the plant and the integrated sum of all earlier interactions with its environment.

Croteau (2010) reported that Passive dispersal involves plants that cannot themselves move but use dispersal units called disseminules to aid in reproduction or the exploitation of new habitats. Many disseminules were adapted for movement by specific dispersal agents available in the environment, like wind, water, or another animal capable of active dispersal, or species may have a motile larval stage. These include seeds, spores, and fruits, all of which have modifications for movement away from the parent plant via available environmental kinetic energy. Distance traveled by a disseminule was a result of the velocity and direction of movement by the dispersal agent. The size of a population depends on the number of available seeds, the efficiency of dispersal and the availability of safe sites for seed germination (Harper et al., 1961). The predominance of the sarcochores (soft and fleshy diaspores) indicated that the principal mode of dissemination was the sarcochory (zoochory). The wide distribution of ballochoric species (diaspore forcibly ejected from parent plant) may be due to the explosive nature of their fruits, which is often related to rapid desiccation and hence efficient local seed dispersal (Al-Sodany, 1998). The commonness of pogonochoric species (diaspore has long hairs), microsclerochores (diaspores of very light weight) and pterochores (diaspore with scarious wing like appendages) and rarity of barochores (very heavy diaspores), cyclochores (voluminous diaspores) and desmochores (diaspores adhere to rough surfaces) reflect the suitability for wind dispersal in Egypt. The only auxochoric species (there is no disarticulating from parent plant before diaspore is deposited at a site of further development) in this study is *Ipomoea carnea* that grows on banks of water bodies.

In present study the Desert Region (127 taxa) has the highest number of trees and shrubs. These plants show a number of morpho-physiological features that allow them to adapt with the high aridity and low nutrient availability which characterizes the arid environments, such as deep root systems, tolerance to high radiation levels and capacity for clonal spread, presence of thorns and spines and small leaves (Nobel & Franco, 1989; Pugnaire et al., 1996a, b). Followed by Gebel Elba Region (100 taxa), that has annual rainfall 400mm due to the fact that the coast, slightly curved to the east at this point, presents an unusually broad front to the sea across a 20–25km strip of relatively flat land, which facilitates interception of moisture-laden north-east sea winds. Then Sinai Peninsula (97 taxa) that has rock and soil types that make existence of plants possible. In addition to the landscape that is characterized by a variety of landforms (plains, wadis, springs, salt marshes and sand dunes). There was in fact a great deal of water draining down the wadis, sometimes as violent and destructive flash floods, but under normal circumstances, most of the water was underground, occasionally surfacing to produce short sections of freely flowing permanent water, thus making the area rich in plants. Besides, the great diversity of climate (mean annual precipitation decreases from about 100mm in the north, near the Mediterranean, to 5–30mm in the south (Abd El-Ghani et al., 2017). The vegetation was characterized by sparseness of plant cover of semi-shrubs, restricted to wadis or growing on slopes of rocky hills and in sand fields (Danin, 1986). Seventy six taxa were present in the Mediterranean region that has annual precipitation 275-900mm with at least 65% falling during winter. The Mediterranean vegetation was dominated by evergreen sclerophyllous shrubs that form maquis (over 2m in height), garrigue and jaral (0.6-2m), phrygana or batha (< 0.6m) plant communities (Archibold, 1995).

A mixture of different floristic elements such as Sudano-Zambezian, Saharo-Arabian, Mediterranean, Irano-Turanian and Paleotropical were represented by the highest number of species. This could be attributed to human impact, agriculture and capability of certain floristic elements to penetrate the study area from several phytogeographical regions (Seif El-Nasr & Bidak, 2006). Sudano-Zambezian and Saharo-Arabian chorotypes form the major floristic structures of the study area. Plants of Saharo-Arabian chorotype were good indicators for the desert environmental conditions (Abd El-Ghani & Amer, 2003). The high percentage of regional endemics (61.4% of total species) may be due to a physical barrier, narrow range of ecological tolerance, low reproductive investments or limited dispersal capacity of diaspores (Baumel et al., 2010).

There are many ways in which a species can be rare; a theoretical framework of an eight-celled table is proposed by (Rabinowitz, 1981) for the different types of rarity depending on range, habitat specificity and local abundance. In the present study, 180 taxa (78.9% of the total trees and shrubs) belonged to SNN cell, followed by LNA (23 plants= 10.1%), and LNN (21 plants= 9.2%) Taxa that belonged to SNA and SNN were the classic rarities in the sense of restricted endemics, often endangered or threatened. Both internal and external factors cause plants to become rare. Internal factors refer to the plant biological characteristics, including failures in heritability, reproduction, viability, and adaptability. External factors include both natural and human factors. Natural factors refer to the ecological environment, including climate, topography, soil, and other biological factors (Chen, 2014). Taxa which have large ranges, but are associated with particular habitats were generally quite predictable in their occurrence (LNA & LNN), these taxa tend to be precarious as a result of habitat destruction (Ahmed, 2009); this may be due to human disturbances, roads, and land use types.

