

Ecology of *Echinops spinosissimus* Turra in the Coastal and Inland Deserts of Egypt

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Abstract : This study was performed to explore the floristic and ecological-attributes of the *Echinops spinosissimus* Turra community in the deserts of Egypt. *E. spinosissimus* and its associated plant species were studied in relation to soil variables. A total of 108 species, 89 genera, and 30 families were detailed in 38 stands. Asteraceae, Poaceae, Chenopodiaceae, Brassicaceae, Boraginaceae, Polygonaceae, and Zygophyllaceae were the most species-rich families. Therophytes, Saharo-Sindian and Mediterranean elements predominated among recorded species. Applying TWINSpan of the associated species with *E. spinosissimus* yielded three groups identified after the 1st and 2nd dominant species. Group (A): *Zilla spinosa*- *Echinops spinosissimus*, group (B): *Echinops spinosissimus*- *Carthamus tenuis* and group (C): *Avena fatua*- *Echinops spinosissimus*. Group A represents the vegetation of coastal deserts along the Deltaic Mediterranean coast, group B represents the inland desert along the Eastern Desert, and group C may represent a transitional stage with more similarity to group B. A CCA-biplot of the characteristic species and soils specified, calcium carbonates, sodium, silt, bicarbonates, sand, chlorides, electric conductivity, total nitrogen and pH were the most leading variables affecting the *E. spinosissimus* community. In particular, *E. spinosissimus* was disjointed at the right-upper on the CCA diagram and positively-correlated with CaCO₃, silt fraction, HCO₃, total dissolved phosphorous, clay fraction, and potassium.

Keywords: Asteraceae, life forms, chorotypes, multivariate.

1. Introduction

Domesticated plants from the wild supply 90% of the food, fiber, medicines, and other necessities in the world. Many of these plants, which are still unevaluated, are interesting to ecologists, genetic engineers, and agronomists as they create new varieties of crops [1]. Therefore, the interest of ecologists is to address the current status of unevaluated wild plants, especially highly adapted species, medicinal, endemic, and endangered ones in different ecosystems. Concerning the ecological features, it is essential to address the environmental conditions that help plants grow and give them their greatest productivity with high quantities of active materials and high potential economic rates.

Echinops L. belongs to the family Asteraceae and includes 120–130 species distributed across the Mediterranean region,

tropical and north Africa, and Asia [2]. This genus is represented by six species in Egypt [3]. In the current study, *Echinops spinosissimus* Turra (synonymous: *Echinops spinosus*) was the target species. It can survive in a wide-range of soil-types, including coastal, sandy-gravelly, calcareous, and rocky environments [4]. *E. spinosissimus* is a perennial herb belonging to the Family Asteraceae (Compositae), reaching up to 1 m in height with an erect brownish stem, few long-leaves, and hairy-long spines. During the flowering-season, the inflorescence is a single hemispherical globe surrounded by numerous spines [4]. The fruits are achenes covered by scales [5]. *E. spinosissimus* is commonly found along the Deltaic-Mediterranean coast and in the inland desert (the Eastern Desert). The current status of vegetation of the Mediterranean coastal and

the inland-desert of Eastern Desert provide a clear case study for anthropogenic disturbances that caused habitat fragmentation and decreased plant diversity [6-7]. Phytochemical analysis of *E. spinosissimus* in North Africa led to the recognition of 42 components belonging to alkaloids, 22 flavonoids, and sterols [2, 8]. Two sesquiterpenoids were isolated from *E. spinosissimus* [9]. The presence of flavonoids was documented in *E. spinosissimus* aboveground parts from Egypt and Algeria [4]. Traditional investigations of *E. spinosissimus* are commonly applied in folk medicine for diuretic, gastric pain, diabetes, and spasmolytic problems [10]. In conventional medicine, the stems, leaves, and roots of *E. spinosissimus* are documented as a diuretic drug [11].

This study was designed to characterize the spatial distribution, habitat conditions, and floristic features of *E. spinosissimus* with its associated species in two habitat-types: coastal desert (along the Deltaic Mediterranean-coast) and inland desert (along the Eastern Desert) of Egypt.

