CATRINA (2019), 19 (1): 1-13

Vegetation Ecology Associated with Some Species of Family Zygophyllaceae in Different Biogeographic Regions of Egyptian Desert

Mohamed Abd El-Aal, Ibrahim A. Mashaly[*], Magda I. Soliman, Rehab M. Rizk, Mona F. Elmorsy
Botany Department, Faculty of Science, Mansoura University, Mansoura, Egypt

ABSTRACT

The Zygophyllaceae is a widespread family of common existence in arid and semi-arid habitats of the Old and New Worlds, especially in seasonally dry deserts. In the present study, eight species of Zygophyllaceae namely, *Fagonia arabica* L., *Fagonia bruguieri* DC., *Fagonia cretica* L., *Fagonia mollis* Delile, *Zygophyllum aegyptium* Hosny, *Zygophyllum coccineum* L., *Zygophyllum decumbens* Delile, and *Zygophyllum simplex* L. were selected. The floristic features and chorological affinities of the selected species with their associates in relation to soil variables were investigated. The sampling was carried out in 38 sampled stands within two types of deserts in Egypt; the inland Eastern desert and the coastal desert of Mediterranean Sea coast. A total of 133 plant species belonging to 29 families and 107 genera were recorded. Asteraceae, Poaceae, Chenopodiaceae, Brassicaceae, Fabaceae, and Zygophyllaceae were the most species-rich families which represented by approximately 60.15% of the total number of the investigated species. Preponderance of perennials (60%), therophytes (40%) and Saharo-Sindian/ Mediterranean taxa (62%) was remarkable indicating the arid and semi-arid climate of the investigation territory. Based on the importance value, four vegetation groups were identified after the application of TWINSPAN. Group A, was dominated by *Zygophyllum aegyptium* and represented sand formations habitat; group B, was dominated by *Fagonia cretica* and represented road-side habitats of the western Mediterranean coastal desert; group C, was dominated by *Zygophyllum coccineum* and represented Wadi Hagul bed and gravel desert habitats of Suez and group D, was dominated by *Pulicaria undulata* and represented wadi bed and roadside habitats in Ismailia. Ordination of the vegetation groups along 2 axes was performed using Detrended Correspondence Analysis (DCA), while Canonical Correspondence Analysis (CCA) exhibited that calcium carbonate, organic carbon, pH, electrical conductivity, chlorides, total nitrogen, total soluble phosphorus and cations (Na, K, Ca & Mg) were the most important soil variables that affecting the abundance of vegetation groups.
Keywords: Chorotype, Classification, Desert, Medicinal plants, Ordination, Soil, Zygophyllaceae.

INTRODUCTION

Over recent decades, the majority of the natural flora of the Egyptian desert was influenced by human activities, for example, development of the deltaic part of wadis, over-grazing, the intensive gathering of plant species for its values (fuel, fiber, therapeutic, and so on.), and establishment of new towns, industrial facilities, streets, highways, infrastructure, water pipelines, and quarries. These activities cause desert degradation and fragmentation and a damaging impact in the plant diversity. This implies a great alteration in the presence, distribution, and extinction of the desert plants (Abd El-Ghani *et al.*, 2017; Abdelaal, 2017).

The phytogeographical regions in Egypt are seven regions as reported by Boulos (2009), these include: 1. The Nile region including the Delta, Valley and Faiyum, 2. The Oases of the Western Desert including Wadi Natrun, Siwa, Farafra, Bahariya, Kharga, Dakhla, Kurkur, Dungul and Uweinat, 3. The Mediterranean coastal strip extending from Sallum at west to Rafah at east, 4.The Desert including Western and Eastern Deserts, 5. The Red Sea coastal strip, 6. Gebel Elba and the surrounding mountainous region and 7. Sinai Peninsula.

Zygophyllaceae, the caltrop family, is a group of angiosperm plants frequently restricted to tropical and warm climates. It is widespread in Old and New Worlds especially arid and semi-arid zones. Members of this family are mostly shrubby, but some are herbs and rarely some grow as trees. According to the classification by Sheahan and Chase (1996 & 2000), Zygophyllaceae is a heterogeneous family represented by approximately 27 genera and 285 plant species. The taxonomy within the family has changed over time, since they display a large amount of variability in structural detail (Abdel Khalik, 2012). At the family level, numerous studies were carried out in order to elucidate the systematic position of most of its members (Sheahan and Cutler, 1993; Sheahan and Chase, 1996; Beier *et al*., 2003). However, Engler (1896 & 1931) divided the family into seven subfamilies. Nevertheless, Sheahan and Chase (1996 & 2000) divided Zygophyllaceae into five subfamilies.

In Egypt, Zygophyllaceae is represented by three subfamilies namely: Peganoideae Engl., Tetradiclidoideae Engl., and Zygophylloideae; which encompass of six genera (Täckholm, 1974; El Hadidi ,1972). However, recently five genera were recorded by Boulos (2000).

In this study, two major genera of Zygophyllaceae were selected: *Zygophyllum* and *Fagonia*. *Zygophyllum;* which considered as the largest genus of Zygophyllaceae with about 80 to 100 species distributed in warm, seasonally dry areas of Asia, Africa, and Australia. It is a genus of succulent plants found as shrubs, subshrubs, and herbs, mostly with bifoliolate leaves. In the flora of Egypt, *Zygophyllum* is broadly distributed in Desert, Sinai, Oases, Gebel Elba, Red Sea and Mediterranean area (Täckholm, 1974; Boulos, 2000). The abundance of genus *Zygophyllum* is

* *Corresponding author e-mail: iamashaly1950@yahoo.com*

dependent on its tolerance to the different environmental stresses, while its distribution is correlated to structure of soil in its habitats (Mashaly *et al*., 2015). Many species of *Zygophyllum* are known as economic and medicinal plants that characterized by antidiabetic, anthelmintic, antihyperglycemic, antihypertensive and insecticidal effects and exhibit anti-inflammatory, antimicrobial and antioxidant activity (Gibbons and Oriowo, 2001; El Ghoul *et al*., 2012; Elbadry *et al*., 2015). Regardless of the significance of *Zygophyllum* in addition to its abundance in the Mediterranean and Middle East areas, there isn't sufficient studies and information about them.

Fagonia is a widespread genus represented by 34 species growing in warm and arid zones in all continents except Australia, with a center of distribution in northern Africa and the Middle East, especially in the Saharo-Sindian and Mediterranean regions. It consists of low shrubs and woody perennials often with spinescent or pointed stipules and opposite, simple or 3–7-foliolate leaves. *Fagonia* is often recognized from *Zygophyllum* by its spinescent stipules, usually trifoliolate leaves (however some *Fagonia* species vary from one-foliolate to multifoiolate) (Sheahan and Chase, 2000; Beier *et al*., 2004). In Egypt, with its central position in Saharo-Sindian region, *Fagonia* includes 18 species recorded by El Hadidi (1966) and Täckholm (1974) but recently 15 species were reported by Boulos (2000) and Abdel Khalik, (2012).

This genus is of great concern to many researchers and pharmacists, since it contains many active const-ituents of medicinal and pharmaceutical significance. It is often used as a popular remedy in folk medicine for the treatment of various ailments. Traditionally, *Fagonia* is well known as hepatic tonic for many liver diseases and for the treatment of number of different ailments such as anemia, small-pox, diabetes, joint pain, dropsy, jaundice, cough, asthma, against poisoning and for the treatment of various skin lesions. It is claimed to contain potential anticancer agents acting against breast cancer cell (Lam *et al*., 2012; Pareek *et al*., 2013; Qureshi *et al*., 2016; Farheen *et al*., 2017).

The selected species are *Fagonia arabica* L., *Fagonia bruguieri* DC., *Fagonia cretica* L., *Fagonia mollis* Delile, *Zygophyllum aegyptium* Hosny, *Zygophyllum coccineum* L., *Zygophyllum decumbens* Delile, and *Zygophyllum simplex* L.

This study intended to investigate the spatial distribution, habitat conditions, ecological aspects and chorological affinity of the selected Zygophyllaceae species with their associated plant species in some phytogeographic regions of Egyptian desert.