On the other hand, no species belonged to SWA cell (small range, wide habitat and abundant species), while one species (*Thymelaea hirsuta*) belongs to SWN; this is revert to demographic stochasticity, while a process in small populations analogous to genetic drift, and which in fluctuating population numbers, due to small sample phenomena, may cause local extinction (Rabinowitz, 1981). These deletions of populations may reduce the variety of habitats occupied and in essence, convert perhaps the species into one in the categories SNA and SNN (Rabinowitz 1981). The percentage of rare species (SNN and SWN) approximates 78.9 % of the total trees and shrubs, whereas the common species (LNA, LNN and LWA) attained 21.9 %, this finding provides an alarm to consider conservation of natural vegetation of trees and shrubs in Egypt as a must.

All the trees and shrubs have at least one aspect of the potential or actual economic goods. There were 154 taxa that had medicinal uses (70.6% of the total species). For example, the antioxidant activity, polyphenolic content and anticancer activity of *Salvadora persica* that was used by ancient Arabs to whiten and polish the teeth. A recent research reported that *S. persica* extract was rich in antioxidants and in polyphenols, which merited further investigations. Herein, *S. persica* was shown to exhibit antiangiogenic and anti-proliferative activities, a discovery that makes this species a promising source of anticancer agent development especially for solid tumors such as liver cancer (Al -Dabbagh et al., 2018). The extract *Juniperus phoenicea* was used by the bedouins for treating diabetes (Moustafa et al., 2016).

Seventy six taxa can be grazed and browsed by the domestic and wild animals (34.9% of the total trees and shrubs) (e.g. *Salix mucronata, Atriplex glauca, Deverra tortuosa, Atriplex farinosa* and *Sarcocornia fruticosa*). There are some examples of selective use of different plant organs at different seasons. Small branches of *Tamarix nilotica* were apparently good for camels and goats, while sheep prefer its flowers only (Shaltout & Al-Sodany, 2000).

Seventy taxa are subjected to cutting for fuel (32.1%) (e.g. *Lycium schweinfurthii, L. shawii, Sarcocornia fruticose* and *Tamarix* trees (Shaltout & A-Sodany, 2002). Hassan et al. (2015) and Al-Sodany et al. (2019) reported that the biomass of *Calotropis procera* was used in biofuel and bioenergy production. The timber plants were limited allover Egypt. There were 53 trees and shrubs (24.3%) suitable as timber such as *Phoenix dactylifera* and *Tamarix* trees (Shaltout & Ahmed, 2012). Fruits, flowers, vegetative and ground parts of 59 taxa (27.1% of the total taxa) were eaten by local inhabitants. For example, *Deverra tortuosa* was eaten as a salad and dates of *Phoenix dactylifera* were eaten (Shaltout & Ahmed, 2012). Seventy six taxa (34.9% of the total good plants) are of several traditional uses. Some species have an ornamental value (e.g. *Ipomoea carnea*), others are used in manufacture of soap (e.g. *Atriplex halimus*) (Shaltout & Al-Sodany, 2002). *Deverra tortuosa* may be used as a natural herbicide as well as a good source for yeast control (Guetat, 2018). The wood of *Phoenix dactylifera* was used as a tooth brush (Shaltout & Ahmed, 2012) A recent study on *Pluchea dioscoridis* proved that the ethanolic leaf extract of it has antifungal activity (Metwally et al., 2020)..

One hundred and eighty six trees and shrubs in the Egyptian flora (81.6% of the total recorded species) have at least one aspect of the environmental services. Salinity tolerant plants (the halophytic vegetation) inhabit the extensive salt affected lands, along the coastal belts (littoral salt marshes) and also in the inland oases and depressions. These plants adapt to live in saline environments either by succulents, excrete, or cumulates (e.g. *Atriplex* spp., *Nitraria retusa, Suaeda monoica* and *Tamarix* spp.) (Zahran & El-Ameir, 2012). Thus, having a role in decreasing soil salinity. Many species have the ability to tolerate salinity through formation of phytogenic mounds (e.g., *Artemisia monosperma, Limoniastrum monopetalum* and *Nitraria retusa*), which help in fixation of sand and provide refuge and shelter for many other species (Bidak et al., 2015).

Drought tolerant plants (the xerophytic vegetation) were the most characteristic type of the natural plant life in Egypt's deserts. They cover vast areas of the wadis, desert plains and mountains (e.g., *Acacia* spp., *Anabasis articulata, Calotropis procera* and *Olea europaea*) (Zahran & El-Ameir, 2012). Sand accumulators (such as *Nitraria retusa, Ricinus communis* and *Tamarix* trees) play a role in preventing soil erosion, increasing soil deposition and improving drainage of low lands (Seif El-Nasr & Bidak, 2005a). Sometimes they make efficient windbreaks that propagate themselves either by seeds or by creeping root systems (e.g., *Ricinus communis* and *Tamarix* trees) (Shaltout & Ahmed, 2012).

Thirty two trees and shrubs have a role in soil fertility. Most of them belong to family Fabaceae (e.g. *Acacia* spp., *Ononis vaginalis* and *Sesbania sesban*). They form a symbiotic association with species of bacteria (*Rhizobium* spp*., Bradyrhizobium* spp., and others). These bacteria take nitrogen from the air and fix it into a form that is usable by the legume plant.