2. Materials and methods

2.1. Study area

The sampled stands were distributed in two types of habitats/deserts in Egypt; the coastal and inland deserts where *E. spinosissimus* grows (Fig. 1). The coastal desert is represented by the middle Mediterranean coast. These coastal-lands where *E. spinosissimus* survives. The inland-desert includes two-locations: Wadi-Hagoul and Kattamyia- Elin Sokhna road in the Eastern Desert. The deltaic coast extends for ca. 180 km, while the Eastern Desert extends for an area of 223,000 km² between the Nile Valley and the Gulf of Suez [12] where Western Desert extends for an area of *****km² between the Nile Valley and ***** . The climate of the Mediterranean coastal desert is semi-arid, with hot-summners and mild-winters. While, the climate in the other studied habitat (inland desert) is an arid-desert with low precipitation, and high-temperatures.

2.2. Vegetation and data analysis

Thirty-eight stands of 25 m² each were selected across the coastal and inland deserts, during Spring 2022 at the blooming of the flora. In each stand, all vascular plants were listed. The importance-value was estimated by the

sum of relative-density and relative cover [13]. The plant species were named after Täckholm [14] and Boulos [2]. According to Raunkiaer [15], the life-form spectrum was labeled. The chorotypes of the surveyed species were created after Zohary [16] and Feinbrun--Dothan [17].

TWINSPAN was operated to categorize the floristic records of 108 species in 38 stands [18-19], while DCA was directed to distribute the sampled stands. CCA to connect the leading characteristic species with the measured soil factors [20].

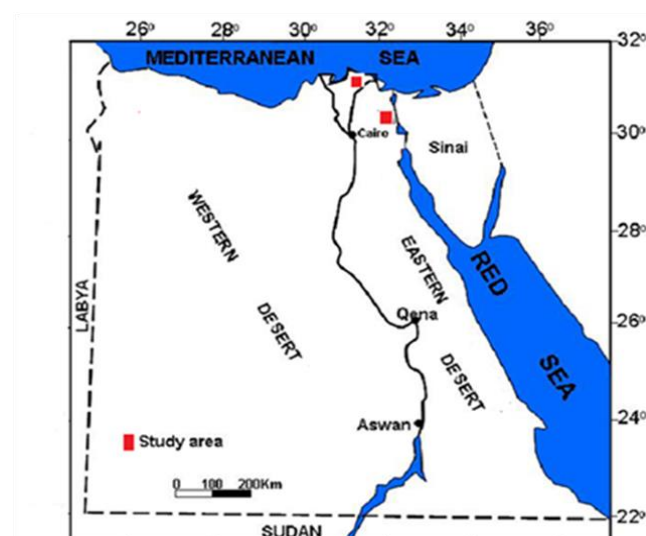


Fig (1): Map of Egypt shows the study area. Plz show location name on the map After [25].

2.3. Soil- analysis

Three soil samples were collected at 30-50 cm depth and pooled together as a composite-sample. For soil-texture, the drying sieves method was used to determine the percentage of soil fractions. Soil-porosity and water-holding-capacity were measured in accordance with the AOAC [21]. Organic carbon was quantified by the Walkley & Black method. Sulphates were valued using a BaCl₂ solution. Calcium carbonate was dissolved in HCl and then determined using NaOH. Total nitrogen was assessed by Kjeldahl-assay. Electrical-conductivity and soil pH were measured. Chlorides and bicarbonates were appraised by titration-method. Total-phosphorus was valued by the stannous-chloride. Soil Na⁺, K⁺, Ca⁺⁺ and Mg⁺⁺ were approximated using a Flame-Photometer. All of these methods were approved according to AOAC [21].

3. Results

3.1. Floristic features

The floristic associates within the *E. spinosissimus* community in the present study are displayed in **Table (1)**. In total, 108 plant-species, 89 genera, 30 families documented in 38 stands. The largest, most species-rich families were Asteraceae (24 species), Poaceae = Chenopodiaceae = Brassicaceae (9 each) and Boraginaceae, Polygonaceae and Zygophyllaceae (5 each). The remaining twenty-three families had a low representation (by either 4, 3, 2 or one species each). With four species, *Launaea* was the largest representable genus. Out of 108 species, 65 species (60.18%) were perennials, 42 species (38.89%) were annuals, and only one species was biennial (0.93%).

As displayed in **Table (1)** and **Fig. (2)**, the life-forms of 108 species encompassed 43 therophytes (39.81%), 29 chamaephytes (26.85%), 20 hemicryptophytes (18.51%), and eight of each of cryptophytes and phanerophytes (7.41% each).