MATERIALS AND METHODS

Study area

Deserts cover about 20% of the land area of the world. In Egypt, It covers approximately 95% of the total area of the country. Desert vegetation is almost certainly the most characteristic and important type of the natural vegetation. The Egyptian deserts are among the most arid areas of the world. Hence, desert vege-tation covers immense zones formed mainly of xerophy-tes shrubs and subshrubs (Abd El-Ghani *et al* 2017). The sampled stands (38) were distributed within coastal desert along the Middle and Western Medi-terranean coast and in the inland Eastern desert (Figure: 1).

The coastal deserts in Egypt extend along the Mediterranean, the Red Sea, and the Gulfs of Suez and Aqaba in Sinai, hence and because of the different distribution, massive variations in the floristic composition and vegetation structure occur. The Mediterranean coast of Egypt expanses between Rafah on the Egyptian-Palestinian border and Sallum on the Egyptian-Libyan border for about 970 km in three sections: Sinai coast (the eastern section), Deltaic coast (the middle section), and finally Mareotis coast (the western section). In general, this region of Egypt belongs to the dry arid zone and the Mediterranean type climate (Zahran and Willis, 2009). The Middle Mediterranean coast extends for about 220 km from Port-Said to Abu-Qir. It can be distinguished into four main habitats: sand formations, salt marshes, sandy lands and reed swamps (Mashaly, 2001 & 2002).

On the other hand, The Western Mediterranean coastal land stretches for about 550 km from Abu-Qir to Sallum. It represents by far the richest biogeographic region of Egypt; with about 50% of the total of the Egyptian flora, because of the relatively high rainfall. Most of these species are therophytes. According to Zahran and Willis (2009), it is partitioned into sand dunes, rocky ridges, saline depressions, barley fields and inland plateau habitats.

The Eastern Desert of Egypt occupies about 21% of the total area of the country. It is distinguished into two main ecological units, the inland Eastern Desert with its wadis, and the Red Sea costal land. The inland Eastern Desert extends for about 223,000 km^2 between the Red Sea coastal mountains in the east and the Nile Valley in the west. It is a rocky plateau dissected by a number of wadis. It can be divided into four main geomorphological and ecological regions: 1) Cairo–Suez Desert, 2) Limestone Desert, 3) Sandstone Desert, and 4) Nubian Desert (Zahran and Willis, 2009).

Floristic sampling

After several field trips during spring 2016, a total of 38 stands (10 × 10 m each) were selected along coastal desert and inland desert. Plant specimens from the different stands were collected and brought to the Herbarium of Botany Department, Faculty of Science, Mansoura University for identification and voucher specimens were preserved. Identification and nomenclature of the investigated plant species were carried out as stated by Boulos (1999-2009). The chorological analysis was according to Zohary (1966 & 1972) and Feinbrun-Dothan (1978 & 1986), while the description and classification of life-forms were followed that of Raunkiaer (1934).

In each stand, the importance value (IV, out of 200) was estimated for the different plant species by calculating the sum of the relative values of density and cover (Mueller-Dombois and Ellenberg, 1974).

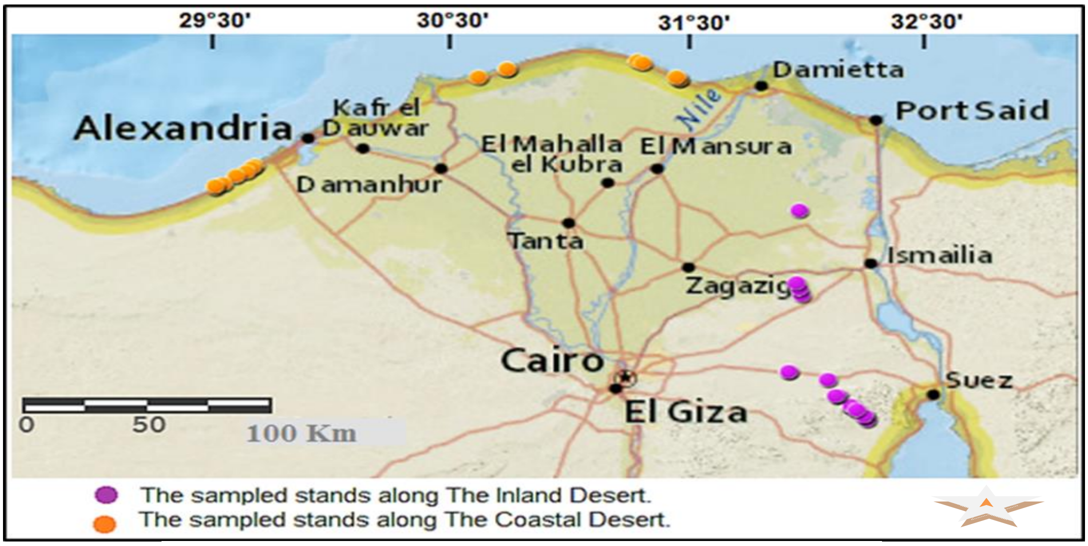

Figure:1 The location of the sampled stands.

Soil sampling

Soil samples were collected from each stand at 0-50 cm depth, allowed to dry in air, well mixed and then sieved to remove any debris and gravel from soil. The chemical variables estimated in this present study were calcium carbonate, organic carbon, pH, electrical conductivity, anions (Cl^-, SO_4^{--} and HCO_3^-), total nitrogen, total dissolved phosphorous, and extractable cations (Na^+, K^+, Ca^{++} and Mg^{++}). Calcium carbonate was estimated by dissolving in HCl then using titration against 1N NaOH. Oxidizable organic carbon was quantified using Walkley-Black rapid method (1934). Extract (1:5 w/v) of each soil sample was prepared for the record of soil reaction (pH) and electrical conductivity (EC) using pH-meter and conductivity meter, respectively. Chloride content was determined by direct titration against silver nitrates using potassium chromates indicator. Sulphates were gravimetrically assessed using barium chloride solution to be participated as barium sulphate (Wilde *et al*., 1964). Soluble bicarbonates content was appraised by titration method with 0.1N HCl and using methyl orange indicator. Total nitrogen was valued using the air dry samples by the conventional semi-micromodification of Kjeldahl method, while total phosphorus was determined by direct stannous chloride method. The extractable cations were approximated in each soil sample according to AOAC (1990). A Flame Photometer was used to determine sodium and potassium cations, whereas calcium and magnesium were estimated by an Atomic Absorption Spectrometer (Upadhyay and Sharma, 2005).

Data analysis

Two Way Indicator Species Analysis (TWINSPAN) was operated to categorize the floristic records of 133 species in 38 stands using Community Analysis Package (CAP) program (Henderson and Seaby 2007), while Detrended Correspondence Analysis (DCA) was directed to ordinate the sampled stands along the first 2 axes. Canonical Correspondence Analysis (CCA) was used to determine the relation between the leading characteristic species and the measured soil factors (Ter Braak, 2003).

RESULTS

Floristic features

The floristic features of the eight selected plant species with their associates in the present study were displayed in Table 1. In total, 133 plant species belonging to 29 families and 107 genera were recorded in the 38 sampled stands. The largest species-rich families were Asteraceae (23 species), Poaceae (17), Chenopodiaceae (13), Brassicaceae, Fabaceae and Zygophyllaceae families (9 for each). The remaining 23 families were represented together by 53 species; in miniature representation 7, 6, 5, 4, 3, 2 or one species). *Fagonia* and *Zygophyllum* were the largest representative genera in the surveyed study with four species for each. Out of 133 species, 80 species (60%) were perennials, 49 species (37%) were annuals, and 4 species (3%) were biennials (Fig. 2).

As displayed in Figure 3, the life-form spectrum therophytes (53 species = 39.85%) were the dominant, followed by chamaephytes (37 species = 27.82%), hemicryptophytes (24 species = 18.05%), phanerophytes (12 species = 9.02 %), geophytes (5 species = 3.76%), cryptophytes (1 species = 0.75%), and parasites (one species = 0.75%).

After excluding the three cultivated and naturalized plant species, the chorotypes of the recorded plant species were presented in Table (2) and Figure (4). Biregional elements achieved the major contribution by 40% (52 species) of the total number of species, followed by monoregional elements (43 species=33%),

Table (1): Associated species of the surveyed plant species with their families, life span, life-forms and chorotypes.