Many trees and shrubs make soil stabilization (e.g. *Suaeda vermiculata, Limbarda crithmoides* and *Asparagus stipularis*) by making intricate root system that holds the soil together or forming phytogenic mats, clumps or mounds that prevent the surface of soil from being disturbed and provide refuge and shelter for many other species. Some of the small trees such as *Salix* and *Acacia* trees are noted for their bank retention quality because of their interloping root systems that form dense network. The shading caused by trees and some shrubs keeps down the growth of weeds (Shaltout & Ahmed, 2012). A study on size structure of some trees and shrubs revealed that their diameter exceeds the height i.e. they expand horizontally, thus providing shade which leads to decreasing the heating effect, increasing soil moisture and providing safe site for their self-regeneration (Galal, 2011).

In the present study, there are 5 taxa that have the ability to accumulate toxic metals, thus can be used in phytoremediation of pollutants (they are *Phyllanthus reticulatus* var. *reticulatus, Pistacia lenticus, Tamarix macrocarpa Pluchea dioscoridis* and *Calotropis procera*). *Phyllanthus reticulatus* had some capacity for phytoremediating chromium (Sampanpanish et al., 2006). *Calotropis procera* showed higher Pb (lead) and cd in their leaves and a positive correlation between Mn concentration in the soil and the plant (Galal et al., 2016). *Pistacia lenticus* was proved to accumulate heavy metals mostly in roots (Bacchetta et al., 2012). Recent researches highlight that *Tamarix aphylla* could be useful in the remediation of polycyclic aromatic hydrocarbons (PAHs) contaminated alkaline saline soil. *Pluchea dioscoridis* was considered a hyper-accumulator of Fe (Eid & Shaltout, 2016). It is proved that it accumulates Cr (Ahmed et al., 2018).

Threats to the world's plants continue to increase as a result of human activities (IUCN, 2003, 2010). From the well-documented threats are habitat loss, poor land management, over-collection, over-grazing, and climate change. Most studies suggest that the rate at which plant species are being lost, or at least reduced in numbers, is faster than the speed at which scientists; land managers, policy-makers, and others can or will respond (IUCN, 2003, 2010). The human impact was a dominant factor in arid environments of the world (Chapman & Reiss, 1992). Most trees and shrubs were subjected to over-collecting and over-cutting by local inhabitants, herbalists and scientific researchers. The collection of wild native medicinal plants for commercial trade had no regulation. The most serious aspect was that it usually targets rare and localized flora leading to damage them further (Seif El-Nasr & Bidak, 2005a). There was an increasing demand by local Bedouin populations for fuel woods, targeting larger woody perennials (especially woody branches and roots). The elimination of large woody perennials (which take many years to reach mature sizes) severely reduces the structural complexity of an already highly exposed environment, rapidly accelerating soil movement and erosion, reducing water retention potential and the chances of germination of annuals and smaller plants to become established The removal of woody perennials initiates the first steps in a process of complete transformation of the natural landscape (Seif El-Nasr & Bidak, 2005a). For example, the small populations of *Juniperus phoenicea* at Gabal El-Maghara and

Gabal Yelleq that were under intensive cutting and burning (El-Bana et al., 2010) and mortality of *Acacia* trees which mainly associated with charcoal production in the eastern desert of Egypt (Andersen & Krzywinski, 2007).

Seventy-five trees and shrubs are subjected to over-grazing where sheep and goats severely depleted the natural vegetation and compete directly with native wildlife over the same food resource (Seif El-Nasr & Bidak, 2005a). For example, Local populations of *Moringa peregrina* were endangered due to over-grazing whose effects were magnified by the extreme of drought. So, failure of regeneration of new individuals, as well as high mortality rate of the old trees occur (Zaghloul et al., 2012). Habitat loss due to urbanization and tourism, clearance for agriculture and construction processes is one of the major threats which impact many species in the Egyptian flora especially in the Mediterranean region. An almost continuous row of tourist facilities occupies the coastline along the North coast. This has not only led to the complete destruction of the habitats, but also its degradation of vast areas of habitat surrounding them. Consequently, this threatens plants in these habitats (e.g., *Lycium europaeum, Thymelaea hirsute* and *Limbarda crithmoides*) (Shaltout & Ahmed, 2012).

Seventy one taxa in present study are damaged during agricultural processes. In the past, donkeys and simple tools were used for plowing, which did not allow the complete elimination of perennial vegetation; leaving behind natural vegetation patches. Nowadays, modern machinery completely removes perennial shrubs (e.g. *Calligonum polygonoides* subsp. *comosum, Nitraria retusa* and *Pluchea dioscoridis*), which provide complexity and shelter to wildlife (Shaltout & Ahmed, 2012).

Thirty one taxa are exposed to mining and quarrying; one of the major processes causing degradation in the ecosystems of many Egyptian regions due to complete destruction of plant cover (e.g. *Lycium shawii* and *Suaeda vermiculata*) (Seif El-Nasr & Bidak, 2005b). The rocky ridges parallel to the sand dune belt were subjected to severe quarrying for making limestone bricks. This had caused the eradication of the ridge in many sites resulting in loss of the associated wild life (Batanoumy, 1999).