The floristic classes of recorded-species are presented in **Table (1)** and **Fig. (2)**. Biregional elements had the highest contribution by 40.75% (44 species), monoregional elements (37 species = 34.26%), and pluriregional elements (17 species = 15.74%). In addition, the floristic analysis revealed that, 70 Saharo-Sindian element (35 biregional, 22 monoregional and 13 pluriregional), 55 Mediterranean taxa (22 biregional, 17 pluriregional, and 15 monoregional), five Cosmopolitan, three Palaeotropical, and one Neotropical species.

3.2. Analysis of vegetation data

Based on the importance value *E. spinosissimus* community, classification of the 38 stands using TWINSpan yielded three groups or community types labelled A, B and C (**Fig. 4**). Group (A): *Zilla spinosa*- *Echinops spinosissimus*, group (B): *Echinops spinosissimus*- *Carthamus tenuis* and group (C): *Avena fatua*- *Echinops spinosissimus*. The identification was based on the first two species with the highest importance values.

Vegetation group A included 54 species,

distributed in 19 stands (**Table 2**). The dominant species were *Zilla spinosa* (IV=39.55) and *E. spinosissimus* (IV=37.29). The most important associates in this group include *Zygophyllum coccineum* and *Ochradenus baccatus*. Group B comprised 15 stands with 60 species. *Echinops spinosissimus* (IV=47.31) and *Carthamus tenuis* (IV=15.63) were the dominant and co-dominant species, respectively. In addition, *Arthrocnemum macrostachyum* and *Mesembryanthemum crystallinum* were the notable associates in this community. Group-C included 18 species in 4 stands, and was dominated by *Avena fatua* (IV=45.27) and *Echinops spinosissimus* (IV=33.82). The most important-associated-species include *Alhagi graecorum*, *Carthamus tenuis* and *Bromus diandrous* (**Table 2**).

The DCA of 38 sampled-stands is explained in **Fig. (4)**. It is obvious; the clusters (A, B and C) were clearly different and had an obvious form of segregation. Group-A was separated on the right sector of DCA, B and C were at the left- sector of DCA.

3.3. Vegetation- soil correlation

The distinction of soil within the obtained groups is in **Table (3)**. The group (A) preferred soils with high sand content (93.77%), porosity (40.69%), water-holding capacity (37.15%), electric conductivity (0.49 mmhos cm⁻¹), chlorides (0.41%), sulphates (0.39%), total nitrogen (35.46 mg 100 g⁻¹ dry soil), sodium (56.82 mg 100 g⁻¹ dry soil), calcium (17.30 mg 100 g⁻¹) and magnesium (10.96 mg 100 g⁻¹ dry soil).

Vegetation group B had the highest-values of silt (8.89%), clay fraction (1.74%), bicarbonates (0.37%), total dissolved phosphorus (3.72 mg 100 g⁻¹ dry soil) and potassium (19.42 mg 100 g⁻¹ dry soil). Finally, the soil of vegetation group (C) was characterized by the highest calcium carbonates (5.22%), organic carbon (0.54%) and pH (8.20).

Moreover, the lowest values of silt fraction (4.77%), clay fraction (1.47%), calcium carbonates (3.83%), pH (7.88), bicarbonates (0.26%), and total dissolved phosphorous (2.33 mg 100 g⁻¹ dry soil) were recorded in group A.

Table (1): Floristic structure within *E. spinosissimus* community. Whereas, life span is indicated by A: annual, B: biennial, P: perennial, but life form by Th: therophyte; Ch: chamaephyte; H: hemicryptophytes; Ph: phanerophytes; Cr: cryptophytes; and floristic category by ME: Mediterranean; SA-SI: Saharo-Sindian; IR-TR: Irano-Turanian; S-Z: Sudano-Zambezian; ER-SR: Euro-Siberian; PAL: Palaeotropical, COSM: Cosmopolitan; NEO: Neotropical; CULT and NAT: Cultivated and Naturalized.