Species	Family	Life span	Life form	Chorotype
Achillea fragrantissima (Forssk.) Sch.Bip.	Asteraceae	Per	Ch	SA-SI+IR-TR
Achillea santolina L.	Asteraceae	Per	Ch	SA-SI+IR-TR
Alhagi graecorum Boiss.	Fabaceae	Per	H	PAL
Anabasis articulata (Forssk.) Moq.	Chenopodiaceae	Per	Ch	SA-SI+IR-TR
Anchusa humilis (Desf.) I. M. Johnst.	Boraginaceae	Ann	Th	ME+SA-SI
Arthrocnemum macrostachyum (Moric.) K. Koch.	Chenopodiaceae	Per	Ch	ME+SA-SI
Atractylis carduus (Forssk.) C. Chr.	Asteraceae	Per	H	SA-SI+ME
Atriplex halimus L.	Chenopodiaceae	Per	Ph	ME+SA-SI
A. lindleyi Moq.	Chenopodiaceae	Ann	Th	AUST
A. semibaccata R. Br.	Chenopodiaceae	Per	H	AUST
Avena fatua L.	Poaceae	Ann	Th	PAL
Bassia indica (Wight) A. J.Scott.	Chenopodiaceae	Ann	Th	S-Z+IR-TR
Beta vulgaris L.	Chenopodiaceae	Bi	Th	ME+IR-TR+ER-SR
Brassica tournefortii Gouan	Brassicaceae	Ann	Th	ME+IR-TR+SA-SI
Bromus diandrus Roth	Poaceae	Ann	Th	ME
B. rubens L.	Poaceae	Ann	Th	ME+IR-TR
Cakile maritima Scop.	Brassicaceae	Ann	Th	ME+ER-SR
Calligonum polygonoides L.	Polygonaceae	Per	Ph	SA-SI+IR-TR
Calotropis procera (Aiton) W.T. Aiton	Asclepiadaceae	Per	Ph	SA-SI+S-Z
Carrichtera annua (L.) DC.	Brassicaceae	Ann	Th	SA-SI
Carthamus tenuis (Boiss. & Blanche) Bornm.	Asteraceae	Ann	Th	ME
Caylusea hexagyna (Forssk.) M. L. Green	Resedaceae	Ann	Th	SA-SI+S-Z
Centaurea aegyptiaca L.	Asteraceae	Bi	Th	SA-SI
C. alexandrina Delile	Asteraceae	Bi	Th	SA-SI
Chenopodium murale L.	Chenopodiaceae	Ann	Th	COSM
Cistanche phelypaea (L.) Cout.	Orobanchaceae	Per	Pa	SA-SI+ME
Citrullus colocynthis (L.) Schrad.	Cucurbitaceae	Per	Ch	CULT and NAT
Cleome amblyocarpa Barratte & Murb.	Cleomaceae	Ann	Th	SA-SI+IR-TR
Convolvulus lanatus Vahl	Convolvulaceae	Per	Ch	SA-SI
Conyza bonariensis (L.) Cronquist	Asteraceae	Ann	Th	NEO
Cornulaca monacantha Delile	Chenopodiaceae	Per	Ch	SA-SI+IR-TR
Crotalaria aegyptiaca Benth.	Fabaceae	Per	Ch	SA-SI
Cutandia memphitica (Spreng.) Benth.	Poaceae	Ann	Th	ME+IR-TR+SA-SI
Cynanchum acutum L.	Asclepiadaceae	Per	H	ME+IR-TR
Cynodon dactylon (L.) Pers.	Poaceae	Per	G	PAN
Deverra tortuosa (Desf.) DC.	Apiaceae	Per	Ch	SA-SI
Diplotaxis harra (Forssk.) Boiss.	Brassicaceae	Per	H	ME+SA-SI
Echinops spinosus L.	Asteraceae	Per	H	ME+SA-SI
Echium angustifolium Mill.	Boraginaceae	Per	H	ME
*E. sericeum (*Vahl) Klotz	Boraginaceae	Per	H	ME
Elymus farctus (Viv.) Runem. ex Melderis	Poaceae	Per	G	ME
Emex spinosa (L.) Campd.	Polygonaceae	Ann	Th	ME+SA-SI
Erodium glaucophyllum (L.) L'Hér.	Geraniaceae	Per	H	ME
E. laciniatum (Cav.) Willd.	Geraniaceae	Ann	Th	ME
Eryngium creticum Lam.	Apiaceae	Per	H	ME+IR-TR
Euphorbia peplus L.	Euphorbiaceae	Ann	Th	ME+IR-TR+ER-SR
E. terracina L.	Euphorbiaceae	Per	H	ME
Fagonia arabica L.	Zygophyllaceae	Per	Ch	SA-SI

Table 1. Continued.

Species	Family	Life span	Life form	Chorotype
F. bruguieri DC.	Zygophyllaceae	Per	Ch	SA-SI
F. cretica L.	Zygophyllaceae	Per	Ch	ME
F. mollis Delile	Zygophyllaceae	Per	Ch	SA- SI
Farsetia aegyptia Turra subsp. *aegyptia*	Brassicaceae	Per	Ch	SA-SI+S-Z
Gymnocarpos decandrus Forssk.	Caryophyllaceae	Per	Ch	SA-SI
Gypsophila capillaris (Forssk.) C. Chr.	Caryophyllaceae	Per	H	SA-SI+IR-TR
Halocnemum strobilaceum (Pall.) M. Bieb.	Chenopodiaceae	Per	Ch	ME+IR-TR+SA-SI
Haloxylon salicornicum (Moq.) Bunge ex Boiss.	Chenopodiaceae	Per	Ch	SA-SI
Heliotropium arbainense Fresen.	Boraginaceae	Per	Ch	SA-SI
H. digynum (Forssk.) Asch. Ex C. Chr.	Boraginaceae	Per	Ch	SA-SI
Herniaria hemistemon J. Gay	Caryophyllaceae	Per	H	ME+SA-SI
Hordeum marinum Huds.	Poaceae	Ann	Th	ME+IR-TR+ER-SR
Hyoscyamus muticus L.	Solanaceae	Per	Ch	SA-SI+IR-TR
Ifloga spicata (Forssk.) Sch. Bip. subsp. *spicata*	Asteraceae	Ann	Th	ME+SA-SI
Imperata cylindrica (L.) Raeusch.	Poaceae	Per	H	ME+PAL
Iphiona mucronata (Forssk.)Asch.	Asteraceae	Per	Ch	SA-SI
Juncus acutus L.	Juncaceae	Per	He	ME+IR-TR+ER-SR
J. rigidus Desf.	Juncaceae	Per	H	ME+SA-SI+IR-TR
Kickxia aegyptiaca (L.) Nabelek.	Schrophulariaceae	Per	Ch	ME+SA-SI
Lasiurus scindicus Henrard.	Poaceae	Per	Cr	SA-SI+S-Z
Launaea mucronata (Forssk.) Musch1.	Asteraceae	Per	H	ME+SA-SI
L. nudicaulis (L.) Hook.f.	Asteraceae	Per	H	SA-SI
L. spinosa (Forssk.)Sch.Bip. ex Kuntze.	Asteraceae	Per	Ch	SA-SI
Lavandula coronopifolia Poir.	Lamiaceae	Per	Ch	SA-SI
Lepidium draba L.	Brassicaceae	Per	H	ME+IR-TR
Leptadenia pyrotechnica (Forrsk.) Decne.	Asclepiadaceae	Per	Ph	SA-SI
Limonium pruinosum (L.) Chaz.	Plumbaginaceae	Per	H	SA-SI
Lolium multiflorum Lam.	Poaceae	Ann	Th	ME+IR-TR+ER-SR
Lotus deserti Täckh. & Boulos	Fabaceae	Ann	Th	SA-SI
L. glaber Mill.	Fabaceae	Per	H	ME+IR-TR+ER-SR
L. halophilus Boiss. & Spruner	Fabaceae	Ann	Th	ME+SA-SI
Lycium shawii Roem. & Schult.	Solanaceae	Per	Ph	SA-SI+S-Z
Malva parviflora L.	Malvaceae	Ann	Th	ME+IR-TR
Matthiola longipetala (Vent.)DC.	Brassicaceae	Ann	Th	ME+IR-TR
Mesembryanthemum crystallinum L.	Aizoaceae	Ann	Th	ME+ER-SR
M. forsskaolii Hochst. ex Boiss.	Aizoaceae	Ann	Th	SA-SI
M. nodiflorum L.	Aizoaceae	Ann	Th	ME+SA-SI+ER-SR
Nicotiana glauca R. C. Graham	Solanaceae	Per	Ph	CULT and NAT
Ochradenus baccatus Delile	Resedaceae	Per	Ph	SA-SI
Ononis serrata Forssk.	Fabaceae	Ann	Th	ME+SA-SI
O. vaginalis Vahl	Fabaceae	Per	Ch	IR-TR+ SA-SI
Onopordum alexandrinum Boiss.	Asteraceae	Bi	Th	IR-TR+ SA-SI
Pancratium maritimum L.	Amaryllidaceae	Per	G	ME
Panicum turgidum Forssk.	Poaceae	Per	H	SA-SI
Parapholis incurva (L.) C.E. Hubb	Poaceae	Ann	Th	ME+IR-TR+ER-SR
Phalaris minor Retz.	Poaceae	Ann	Th	ME+IR-TR
Phragmites australis (Cav.) Trin.ex Steud.	Poaceae	Per	H	COSM
Picris asplenioides L.	Asteraceae	Ann	Th	ME+IR-TR
Plantago lagopus L.	Plantaginaceae	Ann	Th	ME