Climate change, a threat that was still somewhat theoretical in 2005, is becoming more evident and the mitigation of its effects on much localized species represents an important challenge. Due to climate change, the wild population of species could be in extreme danger in a relatively near future. The most important natural threats are the long-lasting droughts and the difficulties of some species to reproduce as a result of long seed dormancy (e.g. *Rosa arabica*) (Omar, 2017). For example, *Acacia tortilis* subsp. *raddiana, Balanites aegyptiaca* and *Calotropis procera* in Wadi Allaqi that showed J-shaped distribution indicating severe decline due to high aridity, natural floods and other environmental constrains (Shaltout et al., 2009).

Most of threats come from the lack of awareness, weak law enforcement, the lack of suitable strategies, a weak financial support and the lack of stakeholder's cooperation. In general, the major effective threats are over- cutting, over-collecting, and over-grazing which are dominant in North Sinai and Mediterranean; habitat loss, urbanization, tourism and clearance for agriculture which are abundant in the Mediterranean and Red Sea coasts as well as Sinai.

Some plants have defensive parts that reduce or avoid consumption by herbivores (Heneidy & Bidak, 1999). In the present study, 4 groups of physical defense were recognized in 117 taxa. The first group includes 64 plants with modified parts such as spines or spinescent branches and may be considered as grazing-resistant species (e.g. *Zilla spinosa, Asparagus stipularis* and *Cornulaca monacantha*) or has defensive parts in the form of densely woody pointed terminates or short spine-like branches (e.g. *Lycium* species). The defensive parts of this group (mostly shrubs or sub-shrubs) are acquired as a result of herbivores attack or are already formed in the early stages of the plant life cycle (Shaltout & Ahmed, 2012).

The second group includes 44 plants with hairy leathery leaves or stem (e.g. *Atriplex glauca, Salsola imbricata* and *Diceratella elliptica*). (Grime & Blyth, 1968) reported that epidermal hairs reduce the palatability of range species or inhibit the passage of food through the gut of animals. Diaz & Cabido (2009) reported that hairy plants may be drought-tolerance adaptations, and (Perkins, 2010) reported that the hairy plants could help in reflecting more sunlight, reducing detrimental heating of the plant. The third group includes 5 taxa that have sticky latex and that are with unpleasant taste and odour (*Pistacia lenticus, Gomphocarpus sinaicus, Solenostemma arghel* and *Salsola imbricata* with its two subsp. *imbricata* and *gaetula*). They seem to be toxic for livestock (Shaltout & Ahmed, 2012). The fourth group includes 4 taxa that are covered with scales, dots or spots (*Deverra triradiata, Deverra tortuosa, Limoniastrum monopetalum* and *Datura metel*). A scale or peltate hair is a type of trichome that has a plate or shield-shaped cluster of cells attached directly to the surface or borne on a stalk of some kind and had a role in physical defense against insect herbivores (Cardoso, 2008).

References

Abd El-Ghani, M., Fahmy, A. (1994) Studies on the threatened woody perennial taxa in the flora of Egypt II. Extinct and endemic taxa. *Feddes Repertorium,* **105**, 243-250.

Abd El-Ghani, M., Amer, W. (2003) Soil–vegetation relationships in coastal desert plain of southern Sinai, Egypt. *Journal of Arid Environments,* **55**, 607-628.

Abd El-Ghani, M., Huerta-Martínez, F., Quresh, R. (2017) "*The Desert of Egypt*". Springer. pp. 11-20.

Abd El-Wahab, R., Seleem, T., Zaghloul, M., El-Rayes, A., Moustafa, A., Abdel-Hamid, A. (2013) Anthropogenic effects on population structure of *Acacia tortilis* subsp. *raddiana* along a gradient of water availability in South Sinai, Egypt. *African Journal of Ecology*, **52**(3), 308-317.

Agren, J., Zackrisson, O. (1990) Age and size structure of *Pinus sylverstris* populations on mires in central and northern Sweden. *Journal of Ecology,* **78**, 1049-1062.

Ahmed, D. (2009) Current situation of the flora and vegetation of the Western Mediterranean Desert of Egypt. *Ph.D. Dissertation*. Tanta University, Tanta, Egypt.

Ahmed, D., El-Bheiry, M., Sharaf, A., Tarek, G. (2018) Factors affecting the distribution of *Pluchea dioscoridis* (L.) DC. and its associated species in Gharbia Governorate, Nile Delta, Egypt. *Taeckholmia,* **38**, 1-16.

Al-Dabbagh, B., Elhaty, I., Murali, C., Madhoon, A., Amin, A. (2018) *Salvadora persica* (Miswak): antioxidant and promising antiangiogenic insights. *American Journal of Plant Sciences*, **9**, 1228-1244.

Al-Sodany, Y. (1998) Vegetation analysis of the canals, drains and lakes of the northern part of Nile Delta. *Ph. D. Dissertation*, Tanta University, Tanta.

Al-Sodany, Y., Kahil, A., Al-Juaid, N. (2019) Population demography of *Calotropis procera* (Ait.) R. Br. In Taif Region, Saudi Arabia. E*gyptian Journal of Botany*, **59**(3), 567-579.

Andersen, G., Krzywinski, K. (2007) Mortality, recruitment and change of desert tree populations in a hyper-Arid environment. *Plos One*, **2**(2): e208. doi:10.1371/journal.pone.0000208.

Archibold, O. (1995) "*Ecology of World Vegetation*". Chapman and Hall, London.