Species	Family	Life span	Life form	Floristic category
<i>Achillea fragrantissima</i> (Forssk.) Sch.Bip.	Asteraceae	P	Ch	SA-SI+IR-TR
<i>Aerva javanica</i> (Burm.F.) Juss. ex Schult.	Amaranthaceae	P	Ch	SA-SI+S-Z
<i>Alhagi graecorum</i> Boiss.	Fabaceae	P	H	PAL
<i>Anabasis articulata</i> (Forssk.) Moq.	Amaranthaceae	P	Ch	SA-SI+IR-TR
<i>Anchusa humilis</i> (Desf.) I. M. Johnst.	Boraginaceae	A	Th	ME+SA-SI
<i>Arthrocnemum macrostachyum</i> (Moric.) K. Koch.	Chenopodiaceae	P	Ch	ME+SA-SI
<i>Asparagus horridus</i> L.	Asparagaceae	P	Cr	ME+SA-SI
<i>Asteriscus graveolens</i> (Forssk.) Less.	Asteraceae	P	Ch	SA-SI
<i>Atractylis carduus</i> (Forssk.) C. Chr.	Asteraceae	P	H	ME+SA-SI
<i>Atriplex halimus</i> L.	Chenopodiaceae	P	Ph	ME+SA-SI
<i>Avena fatua</i> L.	Poaceae	A	Th	PAL
<i>Bassia indica</i> (Wight) A. J.Scott.	Chenopodiaceae	A	Th	S-Z+IR-TR
<i>B. muricata</i> (L.) Asch.	Chenopodiaceae	A	Th	SA-SI+IR-TR
<i>Brassica nigra</i> (L.) Koch	Brassicaceae	A	Th	COSM
<i>B. rapa</i> L.	Brassicaceae	A	Th	NAT and CULT
<i>B. tournefortii</i> Gouan	Brassicaceae	A	Th	ME+IR-TR+SA-SI
<i>Bromus diandrus</i> Roth	Poaceae	A	Th	ME
<i>Cakile maritima</i> Scop.	Brassicaceae	A	Th	ME+ER-SR
<i>Calligonum polygonoides</i> L.	Polygonaceae	P	Ph	SA-SI+IR-TR
<i>Calotropis procera</i> (Aiton) W.T. Aiton	Asclepiadaceae	P	Ph	SA-SI+S-Z
<i>Carduus getulus</i> Pomel	Asteraceae	A	Th	SA-SI
<i>Carthamus tenuis</i> (Boiss. & Blanche) Bornm.	Asteraceae	A	Th	ME
<i>Centaurea aegyptiaca</i> L.	Asteraceae	B	Th	SA-SI
<i>C. glomerata</i> Vahl	Asteraceae	A	Th	ME
<i>Chenopodium murale</i> L.	Chenopodiaceae	A	Th	COSM
<i>Cleome amblyocarpa</i> Barratte&Murb Botsch.	Cleomaceae	A	Th	SA-SI+ IR-TR
<i>C. droserifolia</i> (Forssk.) Delile	Cleomaceae	P	Ch	SA-SI+ IR-TR
<i>Cressa cretica</i> L.	Convolvulaceae	P	H	ME+ IR-TR
<i>Crotalaria aegyptiaca</i> Benth.	Fabaceae	P	Ch	SA-SI