Table 1. Continued.

Species	Family	life span	life form	chorotype
Pluchea dioscoridis (L.) DC.	Asteraceae	Per	Ph	SA-SI+S-Z
Polygonum equisetiforme Sibthi & Sm.	Polygonaceae	Per	G	ME+IR-TR
Polypogon monspeliensis (L.) Desf.	Poaceae	Ann	Th	COSM
Pulicaria incisa (Lam.) DC.	Asteraceae	Per	Ch	SA-SI
P. undulata (L.) C.A.Mey.	Asteraceae	Per	Ch	SA-SI+S-Z
Reaumuria hirtella Jaub. & Spach var. *hirtella*	Tamaricaceae	Per	Ch	IR-TR+ SA-SI
Reichardia tingitana (L.) Roth	Asteraceae	Ann	Th	ME+IR-TR+SA-SI
Reseda decursiva Forssk.	Resedaceae	Ann	Th	SA-SI
Retama raetam (Forssk.) Webb& Berthel.	Fabaceae	Per	Ph	ME+IR-TR+SA-SI
Ricinus communis L.	Euphorbiaceae	Per	Ph	CULT and NAT
Rumex pictus Forssk.	Polygonaceae	Ann	Th	ME+SA-SI
R. vesicarius L.	Polygonaceae	Ann	Th	ME+SA-SI+S-Z
Salsola kali L.	Chenopodiaceae	Ann	Th	COSM
Salvia deserti Decne.	Lamiaceae	Per	Ch	SA-SI+IR-TR
Schismus barbatus (L.) Thell.	Poaceae	Ann	Th	ME+IR-TR+SA-SI
Scrophuloria deserti Delile	Schrophulariaceae	Per	Ch	SA-SI
Senecio glaucus L.	Asteraceae	Ann	Th	ME+IR-TR+SA-SI
Silene succulenta Forssk.	Caryophyllaceae	Per	H	ME
S. viviani Steud.	Caryophyllaceae	Ann	Th	ME+SA-SI
Sisymbrium irio L.	Brassicaceae	Ann	Th	ME+IR-TR+ER-SR
Sonchus oleraceus L.	Asteraceae	Ann	Th	COSM
Spergularia salina J. & C. Presl	Caryophyllaceae	Ann	Th	ME+IR-TR+ER-SR
Stipagrostis lanata (Forssk.) De Winter	Poaceae	Per	G	SA-SI
Suaeda vera Forssk. ex J.F. Gmel.	Chenopodiaceae	Per	Ch	ME+SA-SI+ER-SR
Symphyotrichum squamatum (Spreng.) Nesom	Asteraceae	Per	Ch	NEO
Tamarix nilotica (Ehrenb.) Bunge	Tamaricaceae	Per	Ph	SA-SI+S-Z
Thymelaea hirsuta (L.) Endl.	Thymelaceae	Per	Ph	ME
Tribulus terrestris L.	Zygophyllaceae	Ann	Th	ER-SR+ME+IR-TR
Trichodesma africanum (L.) R.Br.	Boraginaceae	Per	Ch	SA-SI+S-Z
Trigonella stellata Forssk.	Fabaceae	Ann	Th	SA-SI+IR-TR
Urospermum picroides (L.) F.W. Schmidt	Asteraceae	Ann	Th	ME+IR-TR
Zilla spinosa (L.) Prantl	Brassicaceae	Per	Ch	SA-SI
Zygophyllum aegyptium Hosny	Zygophyllaceae	Per	Ch	ME
Z. coccineum L.	Zygophyllaceae	Per	Ch	SA-SI+S-Z
Z. decumbens Delile	Zygophyllaceae	Per	Ch	SA-SI
Z. simplex L.	Zygophyllaceae	Ann	Th	PAL
Ononis serrata Forssk.	Fabaceae	Ann	Th	ME+SA-SI
O. vaginalis Vahl	Fabaceae	Per	Ch	IR-TR+ SA-SI
Onopordum alexandrinum Boiss.	Asteraceae	Bi	Th	IR-TR+ SA-SI
Pancratium maritimum L.	Amaryllidaceae	Per	G	ME

Ann: annuals; Per: perennials; Bi: biennials; Th: therophyte; Ch: chamaephyte; H: hemicryptophytes; Ph: phanerophytes; Cr: cryptophytes; P: parasites; ME: Mediterranean; SA-SI: Saharo-Sindian; IR-TR: Irano-Turanian; S-Z: Sudano-Zambezian; ER-SR: Euro-Siberian; PAL: Palaeotropical, COSM: Cosmopolitan; PAN: Pantropical; NEO: Neotropical; AUST: Australian, CULT and NAT: Cultivated and Naturalized

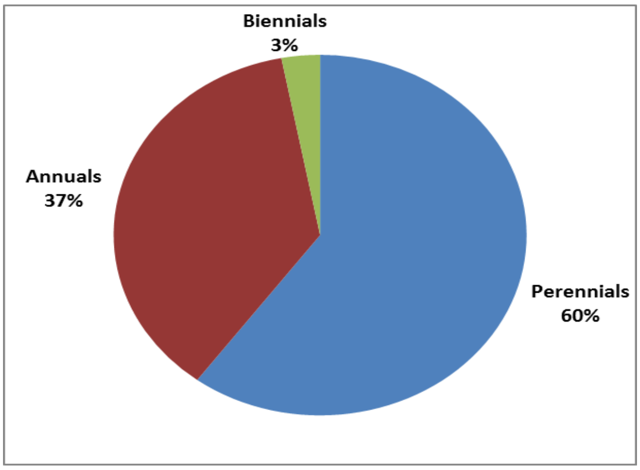

Figure (2): Life-span (%) of the surveyed plant species in the present study.

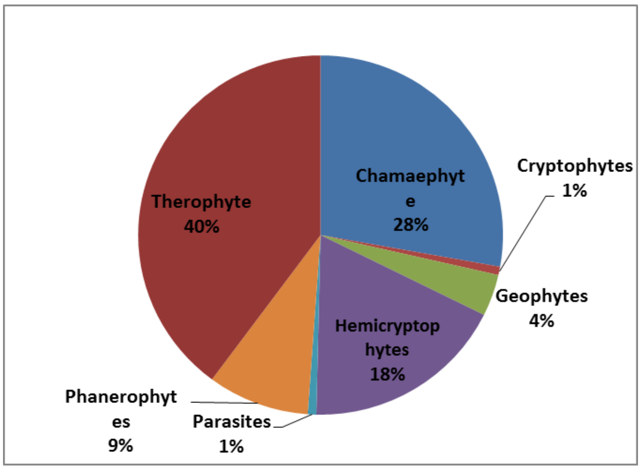

Figure (3): Life-form (%) of the surveyed plant species in the present study.