Ayyad, M., Ghabbour, S. (1986) Hot deserts of Egypt and the Sudan. Chapter 5. In: "*Ecosystems of the World B. Hot Deserts and Arid Shrub*", Eveneri, M. et al. (Eds), pp.149-202. Elsevier, Amsterdam.

Baccheta, G., Cao, A., Cappai, G., Carucci, A., Casti, M., Fercia, M., Lonis, R., Mol, F. (2012) A field experiment on the use of *Pistacia lentiscus* L. and *Scrophularia canina* L. subsp. bicolor (Sibth. et Sm.) Greuter for the phytoremediation of abandoned mining areas. *Plant Biosystems*, **146**(4), 1054-1063.

Baker, H., Hurd, P. (1968) Intra-floral ecology. *Annual Review*, **13**, 385-414.

Barrett, S.C.H. (2002) The evolution of plant sexual diversity. Nat. Rev. *American Journal of Botany,* **101**, 1588-1596.

Batanoumy, K. (1999) The Mediterranean coastal dunes in Egypt: An endangered landscape. *Estuarine, Coastal and Shelf Science*, **49**, 3-9.

Baumel, A., Youssef, S., Véla, E., Juin, M., Dumas, E., Affre, L., Tatoni, T. (2010) Potentials causes of narrow endemism Factors driving endemism of an annual Mediterranean plant species. *Proceedings of Evolutionary Biology Meeting,* Marseille. Also at websitehttps://www.researchgate.net/publication/316273429_Potentials_causes_of_narrow_endemism_Factors_driving_endemism_ of_an_annual_Mediterranean_plant_species

Bidak, L., Kamal, S., Hamly, M., Heneidy, S. (2015) Goods and services provided by native plants in desert ecosystems: Examples from the northwestern coastal desert of Egypt. Elsevier, *Global Ecology and Conservation*, **3**, 433-447.

Bircher, W. (1998) Delchevalerie" Les Plantes Exotiques Cultivées en Égypte" an Updated English Version. *Taeckholmia*, **18**(2), 1-111.

Boulos, L. (1995) "*Flora of Egypt Checklist*". Al-Hadara Publishing, Cairo, Egypt.

Boulos, L. (1999) "*Flora of Egypt*": Volume 1. Al-Hadara Publishing, Cairo, Egypt.

Boulos, L. (2000) "*Flora of Egypt*": Volume 2. Al-Hadara Publishing, Cairo, Egypt.

Boulos, L. (2002) "*Flora of Egypt*": Volume 3. Al-Hadara Publishing, Cairo, Egypt.

Boulos, L. (2005) "*Flora of Egypt*": Volume 4. Al-Hadara Publishing, Cairo, Egypt.

Boulos, L. (2009) "*Flora of Egypt Checklist*" Revised Annotated Edition. Al-Hadara publishing, Cairo, Egypt.

Boulos, L., El-Hadidi, N. (1986) "*The Street Trees of Egypt*". The American University in Cairo Press, Cairo, Egypt.

Bram, M., Quinn, J. (2000) Sex expression, sex-specific traits and the effect of salinity on growth and reproduction of *Amaranthus cannabinus*. *American Journal of Botany*, **87**, 1609-1618.

Burnie, G., Forrester, S., Guest, S., Harmony, M., Lavarack, P., Letgett, M., McDonald, R., Macoboy, S., Molyneux, B., Moodie, D., Moore, J., Newman, D., North, T., Piennaar, K., Purdy, G., Silk, J., Ryan, S., Schien, G. (2004) "*Botanica*", Ullmann Press, China.

Byng, J., Chase, M., Christenhusz, M., Fay, M., Judd, W., Mabberley, D., Sennikiv, A., Soltis, D., Soltis, P., Stevens, P. (2016) An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV. *Botanical Journal of Linnean Society*, **181**, 1-20.

Cardoso, M, (2008) Ecology, Behavior and Binomics: Herbivore Handling of a Plant's Trichome: The Case of *Heliconius charithonia* L. (Lepidoptera: Nymphalidae) and *Passiflora lobata* (Kilip) Hutch. (Passifloraceae). *Neotropical Entomology*, **37**(3), 247-52.

Chapman, J., Reiss, M. (1992) "*Ecology Principles and Applications*". Cambridge University Press. Cambridge, England.

Chen, Y., Yang, X., Yang, Q., Li, D., Long, W., Luo, W. (2014) Factors affecting the distribution pattern of wild plants with extremely small populations in Hainan Island, China. *Plos One*, **9**(5), 1-15.

Crisp, M., Lange, R. (1976) Age structure, distribution and survival under grazing of the arid-zone shrub *Acacia burkitii*. *Oikos*, **27**, 86-92.

Croteau, E. (2010) Causes and consequences of dispersal in plants and animals. *Nature Education Knowledge*, **3**(10), 12.

Danin, A. (1986) Flora and vegetation of Sinai. *Proceedings of Royal Society of Edinburgh* **89**, 159-168.

Dansereau, P., Lems, K. (1957) The Grading of Dispersal Types in Plant Communities and their Ecological Significance. *Institut Botanique de L'Universitè de Montrèal, Montrèal,* **71**, 1-52.