<i>Cynanchum acutum</i> L.	Asclepiadaceae	P	H	ME+ IR-TR
<i>Cyperus capitatus</i> Vand.	Cyperaceae	P	Cr	ME
<i>C. conglomeratus</i> Rottb.	Cyperaceae	P	Cr	SA-SI+ S-Z
<i>Daucus glaber</i> (Forssk.) Thell.	Apiaceae	A	Th	ME
<i>Deverra tortuosa</i> (Desf.) DC.	Apiaceae	P	Ch	SA-SI
<i>Diploxys acris</i> (Forssk.) Boiss.	Brassicaceae	A	Th	SA-SI
<i>D. harra</i> (Forssk.) Boiss.	Brassicaceae	P	H	ME+SA-SI
<i>Echinops spinosissimus</i> Turra	Asteraceae	P	H	ME+SA-SI
<i>Echium angustifolium</i> Mill.	Boraginaceae	P	H	ME
<i>Emex spinosa</i> (L.) Campd.	Polygonaceae	A	Th	ME+SA-SI
<i>Erodium gruinum</i> (L.) L'Hér.	Geraniaceae	A	Th	ME
<i>E. laciniatum</i> (Cav.) Willd.	Geraniaceae	A	Th	ME
<i>Euphorbia retusa</i> Forssk.	Euphorbiaceae	P	H	SA-SI
<i>Fagonia arabica</i> L.	Zygophyllaceae	P	Ch	SA-SI
<i>Fagonia mollis</i> Delile	Zygophyllaceae	P	Ch	SA-SI
<i>Farsetia aegyptia</i> Turra subsp <i>aegyptia</i>	Brassicaceae	P	Ch	SA-SI+S-Z
<i>Gypsophila capillaris</i> (Forssk.) C. Chr.	Caryophyllaceae	P	H	SA-SI+ IR-TR
<i>Halocnemum strobilaceum</i> (Pall.) M. Bieb.	Chenopodiaceae	P	Ch	ME+IR-TR+ SA-SI
<i>Haloxylon salicornicum</i> (Moq.) Bunge	Chenopodiaceae	P	Ch	SA-SI
<i>Haplophyllum tuberculatum</i> (Forssk.) Juss.	Rutaceae	P	H	SA-SI
<i>Herniaria hemistemon</i> J. Gay	Caryophyllaceae	P	H	ME+ SA-SI
<i>Hordeum marinum</i> Huds.	Poaceae	A	Th	ME+IR-TR+ER-SR
<i>Hormuzakia aggregata</i> (Lehm.) Guşul.	Boraginaceae	Ann	Th	ME
<i>Iflaga spicata</i> (Forssk.) Sch. Bip. subsp. <i>spicata</i>	Asteraceae	Ann	Th	ME+SA-SI
<i>Iphiona mucronata</i> (Forssk.) Asch.	Asteraceae	Per	Ch	SA-SI
<i>Ipomoea imperati</i> (Vahl) Griseb.	Convolvulaceae	Per	H	ME
<i>Juncus acutus</i> L.	Juncaceae	Per	He	ME+IR-TR+ER-SR
<i>Juncus rigidus</i> Desf.	Juncaceae	Per	H	ME+SA-SI+IR-TR
<i>Kickxia aegyptiaca</i> (L.) Nabelek.	Schrophulariaceae	Per	Ch	ME+SA-SI