Table (2): Chorological analysis (Number of species and percentage) in the present study

Chorotype	Number	%
Mono-regional elements		
ME	14	10.77%
SA-SI	29	22.31%
Sub-total	**43**	**33%**
Bi-regional elements		
SA-SI+IR-TR	13	10%
S-Z+IR-TR	1	0.77%
SA-SI+S-Z	10	7.69%
ME+SA-SI	16	12.31%
ME+IR-TR	10	7.69%
ME+ER-SR	2	1.54%
Sub-Total	**52**	**40%**
Pluri-regional		
ME+IR-TR+ER-SR	10	7.69%
ME+IR-TR+SA-SI	8	6.15%
ME+SA-SI+ER-SR	2	1.54%
ME+SA-SI+S-Z	1	0.77%
Sub-total	**21**	**16%**
Worldwide		
PAL	3	2.31%
AUST	2	1.54%
COSM	5	3.85%
NEO	2	1.54%
PAN	1	0.77%
ME+PAL	1	0.77%
Sub-Total	**14**	**11%**
Total	**130**	**100%**

then Pluriregional elements (21 species=16%) and world-wide elements (14 species= 11%). In addition, the chorological affinity was chiefly made up of 78 Saharo-Sindian species, 64 species for Mediterranean taxa, 42 Irano-Turanian taxa, 14 Euro-Siberian taxa, 12 Sudano-Zambezian taxa, 5 Cosmopolitans, 4 Palaeotropical taxa, 2 species for each Neotropical and Australian taxa, and one species for Pantropical.

Analysis of vegetation

Classification of stands

Based on the importance value (out of 200) of the selected Zygophyllaceae species and their associates, classification of the 38 plotted stands using TWINSAPN led to the recognition of four community types (A, B, C and D) at the third hierarchical level (Fig. 5). These community types (or vegetation groups) were named after the first dominant species with the highest importance value as follows: group A: *Zygophyllum aegyptium*, group B: *Fagonia cretica*, group C: *Zygophyllum coccineum* and group D: *Pulicaria undulata*.

Vegetation group A included 41 species distributed in 8 stands. It characterized sand formation habitats along Deltaic Mediterranean coastal desert. The indicator species of this group was *Bromus rubens.* The first and the second dominant species were *Zygophyllum aegyptium* and *Rumex pictus*. The most important associates included *Senecio glaucus*, *Arthrocnemum macrostachyum, Reichardia tingitana and Tamarix nilotica*. Group B dominated roadside habitats of the western Mediterranean coastal desert. It comprised 7 stands with 61 species. The indicator species in this group were *Diplotaxis harra* and *Centaurea alexandrina*, whereas *Fagonia cretica* and *Avena fatua* were the most dominant species. *Reichardia tingitana, Mesembryanthemum crystallinum, Carthamus tenuis and Echinops spinosus* represented the most important associates in this community type. Group C included 56 species in 19 stands representing Wadi Hagul bed and gravel desert habitats of Suez. It was codominated by *Zygophyllum coccineum* and *Zilla spinosa*. *Ochradenus baccatus, Zygophyllum decumbens, Zygophyllum simplex and Diplotaxis harra* were the most important associates, while *Urospermum picroides* was the indicator species in this vegetation group. At last, vegetation group D contained 18 species in 4 stands. This group inhabited wadi bed and roadside habitats in Ismailia. It was codominated by *Pulicaria undulata* and *Zygophyllum aegyptium*. The most important associated species in this community type included *Haloxylon salicornicum, Fagonia arabica and Heliotropium digynum*. *Cleome amblyocarpa* was the indicator species in this group (Table 3).

Ordination of stands

As shown in Fig. (6), the DCA ordination of the sampled stands was plotted on the plane of the first and second DCA axes. The vegetation groups yielded by TWINSPAN classification were clearly noticeable and distinguishable. The plot revealed a clear pattern of

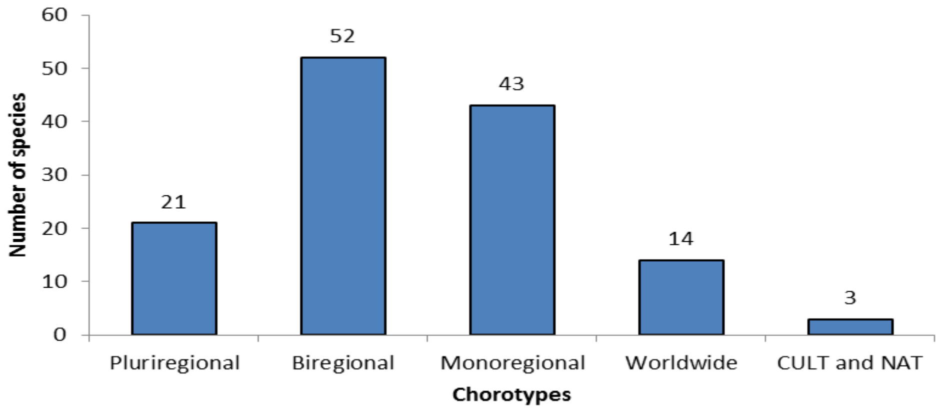

Figure (4): Chorological analysis of the surveyed plant species in the present study.

segregation of the obtained groups on the ordination plane. Groups A and D were separated at the bottom left part of DCA-diagram, while group B was segregated at the top left side. On the other hand, group C was detached in the right border of DCA diagram and intersected by DCA axis 2.

Vegetation-soil relationships

Canonical Correspondence Analysis (CCA) ordination diagram was designated to illustrate the relationship between the identified vegetation groups and soil variables (Fig. 7). Eleven significant soil factors (CaCO3, organic carbon, pH, electrical conductivity, Cl, total nitrogen, total phosphorus, Na, K, Ca and Mg) were utilized on the produced CCA-biplot. Calcium carbonate, calcium, chlorides, potassium, sodium, magnesium and EC showed the highest impact among the soil factors. These highly effective factors were correlated positively with axis 1and axis 2, while pH, total nitrogen, total phosphorus and organic carbon exhibited negative correlations with both axes.

The dominant species of vegetation group C (Zygophyllum coccinium and Zilla spinosa) were segregated at the upper-right quarter of CCA and closely related with magnesium, potassium, chlorides, electrical conductivity and calcium carbonates. Zygophyllum aegyptium and Rumex pictus as the first and second dominant species in group A and the first dominant species in group D Pulicaria undulata were segregated in the lower-left quarter of CCA, and obviously correlated with organic carbon, total nitrogen, total phosphorus and pH. On the other hand, the characteristic leading species of vegetation group B namely Fagonia cretica and Avena fatua were isolated at the upper-left quarter of CCA-diagram.

Table (3): Floristic composition features of the four vegetation groups using TWINSPAN.

Group	No. of stands	No. of species	1st and 2nd dominant species (IV out of 200)	Other important species (IV out of 200)	Indicator species
A	8	41	*Zygophyllum aegyptium* (IV=49.75) and *Rumex pictus* (IV=19.24)	*Senecio glaucus* (IV=13.88), *Arthrocnemum macrostachyum* (IV=10.41), *Reichardia tingitana* (IV=8.12), and *Tamarix nilotica* (IV=8.01)	*Bromus rubens*
B	7	61	*Fagonia cretica* (IV=22.93) and *Avena fatua* (IV=15.8)	*Reichardia tingitana* (IV=11.93), *Mesembryanthemum crystallinum* (IV=10.92), *Carthamus tenuis* (IV=9.09) and *Echinops spinosus* (IV=8.82)	*Diplotaxis harra* and *Centaurea alexandrina*
C	19	56	*Zygophyllum coccineum* (IV=25.58) and *Zilla spinosa* (IV=24.02)	*Ochradenus baccatus* (IV=22.81), *Zygophyllum decumbens* (IV=18.11), *Zygophyllum simplex* (IV=8.87) and *Diplotaxis harra* (IV=8.29)	*Urospermum picroides*
D	4	18	*Pulicaria undulata* (IV=35.24) and *Zygophyllum aegyptium* (IV=34.09)	*Heliotropium salicornicum* (IV=30.29), *Fagonia arabica* (IV=13.42) and *Heliotropium digynum* (IV=10.99)	*Cleome amblyocarpa*