Diaz, S., Cabido, M. (2009) Plant functional types and ecosystem function relation to global change. *Journal of Vegetation Science*, **8**(3), 463-474.

Eid, E. (2002) Population Ecology of *Ipomoea carnea* Jacq. In the Nile Delta region. *M.Sc. Dissertation,* Tanta University, Tanta, Egypt.

Eid, E., Shaltout, K. (2016) Bioaccumulation and translocation of heavy metals by nine native plant species grown at a sewage sludge dump site. *International Journal of Phytoremediation*, **12**, 1075-1085.

El-Bana, M., Shaltout, K., Khalafallah, A., Mosallam, H. (2010) Ecological status of the Mediterranean *Juniperus phoenicea* L. Relicts in the Desert Mountains of North Sinai, Egypt. *Flora,* **205**, 171-178.

El-Hadidi, M., Hosni, H.A. (2000) Chapter 3:

Conservation and threats. In: "*Flora Aegyptiaca 1(1)*" M.N. El Hadidi (Ed.). The Palm Press and Cairo University Herbarium, Cairo, Egypt.

El-Khalafy, M. (2018) Red list of the endemic and near endemic plant species in Egypt. *M.Sc. Dissertation*, Tanta University, Tanta, Egypt.

Feinbrun-Dothan, N. (1978) "*Flora Palaestina*": Part 3. The Israel Academy of Science and Humanities, Israel Jerusalem Academic Press, Jerusalem.

Feinbrun-Dothan, N. (1986) "*Flora Palaestina*": Part 4. The Israel Academy of Science and Humanities, Israel Jerusalem Academic Press, Jerusalem.

Galal, T.M. (2011) Size structure and dynamics of some woody perennials along elevation gradient in Wadi Gimal, Red Sea coast of Egypt. *Ecologia*, **1**(1), 56-67.

Galal, T.M., Farahat, E., El-Midany, M., Hassan, L. (2016) Nutrients and heavy metals accumulation by the giant milkweed Calotropis procera in urbanized areas. *Egypt. Rendiconti Lincei*, **27**, 241-250.

Good, R. (1974) "*The Geography of Flowering Plants*" 4th ed. Longman, London.

Griffiths, M. (1992) "*The New Royal Horticultural Society Dictionary of Gardening*", 4 Vol. Publisher Macmillan, UK.

Grime, G., Blythe, G. (1968) An investigation of leaf palatability using the snail. *Genetics*, **3**, 274-284.

Guetat, A., Boulila, A., Boussai, M. (2018) Phytochemical profile and biological activities of Deverra tortuosa (Desf.)DC.: A desert aromatic shrub widespread in Northern Region of Saudi Arabia. *Natural Product Research*. Also at https://doi.org/10.1080/14786419.2018.1460842

Harper, J., Clatwarthy, J., Mc-Naughton, I., Sagar, G. (1961) The evolution and ecology of closely related species living in the same area. *Evolution*, **15**, 209-227.

Hassan, L., Galal, T., Farahat, E., El-Midany, M. (2015) The biology of *Calotropis procera* (Aiton) W.T. *Trees*, **29**, 211-320.

Heneidy, S., Bidak, L. (1999) Physical defenses and aversion factor of some forage plant species in the Western Mediterranean coastal region of Egypt. Journal of Union of Arab Biologists, **9** (B), 15-30.

Heneidy, S. (2010) "*Plant Altas*", The Botanic Garden (Alex). Faculty of Science, Alexandria University, Monsha'a Al Maaref, Alexandria, Egypt.

IUCN (2003) Guidelines for Application of IUCN Red List Criteria at Regional Levels: Version 3.0. IUCN Species Survival Commission. IUCN, Gland, Switzerland &Cambridge, UK.

IUCN (2010) Standards and Petitions Subcommittee. 2010. Guidelines for using the IUCN Red List Categories and Criteria. Version 8.1. Prepared by the Standards and Petitions Subcommittee in March 2010.

Lewis, D. (1941) The evolution of sex in flowering plants. *Biological Review of Cambridge, Philosophical Society,* **17**, 46-67.

Lund, H. (2015) Definitions of 'tree' and 'shrub'. Unpublished Report. Forest Information Services. Gainesville, USA.

Lykke, A. (1998) Assessment of species composition change in savanna vegetation by means of woody plant's size class distributions and local information. *Biodiversity and Conservation*, **7**, 1261-1275.

Metwally, M., Mubarak, H., Gamea, A., El-Zawawy, N. (2020) Isolation, characterization and identification of the active antifungal compunds from ethanolic leaf extract of *Pluchea dioscoridis*. *Egyptian Journal of Botany*, **60** (In press).

Moustafa, A., Zaghloul, M., Abd El-Wahab, R., Alsharkawy, D., Ismail, M., Salman, A. (2016) Ecological Prominence of *Juniperus phoenicea* L. Growing in Gebel Halal, North Sinai, Egypt. *Catrina*, **15**(1), 11-23.

Mueller-Dombois, H., Ellenberg, H. (1974) "*Aims and Methods of Vegetation Ecology*". John Wiley & Sons, New York, USA.

Nobel, S., Franco, C. (1989) Effect of nurse plants on the microhabitat and growth of cacti. *Journal of Ecology*, **77**, 870-886.