<i>Lactuca serriola</i> L.	Asteraceae	Ann	Th	ME+IR-TR+ER-SR
<i>Lasiurus scindicus</i> Henrard.	Poaceae	Per	Cr	SA-SI+S-Z
<i>Launaea fragilis</i> subsp. <i>fragilis</i> (L.) Kuntze	Asteraceae	P	H	ME+SA-SI
<i>Launaea mucronata</i> (Forssk.) Musch	Asteraceae	P	H	ME+SA-SI
<i>L. nudicaulis</i> (L.) Hook.f.	Asteraceae	P	H	SA-SI
<i>L. spinosa</i> (Forssk.) Sch.Bip	Asteraceae	P	Ch	SA-SI
<i>Lavandula coronopifolia</i> Poir.	Lamiaceae	P	Ch	SA-SI
<i>Limbarda crithmoides</i> (L.) Dumort.	Asteraceae	P	Ch	ME+ER-SR+SA-SI
<i>Limoniastrum monopetalum</i> (L.)	Plumbaginaceae	P	Ch	ME
<i>Lolium perenne</i> L.	Poaceae	A	Th	ME+IR-TR+ER-SR
<i>Lycium schweinfurthii</i> Dammer	Solanaceae	P	Ph	ME
<i>Lycium shawii</i> Roem. & Schult.	Solanaceae	P	Ph	SA-SI+ S-Z
<i>Malva parviflora</i> L.	Malvaceae	A	Th	ME+ IR-TR
<i>Matthiola longipetala</i> (Vent.) DC.	Brassicaceae	A	Th	ME+ IR-TR
<i>Mesembryanthemum crystallinum</i> L.	Aizoaceae	A	Th	ME+ ER-SR
<i>Mesembryanthemum nodiflorum</i> L.	Aizoaceae	A	Th	ME+SA-SI+ER-SR
<i>Moltkiopsis ciliata</i> (Forssk.) I. M.	Boraginaceae	P	Ch	ME+SA-SI+S-Z
<i>Neurada procumbens</i> L.	Neuradaceae	A	Th	SA-SI+ S-Z
<i>Ochradenus baccatus</i> Delile.	Resedaceae	P	Ph	SA-SI
<i>Pancratium maritimum</i> L.	Caryophyllaceae	P	Cr	ME
<i>Panicum turgidum</i> Forssk.	Poaceae	P	H	SA-SI
<i>Pergularia tomentosa</i> L.	Asclepiadaceae	P	Ch	SA-SI
<i>Phragmites australis</i> (Cav.) Trin.ex	Poaceae	P	H	COSM
<i>Plantago ovata</i> Forssk.	Plantaginaceae	A	Th	ME+IR-TR+SA-SI
<i>Polygonum equisetiforme</i> Sibthi	Polygonaceae	P	Cr	ME+ IR-TR
<i>Pulicaria undulata</i> (L.) C.A.Mey.	Asteraceae	P	Ch	SA-SI+ S-Z
<i>Reichardia tingitana</i> (L.) Roth	Asteraceae	A	Th	ME+IR-TR+SA-SI
<i>Reseda decursiva</i> Forssk.	Resedaceae	A	Th	SA-SI
<i>Retama raetam</i> (Forssk.) Webb.	Fabaceae	P	Ph	ME+IR-TR+SA-SI
<i>Rumex pictus</i> Forssk.	Polygonaceae	A	Th	ME+ SA-SI
<i>Rumex vesicarius</i> L.	Polygonaceae	A	Th	ME+ SA-SI+S-Z
<i>Salsola kali</i> L.	Chenopodiaceae	A	Th	COSM
<i>Salvia deserti</i> Decne.	Lamiaceae	P	Ch	SA-SI+IR-TR
<i>Senecio aegyptius</i> L.	Asteraceae	A	Th	IR-TR+ SA-SI
<i>Senecio glaucus</i> L.	Asteraceae	A	Th	ME+IR-TR+SA-SI
<i>Silene succulenta</i> Forssk.	Caryophyllaceae	P	H	ME
<i>Sonchus oleraceus</i> L.	Asteraceae	A	Th	COSM
<i>Sporobolus spicatus</i> (Vahl) Kunth	Poaceae	P	Cr	ME+SA-SI+S-Z
<i>Stipagrostis lanata</i> (Forssk.) De We	Poaceae	P	Cr	SA-SI
<i>Suaeda vera</i> Forssk. ex J.F. Gmel.	Chenopodiaceae	P	Ch	ME+SA-SI+ER-SR
<i>Symphyotrichum squamatum</i> (Spreng.) Nesom	Asteraceae	P	Ch	NEO
<i>Tamarix nilotica</i> (Ehrenb.) Bunge	Tamaricaceae	P	Ph	SA-SI+ S-Z
<i>Trichodesma africanum</i> (L.) R.Br.	Boraginaceae	P	Ch	SA-SI+ S-Z
<i>Trigonella stellata</i> Forssk.	Fabaceae	A	Th	SA-SI+IR-TR
<i>Urospermum picroides</i> L.	Asteraceae	A	Th	ME+IR-TR
<i>Volutaria lippii</i> (L.) Cass. ex Maire.	Asteraceae	A	Th	SA-SI
<i>Zilla spinosa</i> (L.) Prantl	Brassicaceae	P	Ch	SA-SI
<i>Zygophyllum aegyptium</i> Hosny	Zygophyllaceae	P	Ch	ME
<i>Zygophyllum coccineum</i> L.	Zygophyllaceae	P	Ch	SA-SI+ S-Z
<i>Zygophyllum simplex</i> L.	Zygophyllaceae	A	Th	PAL
<i>Ifloga spicata</i> (Forssk.) Sch. Bip. subsp. <i>spicata</i>	Asteraceae	A	Th	ME+SA-SI
<i>Iphiona mucronata</i> (Forssk.) Asch.	Asteraceae	P	Ch	SA-SI
<i>Ipomoea imperati</i> (Vahl) Griseb.	Convolvulaceae	P	H	ME
<i>Juncus acutus</i> L.	Juncaceae	P	He	ME+IR-TR+ER-SR
<i>J. rigidus</i> Desf.	Juncaceae	P	H	ME+SA-SI+IR-TR
<i>Kickxia aegyptiaca</i> (L.) Nabelek.	Schrophulariaceae	P	Ch	ME+SA-SI
<i>Lactuca serriola</i> L.	Asteraceae	A	Th	ME+IR-TR+ER-SR