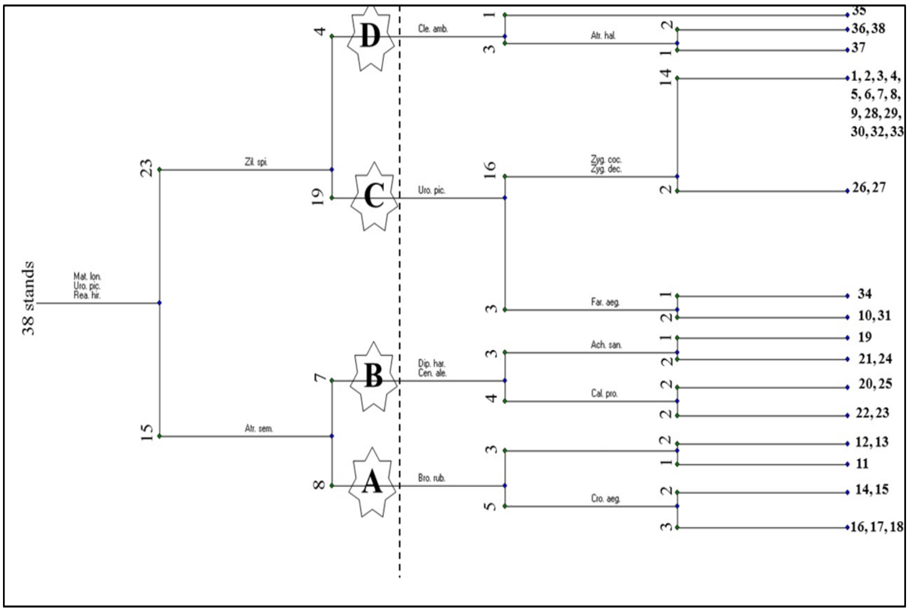

Figure. 5. TWINSPAN dendrogram displaying the four vegetation groups (A, B, C and D) at the 3rd classification level. Dashed line illustartes the level of classification. The indicator species are abbreviated by the first three letters of genus and species, respectively. The indicators species were coded as follow: Mat. lon.: Matthiola longipetala; Uro. pic.: Urpspermum picroides; Rea. hir.: Reaumuria hirtella; Zil. spi.: Zilla spinosa; Atr. sem.: Atriplex semibaccata; Cle. amb.: Cleome amblyocarpa; Dip. har.: Diplotaxis harra; Cen. ale.: Centaurea alexandrina; Bro. rub.: Bromus rubens, Atr. hal.:Atriplex halimus; Zyg. coc.: Zygophyllum coccineum; Zyg. dec.: Zygophyllum decumbens; Far. aeg.: Farsetia aegyptia; Ach. san.: Achillea santolina; Cal. pro.: Calotropis procera; and Cro. aeg.: Crotalaria aegyptiaca.

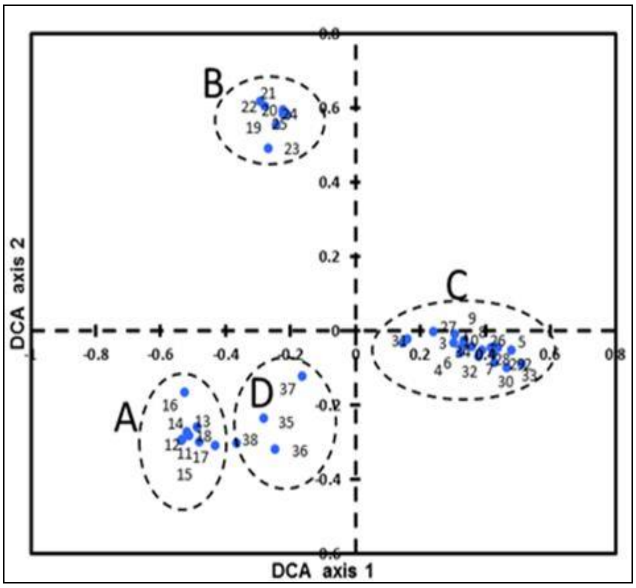

Figure 6. DCA ordination diagram of the four vegetation groups, identified by TWINSPAN classification.

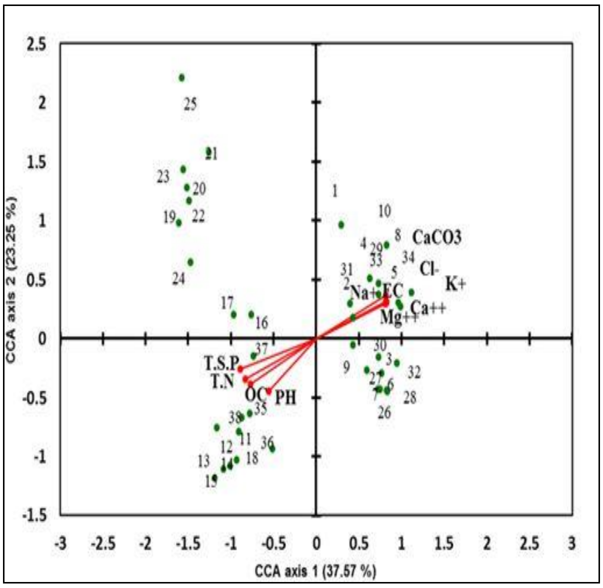

Figure. 7. CCA-ordination biplot of the sampled stands and soil variables in the present study, EC = Electrical conductivity, OC= Organic carbon, T.S.P= Total soluble phosphorus, T.N=Total nitrogen.

DISCUSSION

The present study was aimed to investigate the spatial distribution, habitat condition, ecological aspects and chrological affinity of the selected Zygophyllaceae species with their associated plant species in some phytogeographic regions of the Egyptian desert. In Egypt, desert ecosystem is distinguished into two types of deserts; coastal and inland deserts. The coastal one is related with and adjacent to the sea coast (the Mediterranean, Red Sea or the two Gulfs of Sinai). In contrast, the inland desert incorporates the inland oases and depressions that are far from the effects of the seas (Zahran and Willis, 2009).

The floristic inventory included 133 plant species belonging to 107 genera and 29 families. About 60.15% of the investigated species were belonging to only six families namely, Asteraceae, Poaceae, Chenopodiaceae, Fabaceae, Brassicaceae and Zygophyllaceae. These results were in agreement with the studies of El-Amier et al. (2015) and Mashaly et al. (2016).

Asteraceae ranked first followed by Poaceae then Chenopodiaceae, which together account for 34 % of the Egyptian flora (Boulos 2009), while Fabaceae, Brassicaceae and Zygophyllaceae were the last among the six families with 9 species for each. In the present study, the life-form spectrum in the surveyed area is predominantly therophytic species. The predominance of therophytes is an indicator of the prevailing arid climate as those elements are characterized by high reproductive capacity, ecological and genetic plasticity and high adaptation to mild moist winter and hot dry summer. This has been confirmed by Salama et al. (2013), Abd El-Ghani et al. (2014), Abd El-Aal et al. (2015) and Mashaly et al. (2016). In addition, the dominance of perennials (60% of total surveyed taxa) may be related to the nature of the habitat types in the study area in which the reproductive capacity, morphological, ecological and genetic plasticity are the limiting factors (Grime ,2006). These results show the influence of climate topographic, hot-arid variation and biotic factors in the study area (Shaltout et al., 2015).

The current study was mainly regarded as a mixture of the chorotypes belonging to Saharo-Sindian, Mediterranean and Irano-Turanian regions. The effect of these phytogeographical zones was highly reflected in the flora of the study area. The Preponderance of Saharo-Sindian chorotypes could be attributed to the location of Egypt in the center of Saharo-Sindian region (Barakat et al., 2014). The other floristic elements such as Euro-Siberian, Sudano-Zambezian, Cosmopolitans, Palaeotropical, Neotropical, Australian and Pantropical were in a varying miniature representation reflecting their differential capability to penetrate the region (Shaltout et al., 2015).

The yielded four vegetation groups using TWINSPAN classification and DCA ordination reflect the different habitats in the study area. These groups were named after the first dominant species. Group A: *Zygophyllum aegyptium*, group B: *Fagonia cretica*, group C: *Zygophyllum coccineum* and group D: *Pulicaria undulate.*.

Groups A and B represented the surveyed coastal desert, while C and D communities reflect the inland Eastern desert. *Zygophyllum aegyptium* community may stand for the sand formation habitats along Deltaic Mediterranean coastal desert. In addition, *Fagonia cretica* community dominated the roadside habitats of the western Mediterranean coastal desert. On the other hand, *Zygophyllum coccineum* community represented Wadi Hagul bed and gravel desert habitats of Suez. At last, *Pulicaria undulata* community inhabited wadi bed and roadside habitats in Ismailia. This agrees more or less, with the findings of Abd El-Ghani et al. (2014), Mashaly et al. (2015 & 2016).