Oliver, C. (1980) Forest development in North America following major disturbances. *Forest Ecology and Management*, **3**, 153-168.

Omar, K. (2017) *Rosa arabica*. The IUCN Red List of Threatened Species 2017.

Panawala, L. (2017) "*Difference between Unisexual and Bisexual Flowers Difference Between Unisexual and Bisexual Flowers Main Difference – Unisexual vs Bisexual Flowers*". Pediaa. pp. 1-6.

Perkins, S. (2010) Mitigation: Help from hairy crops. "*Nature Climate Change*", climate 1013p.

Pugnaire, F., Haase, P., Puigdefábregas, J., Cueto, M., Clark, C., Incoll, L. (1996a) Facilitation and succession under the canopy of a leguminous shrub, *Retama sphaerocarpa*, in a semi-arid environment in southeast Spain. *Oikos*, **76**, 455-464.

Pugnaire, F., Puigdefábregas, J., Haase, P. (1996 b) Facilitation between higher plant species in a semi-arid environment. *Ecology*, **77**, 1420-1426.

Queenborough, S., Mazer, S., Vamosi, S., Garwood, N., Valencia, R., Freckleton, R. (2009) Seed mass, abundance and breeding system among tropical forest species. *Journal of Ecology*, **97**, 555-566.

Rabinowitz, D. (1981) Seven Forms of Rarity. In: "*The Biological Aspects of Rare Plant Conservation*", Synge, H. (Ed.), pp. 205-217. John Wiley & Sons Ltd, London.

Raunkiaer, C. (1937) Plant Life Forms. Clarendon, Oxford.

Sakio, H., Kubo, M., Shimano, K., Ohno, K. (2002) Coexistence of three canopy tree species in a riparian forest in the Chichibu Mountains, central Japan. *Folia Geobotanica*, **37**, 45-61.

Sampanpanish, P., Pongsapich, W., Khaodhiar, S., Khan, E. (2006) Chromium removal from soil by phytoremediation with weed plant species in Thailand. *Springer*, **6**, 191-206.

Seif El-Nasr, M., Bidak, L. (Eds.) (2005a) Conservation and Sustainable Use of Medicinal Plants Project: National Survey, North Western Coastal Region. First Quarterly Report. Mubarak City for Scientific Research and Technology Applications, Egypt.

Seif El-Nasr, M., Bidak, L. (Eds.) (2005b) Conservation and sustainable Use of Medicinal Plants Project: National Survey, Northwestern Coastal Region. Third Quarterly Report. Mubarak City for Scientific Research and Technology Applications, Egypt.

Seif El-Nasr, M., Bidak, L. (2006) Conservation and Sustainable Use of Medicinal Plants Project: National Survey, North Western Coastal Region. Vol II. Medicinal plants in the area. Final report. Mubarak City for Scientific Research and Technology Applications, Egypt.

Senarath, T. (2008) Dioecy and monoiecy in the flora of Serilanka and their evolutionary correlations to endemism, growth form, fruit type, seed number and flower size. *Bangladesh Journal Plant Taxonomy*, **15**(1), 13-19.

Shaltout, K., El-Keblawy, A. (1992) Sex expression in Egyptian Thymelaea hirsute populations. *Plant Systematics and Evolution*, **181**, 133-141.

Shaltout, K., Al-Sodany, Y. (2000) Flora and vegetation of lake Burullus area. MedWetCoast, for Egyptian Environmental Affairs Agency, Cairo.

Shaltout, K., Al-Sodany, Y. (2002) Phytoecology of Omayed site. MedWetCoast, for Egyptian Environmental Affairs Agency, Cairo.

Shaltout, K., Sheded, M., Salem, A. (2009) Population structure of common shrubs and trees in Wadi Allaqi Biosphere Reserve, South-East Egypt. *Feddes Repertorium*, **120**, 343-354.

Shaltout, K., Sharaf El-Din, A., Ahmed, D. (2010) Plant life in the Nile Delta. Tanta University Press, Tanta, Egypt.

Shaltout, K., Ahmed, D. (2012) Ecosystem services of the flora of southern Mediterranean desert of Egypt. *Ethnobotany Research & Applications,* **10**, 403-422.

Shaltout, K., Ahmed, D., Diab, M., El-Khalafy, M. (2018) Re-assessment of the near-endemic taxa in the Egyptian flora. *Taeckholmia*, **38**, 61-83.

Shaltout, S. (2014) Ecological study on the alien species in the Egyptian flora. *M.Sc. Dissertation*, Tanta University, Tanta, Egypt.

Shrestha, M., Stock, W., Ward, D., Golan-Goldhersh, A. (2003) Water status of isolated Negev desert populations of *Acacia raddiana* with different mortality levels. *Plant Ecology*, **168**(2), 297-307.

Skarpe, C. (1990) Structure of woody vegetation in disturbed and undisturbed arid savanna, Botswana. *Vegetatio*, **78**, 11-18.

Stewart, G., Rose, A. (1990) The significance of life history strategies in the development history of mixed beech (Nothofagus) forests, New Zealand. *Vegetatio*, **87**, 101–114.

Täckholm, V. (1956) "*Student's flora of Egypt*". Anglo-Egyptian Bookshop, Cairo, Egypt.