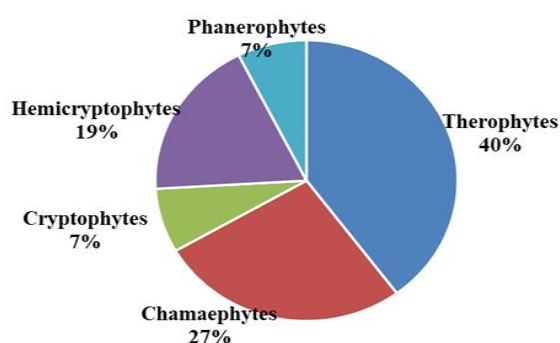


Fig (2): Life-forms of the surveyed plants.

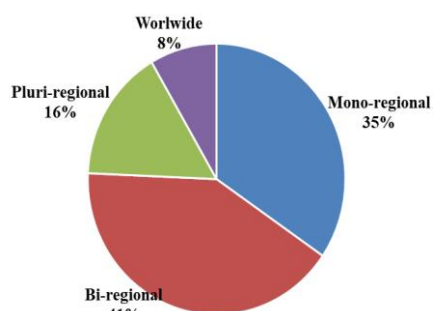


Fig (3): Floristic categories of the surveyed species.

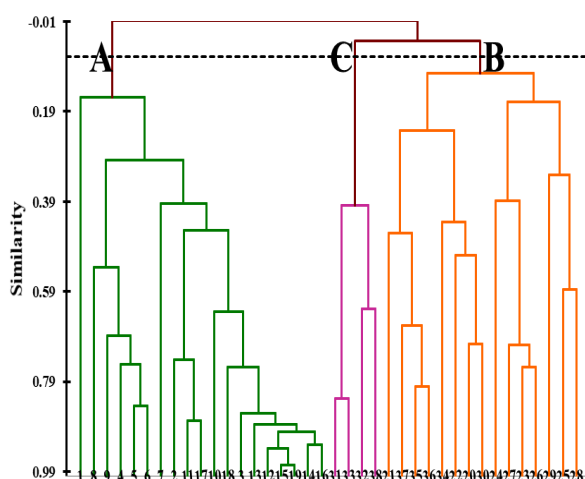


Fig. (4): TWINSPAN dendrogram shows the three vegetation groups. Dashed line shows the level of classification.

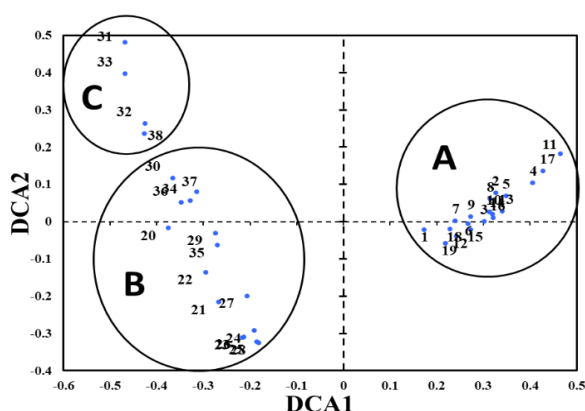


Fig. (5): DCA of three vegetation groups (38 sampled stands) in the study area.

Table (2): Characteristic features of three vegetation groups with their first, second and important species with their importance values (IV).

Group	No. of stands	No. of species	Dominant species	Important-species
A	19	54	<i>Zilla spinosa</i> (IV= 39.55) and <i>Echinops spinosissimus</i> (IV= 37.29)	<i>Zygophyllum coccineum</i> (IV= 36.06) and <i>Ochradenus baccatus</i> (IV= 12.28)
B	15	60	<i>Echinops spinosissimus</i> (IV= 47.31) and <i>Carthamus tenuis</i> (IV= 15.63)	<i>Arthrocnemum macrostachyum</i> (IV= 10.46) and <i>Mesembryanthemum crystallinum</i> (IV= 8.48)
C	4	18	<i>Avena fatua</i> (IV= 45.27) and <i>Echinops spinosissimus</i> (IV= 33.82)	<i>Alhagi graecorum</i> (IV= 27.68), <i>Carthamus tenuis</i> (IV= 23.68) and <i>Bromus diandrus</i> (IV= 21.23)

In addition, the lowest contents of sand (89.37%), water-holding capacity (34.89%), organic carbon (0.39%), TN (28.80 mg 100 g⁻¹) and Ca⁺⁺ (15.01 mg 100 g⁻¹ dry soil) were found in the soils of group B. Also, the lowest values of porosity (35.21%), EC (0.31 mmhos cm⁻¹), sulphates (0.31%), Na⁺ (13.22 mg 100 g⁻¹), K⁺ (11.41 mg 100 g⁻¹ dry soil), and Mg⁺⁺ (6.00 mg 100 g⁻¹ dry soil) were recorded in the soils of group C.

WHC: water-holding capacity, OC: organic carbon, EC: electrical conductivity, TN: total nitrogen, TDP: total dissolved phosphorus.