Results of CCA-biplot of species and soil factors indicated that soil factors especially calcium carbonate, calcium, chlorides, potassium, sodium, magnesium and EC showed the highest impact among the soil factors that affecting the distribution and abundance of the surveyed plant species. The dominant species of vegetation group C (*Zygophyllum coccinium* and *Zilla spinosa*) were segregated at the upper-right quarter of CCA and closely related with magnesium, potassium, chlorides, electrical conductivity and calcium carbonates. *Zygophyllum aegyptium* and *Rumex pictus* as the first and second dominant species in group A and the first dominant species in group D *Pulicaria undulata* were segregated in the lower-left quarter of CCA, and obviously correlated with organic carbon, total nitrogen, total phosphorus and pH. On the other hand, the characteristic leading species of vegetation group B namely *Fagonia cretica* and *Avena fatua* were isolated at the upper-left quarter of CCA-diagram. These results were in agreement with the findings of Alattar (2018) and Showran (2018).

Acknowledgement

The authors would like to thank the Academy of Scientific Research and Technology, Ministry of Scientific Research for supporting Mona Elmorsy by the grant of Scientists for Next Generation (ASRT/SNG/FA/2014-9).

REFERENCE

ABD ELAAL, M., H. M. EL-SHORA AND O. J. KADHIM. 2015. Community Associates of the Medicinal *Farsetia Aegyptia* Turra and its Soil Correlates in the North-Eastern Desert of Egypt. Mansoura Journal of Biology, **40:**130-142.

ABD EL-GHANI, M. M., HUERTA-MARTÍNEZ, F. M., L. Hongyan and R.Qureshi. 2017. Plant Responses to Hyperarid Desert Environments. Springer International Publishing.

ABD EL-GHANI, M. M., SALAMA, F., SALEM, B., EL HADIDY, A. AND ABDEL-ALEEM, M. 2014. Biogeographical relations of a Hyper Arid Desert Flora in Eastern Egypt. African Journal of Ecology, **52:**173–191

ABDEL KHALIK, K. N. 2012. A Numerical Taxonomic Study of the Family Zygophyllaceae from Egypt. Acta Botanica Brasilica, **26:** 165-180.

ABDELAAL, M. 2017. Current Status of the Floristic Composition in Wadi Hagul, Northwest Suez Gulf, Egypt. Rendiconti Lincei, **28(1):** 81-92.

ALATTAR, A. Y. 2018. Ecological Features and Economic Potentialities of Some Species of Family Boraginaceae in the Mediterranean Coast, Egypt. M. Sc. Thesis, Faculty of Science, Mansoura University, Egypt.

AOAC. 1990. Official Methods of Analysis, 15th Edition. Association of Official Analytical Chemists, Arlington, Virginia.

BARAKAT, N. A. M., A. M. A. EL-GAWAD, V. LAUDADIO, H. F. KABIEL, V. TUFARELLI, AND E.CAZZATO. 2014. A Contribution to the Ecology and Floristic Markers of Plant Associations in Different Habitats of Sinai Peninsula, Egypt. Rendiconti Lincei**, 25(4):** 479-490.

BEIER, B. A., J. A. A. NYLANDER, M. W. CHASE AND M.THULIN. 2004. Phylogenetic relationships and biogeography of the Desert Plant Genus *Fagonia* (Zygophyllaceae), inferred by Parsimony and Bayesian Model Averaging. Molecular Phylogenetics and Evolution, **33(1):** 91-108.

BEIER, B. A., M. W. CHASE AND M. THULIN. 2003. Phylogenetic Relationships and Taxonomy of Subfamily Zygophylloideae (Zygophyllaceae) Based on Molecular and Morphological Data. Plant Systematics and Evolution, **240(1-4):** 11-39.

BOULOS L. 1999. Flora of Egypt. Azollaceae—Oxalidaceae, Vol 1. Al Hadara, Cairo, p 419.

BOULOS L. 2000. Flora of Egypt. Geraniaceae-Boraginaceae, Vol 2. Al Hadara, Cairo, p 352.

BOULOS L. 2002. Flora of Egypt. Verbinaceae-Compositae, Vol 3. Al Hadara, Cairo, p 373.

BOULOS L. 2005. Flora of Egypt. Monocotyledons (Alismataceae- Orchidaceae), Vol 4. Al Hadara, Cairo, p 617.

BOULOS L. 2009. Flora of Egypt Checklist, Revised Annotated Edition. Al Hadara, Cairo.

EL GHOUL, J., M. SMIRI, S. GHRAB, N. A BOUGHATTAS. AND M. BEN-ATTIA, 2012. Antihyperglycemic, Antihyperlipidemic and Antioxidant activities of Traditional Aqueous Extract of *Zygophyllum album* in Streptozotocin Diabetic Mice. Pathophysiology, **19(1):** 35-42.

EL HADIDI, M. N. 1966. The Genus *Fagonia* L. Egypt. Candollea, **21(1):** 13-54.

EL HADIDI, M. N. 1972. The family Zygophyllaceae in Egypt: 1. *Fagonia* L. and *Seetzenia* R. Br. Botaniska Notiser, **125(4):** 523-535.

EL-AMIER, Y. A., E. S. F. EL-HALAWANY, S. A. HAROUN, AND S. G. MOHAMUD. 2015. Vegetation Analysis and Soil Characteristics on Two Species of Genus *Achillea* Growing in Egyptian Desert. Open Journal of Ecology, **5:** 420-433.

ELBADRY, M. A., M. M. ELAASSER, H. H. ELSHIEKH, AND M. M. SHERIFF. 2015. Evaluation of Antimicrobial, Cytotoxic and larvicidal Activity of *Zygophyllum coccineum* North Sinai, Egypt. Med Aromat Plants, **4(214):** 2167-0412.

ENGLER A. 1896. Uber Die Geographische Verbreitung Der Zygophyllaceen Im Verhaltniss Zu Ihrer Systematischen Gliederung. Abhandlungen Der Preussischen Akademie Der Wissenschaften, Physikalisch-Mathematische Klasse, Berlin.

ENGLER A. 1931. Zygophyllaceae, Rutaceae, Simaroubaceae, Burseraceae. in: Engler A, Prantl K (eds) Die natürlichen Pflanzenfamilien, 2nd edn, Vol 19a. Engelmann, Leipzig, pp 144–184, 187–456.

FARHEEN, R., MAHMOOD, I., PARVEEN, R., KISHWAR, F. AND ANWAR, A. 2017. Review on Medicinal and Bioactive Role Of Genus *Fagonia*. FUUAST Journal Of Biology, **7(1):** 33-36.

FEINBRUN-DOTHAN, N. 1978. Flora Palaestina: Part 3. Ericaceae to Compositae. Jerusalem, Israel Academy of Sciences and Humanities. 481.

FEINBRUN-DOTHAN, N.1986. Flora Palestina, Part 4. Israel Acad Sciences and Humanities, Jerusalem. Israel Academy of Sciences and Humanities. 463.

GIBBONS, S. AND M. A. ORIOWO. 2001. Antihypertensive Effect of an Aqueous Extract of *Zygophyllum coccineum* L. in Rats. Phytotherapy Research, **15(5):** 452-455.

GRIME, J. P. 2006. Plant Strategies, Vegetation Processes, and Ecosystem Properties. John Wiley & Sons.

HENDERSON P. A. AND R. M. SEABY 2007. Community Analysis Package 4.0. Pisces Conservation Ltd, Lymington.

LAM, M., A. R. CARMICHAEL AND H. R. GRIFFITHS. 2012. An Aqueous Extract of *Fagonia cretica* Iinduces DNA Damage, Cell Cycle Arrest and Apoptosis in Breast Cancer Cells Via FOXO3a and p53 Expression. PLoS ONE, **7(6):** e40152.

MASHALY, I. A. 2001. Contribution to the Ecology of the Deltaic Mediterranean Coast, Egypt. Online Journal of Biological Sciences, **1 (7):** 628-635.

MASHALY, I. A. 2002. Ecological Studies on *Zygophyllum aegyptium* in the Deltaic Mediterranean Coast of Egypt. Pakistan Journal of Biological Sciences, **5 (2):** 152-160.