Täckholm, V. (1974) "*Students' Flora of Egypt*", 2nd ed. Cairo University Press, Cairo. 888p.

Täckholm, V., Täckholm, G. (1941) "*Flora of Egypt*". Vol. 1. Bulletin of the Faculty of Science no. 17: 1-573.

Täckholm, V., Drar, M. (1950) "*Flora of Egypt*". Vol. 2. Bulletin of the Faculty of Science no. 28: pp. 1-547.

Täckholm, V., Drar, M. (1954) "*Flora of Egypt*". Vol. 3. Bulletin of the Faculty of Science no.30, 1-638 .

Täckholm, V., Drar, M. (1969) "*Flora of Egypt*". Vol. Bulletin of the Faculty of Science n0. 36: 423 .

Tanaka, H., Shibata, M., Masaki, T., Iida, S., Niiyama, K., Abe, S., Kominami, Y., Nakashizuka, T. (2008) Comparative demography of three coexisting *Acer* species in gaps and under closed canopy. *Journal of Vegetation Science*, **19**, 127-138.

Thalen, D. (1979) "*Ecology and Utilization of Desert Shrub Rangelands in Iraq*". Junk Publ., The Hague, Netherlands.

Tomaszewski, C., Kulbaba, M., Harder, L. (2018) Mating consequences of contrasting hermaphroditic plant sexual systems. *Evolution*, **72**(10), 1-15.

Valiente-Banuet, A., Ezcurra, E. (1991) Shade as a cause for the association between the cactus *Neobuxbaumia tetetzo* and the nurse plant *Mimosa Luisana* in the Tehuacan Valley, Mexico. *J. Ecol.* **79**, 661-671.

Varga, S. (2016) Light availability affects sex lability in a gynodioecious plant. *American Journal of Botany*, **103**, 1928-1936.

Veblen, T. (1992) Regeneration dynamics. In: "*Plant Succession: Theory and Prediction*", Glenn-Lewin, D.C. Peet, R.K., Veblen, T.T. (Eds.). Chapman and Hill, London.

Welden, C., Hewett, S., Hubbell, P., Foster, R. (1991) Sapling survival, growth, and recruitment: Relationship to canopy height in a neotropical forest. *Ecology*, **72**, 35-50.

Zaghloul, M., Moustafa, A., Dadamouny, M. (2012) Age structure and population dynamics of *Moringa peregrina*, an economically valuable medicinal plant. *Egypt. J. Bot.* **52**(2), 499-519.

Zahran, M., Willis, A. (2009) "*The Vegetation of Egypt*", 2nd ed. Springer Publisher, German.

Zahran, M., El-Ameir, Y. (2012) On the ecology and propagation of the wood producing trees and shrubs in the Egyptian deserts. Cepaea nemoralis L. *Journal of Ecology*, **56**(2), 405-42.

Zohary, M. (1966) "*Flora Palaestina*", Parts One. Israel Academy of Science and Humanities, Jerusalem.

Zohary, M. (1972) "*Flora Palaestina*", Parts Two. Israel Academy of Science and Humanities, Jerusalem.

وصف الأشجار والشجيرات البرية في الفلوره المصرية

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يهتم هذا البحث بدراسة الخصائص الفلورية للأشجار والشجيرات ذات إرتفاع ≤ 50 سم المتوطنة في الفلورة المصرية. تشتمل هذه الخصائص الفلورية على التنوع التصنيفي، أشكال الجنس، أشكال الحياة، أشكال الندرة، وقت الإزهار، أشكال الإنتشار، الأهمية الإقتصادية، التهديدات الواقعة على الأنواع والتوزيع المحلي والعالمي لها. تم إجراء 9 رحلات فلورية لتجميع هذه الأنواع والبذور الخاصة بها من أنحاء مصر. تم إعداد قائمة تشتمل علي 228 نوع نباتي تنتمي إلى 126 جنس و45 عائلة، والتي تحتوي على نوعين مقتصري التوزيع في مصر و5 أنواع شبه مقتصرة التوزيع. تحتل الأنواع المسجلة 14 بيئة (منها 8 بيئات طبيعية و6 صناعية). أغلب أشكال الحياه الممثلة هي كل من النباتات الظاهرة والنباتات فوق السطحية، بينما تمثل الوحدات المتشحمة والمقذوفة والشعرية أغلب وحدات الإنتشار. وجد أن أغلب الأنواع تزهر في شهري مارس وأبريل. عند حساب أشكال الندرة وجد أن هناك 180 نوع غير وافر ويحتل مدى جغرافي وبيئي ضيق. تعتبر الصحاري المصرية أغنى المناطق بالأشجار والشجيرات في مصر.كل الأنواع تقدم على الأقل سلعة واحدة للإنسان، أكثرها تمثيلا الأهمية الطبية للأنواع، بينما هناك 186 نوع يقدم خدمات للبيئة المحيطة، أكثرها تمثيلا القدرة على تحمل الملوحة، وجد أن القطع الجائر للأشجار والشجيرات هو التهديد الأكثر وقعا على الأنواع في هذه الدراسة. النباتات الشوكية التي قد تحمل أذينات أو أوراق أو أفرع أو نورات أو ثمار شوكية، أو أفرع خشبية ذات نهايات شوكية تمثل 64 نوع في هذه الدراسة.