MASHALY, I. A., M. ABD EL-AAL, H.S. ALDESUQUY AND B.A. MAHDEE. 2016. Floristic Perspective for Some Medicinal Plants Growing in the Coastal and Inland Deserts of Egypt. International Journal of Current Research**, 8:** 24917-24925.

MASHALY, I. A., Y. EL-AMIER AND A.YAHIA. 2015. Phytosociological and ecological studies of five species of genus *Zygophyllum* in Egypt. Mansoura Journal of Biology, **40:** 79-96.

MUELLER-DOMBOIS, D. AND H. ELLENBERG. 1974. Aims and Methods of Vegetation Ecology.John Willey and Sons, New York, Chichester Brisbone, Toranto.

PAREEK, A., A. GODAVARTHI, R. ISSARANI AND B. P. NAGORI. 2013. Antioxidant and Hepatoprotective Activity of *Fagonia schweinfurthii* (Hadidi) Hadidi Extract in Carbon Tetrachloride induced Hepatotoxicity in HepG2 Cell line Andrats. Journal of Ethnopharmacology, **150(3):** 973-981.

QURESHI, H., S. ASIF, H. AHMED, H. A. AL-KAHTANI AND K. HAYAT. 2016. Chemical Composition and Medicinal Significance of *Fagonia cretica*: A Review. Natural Product Research, **30(6):** 625-639.

RAUNKIAER, C. 1934. The Life Forms of Plants and Statistical Plant Geography. The Clarendon Press.

SALAMA, F. M., M. M. A.. EL-GHANI, S. M. EL-NAGGAR,. AND M. M. ALJARROUSHI. 2013. Vegetation Analysis and Species Diversity in the Desert Ecosystem of Coastal Wadis of South Sinai, Egypt. Journal of Biology and Earth Sciences, **3(2):** 214-227.

SHALTOUT, K. H., H. A. HOSNI, R. A.EL-FAHAR, AND D. A. AHMED. 2015. Flora and Vegetation of the Different Habitats of the Western Mediterranean Region of Egypt. Taeckholmia, **35:** 45-76.

SHEAHAN, M. C. AND D. F.CUTLER. 1993. Contribution of Vegetative Anatomy to the Systematics of the Zygophyllaceae R. Br. Botanical Journal of the Linnean Society**, 113(3):** 227-262.

SHEAHAN, M. C. AND M. W CHASE,. 2000. Phylogenetic Relationships Within Zygophyllaceae Based on DNA Sequences of Three Plastid Regions, with Special Emphasis on Zygophylloideae. Systematic Botany, **25(2):**371-384.

SHEAHAN, M. C. AND M. W. CHASE. 1996. A Phylogenetic Analysis of Zygophyllaceae R. Br. Based on Morphological, Anatomical and rbc L DNA Sequence Data. Botanical Journal of the Linnean Society, **122(4):** 279-300.

SHOWRAN, R. A. 2018. Ecological Study on the Desert Shrub *Ochradenus baccatus* Delile in Wadi Hagul, North Eastern Desert, Egypt. M. Sc. Thesis, Faculty of Science, Mansoura University, Egypt.

TACKHOLM, V. 1974. Students' Flora of Egypt. Beirut, Cairo University.

TER BRAAK, C. F. 2003. CANOCO, Version 4.52. Wageningen University and Research Centre, Wageningen.

UPADHYAY, R. M. AND N. L. SHARMA.2005. Manual of Soil, Plant, Water and Fertilizer Analysis. Kalyani, New Delhi.

WALKLEY, A., AND I. A. BLACK. 1934. An Examination of the Degtjareff method for Determining Soil organic Matter, and A Proposed Modification of the Chromic Acid Titration Method. Soil Sci., **37:**29–38.

WILDE, S. A., G. K. VOIGT AND J. G.LYER. 1964. Soil and Plant Analysis for Tree Culture. Edited by Gordon Chesters, Applied Soil Science Publisher.

ZAHRAN, M.A. AND A.J. WILLIS. 2009. The Vegetation of Egypt.2nd ed. Springer. Netherlands.

ZOHARY, M. 1966. Flora Palaestina, Part 1. The Israel Academy of Sciences and Humanities, Jerusalem, 364.

ZOHARY, M. 1972. Flora Palaestina, Part 2. The Israel Academy of Sciences and Humanities. Jerusalem, 203.

بيئة الغطاء الخضري للنباتات المرافقة لبعض أنواع الفصيلة الرطريطية في مناطق جغرافية مختلفة من الصحراء المصرية

محمد عبد العال ، إبراهيم مشالي* ، ماجدة سليمان ، رحاب رزق ، منى مرسي
قسم النبات ، كلية العلوم ، جامعة المنصورة ، المنصورة ، مصر

الملخص العربـــي

تعد العائلة الرطراطية فصيلة نباتية واسعة الانتشار تتميز بوجود شائع فى البيئات الجافة والشبه جافة في كل من العالمين القديم والجديد وبشكل خاص فى الصحاري الجافة موسميا.وقد اختيرت فى هذه الدراسة ثمانية أنواع من العائلة الرطراطية وهي:الشويكة *Fagonia arabica*،الحلاوى*Fagonia bruguieri*،عاقول الغزال *Fagonia cretica*، الشكاعة الناعمة*Fagonia mollis*، الرطريط المصري Zygophyllum aegyptium، البطباط*Zygophyllum coccineum* ، الرطريط المفلطح *Zygophyllum decumbens*، القرمل *Zygophyllum simplex*. تمت دراسة السمات الفلورية للأنواع النباتية المختارة والمجتمعات النباتية المصاحبة لها ودراسة مدى تأثرها بعوامل التربة المختلفةحيث تم اختيار 38 موقعا فى صحراء مصر الشرقية والصحراء الساحلية المطلة على ساحل البحر المتوسط. أظهرت نتائج الدراسة تسجيل 133 نوعا من النباتات تتبع 107 جنسا وتنتمي إلى 29 عائلة زهرية ووجد أن الفصائل: المركبة والنجيلية والرمرامية والصليبية والقرنية والرطريطية هي أكثر العائلات انتشارا حيث حققت مجتمعة حوالي 61.15% من إجمالي النباتات المسجلة فى هذه الدراسة. ووفقا لنتائج الدراسة، كانت سيادة كل من النباتات المعمرة (60%)والنباتات من طراز الحوليات (40%) وكذلك سيادة النباتات التى تتبع إقليم الصحاري –السندي فى الجنوب والتي تتبع إقليم البحر المتوسط معا(62%) دليلا معبرا على المناخ الجاف والشبه جاف لمنطقة الدراسة. ولتقدير وفرة الأنواع النباتية بالعشائر المختلفة فى منطقة الدراسة تم تطبيق برامج التصنيف والتسلسل ثنائي الاتجاه (TWINSPAN) على البيانات الخاصة بالوفرة والتي تتمثل فى قيمة الأهمية

(Importance value)وذلك حتى يمكن التعرف على المجموعات النباتية وقد أمكن التعرف على أربعة مجموعات من النباتات (A, B, C and D) ووجد أن توزيع السيادة فى تلك المجموعات النباتية كان على النحو التالي:تميزت المجموعة A بسيادة نبات الرطريط المصري *Zygophyllum*) *aegyptium*)،أما المجموعة B فقد تميزت بسيادة نبات عاقول الغزال(*Fagonia cretica*) ، وتميزت المجموعة C بسيادة نبات البطباط (*Zygophyllum coccineum*)، و أخيرا تميزت المجموعة D بسيادة نبات الجثجاث .(*Pulicariaundulata*) وباستخدام برنامج التوزيع التطابقي العكسي (DCA) فقد أمكن فصل المجموعات النباتية الناتجة باستخدام برنامج التصنيف والتسلسل ثنائي الاتجاه. وباستخدام برنامج تحليل التطابق الكنسى (CCA) فقد تم التوصل إلى تحديد أهم عوامل التربة ارتباطا بمحاور التسلسل ومن أهم هذه العوامل:كربونات الكالسيوم والكربون العضويورقم الأس الهيدروجيني والتوصيل الكهربائي والكلوريدات والنيتروجين الكلي والفسفور الكلي الذائب والعناصر المعدنية الصوديوم، البوتاسيوم، الكالسيوم، الماغنسيوم .