Results of the CCA of characteristic species and soil specified, soil factors, especially calcium carbonates, sodium, silt, bicarbonates, sand, chlorides, electric conductivity, total nitrogen, and pH were the leading variables in *E. spinosissimus* community (**Fig. 6**). *E. spinosissimus* and the characteristics leading species of vegetation group B (*Carthamus tenuis*, *Arthrocnemum macrostachyum* and

Mesembryanthemum crystallinum and *Cakile maritima*) were parted at the right-upper part of the CCA and positively correlated with CaCO_3 , silt fraction, HCO_3^- , total dissolved phosphorous, clay fraction and potassium. In addition, the leading species of group C (*Avena fatua*, *Alhagi graecorum*, *Carthamus tenuis* and *Bromus diandrous*) were parted at the lower-right quarter of the CCA and positively correlated with soil reaction, and negatively with porosity and sulphates. Moreover, the dominant and leading species of group A (*Zilla spinosa*, *Zygophyllum coccenium* and *Ochradenus baccatus*) were parted at the lower-left quarter of CCA and positively correlated with sodium, chlorides, sand fraction, total nitrogen and electric conductivity.

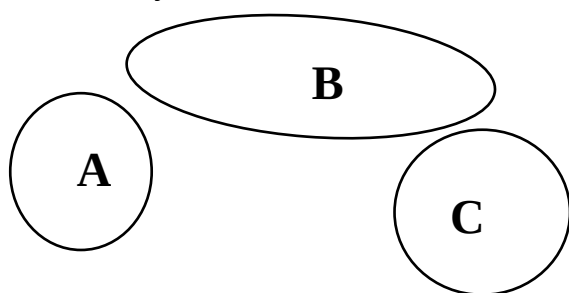


Table (3): Mean soil values $\pm$ standard errors for three vegetation groups

Soil variable	Vegetation group		
	A	B	C
Sand (%)	93.77 $\pm$ 0.26	89.37 $\pm$ 0.81	91.64 $\pm$ 1.98
Silt (%)	4.77 $\pm$ 0.26	8.89 $\pm$ 0.79	6.67 $\pm$ 1.77
Clay (%)	1.47 $\pm$ 0.08	1.74 $\pm$ 0.15	1.69 $\pm$ 0.34
Porosity(%)	40.69 $\pm$ 1.04	39.41 $\pm$ 0.95	35.21 $\pm$ 0.95
WHC (%)	37.15 $\pm$ 0.59	34.89 $\pm$ 0.68	36.19 $\pm$ 2.72
CaCO_3 (%)	3.83 $\pm$ 0.16	5.16 $\pm$ 0.18	5.22 $\pm$ 0.57
OC (%)	0.49 $\pm$ 0.02	0.39 $\pm$ 0.03	0.54 $\pm$ 0.08
pH	7.88 $\pm$ 0.09	7.94 $\pm$ 0.05	8.20 $\pm$ 0.07
EC (mmhos cm^{-1})	0.49 $\pm$ 0.03	0.35 $\pm$ 0.01	0.31 $\pm$ 0.02
Cl^- (%)	0.41 $\pm$ 0.06	0.06 $\pm$ 0.01	0.10 $\pm$ 0.04
SO_4^{2-} (%)	0.39 $\pm$ 0.04	0.36 $\pm$ 0.02	0.31 $\pm$ 0.02
HCO_3^- (%)	0.26 $\pm$ 0.02	0.37 $\pm$ 0.01	0.33 $\pm$ 0.02
TN (mg/100g)	35.46 $\pm$ 1.32	28.80 $\pm$ 0.56	32.25 $\pm$ 0.93
TDP (mg/100g)	2.33 $\pm$ 0.25	3.72 $\pm$ 0.27	3.58 $\pm$ 0.80
Na^+ (mg/100g)	56.82 $\pm$ 5.92	15.67 $\pm$ 2.13	13.22 $\pm$ 0.69
K^+ (mg/100g)	14.89 $\pm$ 1.85	19.42 $\pm$ 1.35	11.41 $\pm$ 2.18
Ca^{++} (mg/100g)	17.30 $\pm$ 1.96	15.01 $\pm$ 1.05	17.21 $\pm$ 2.73
Mg^{++} (mg/100g)	10.96 $\pm$ 1.13	7.60 $\pm$ 0.55	6.00 $\pm$ 0.60

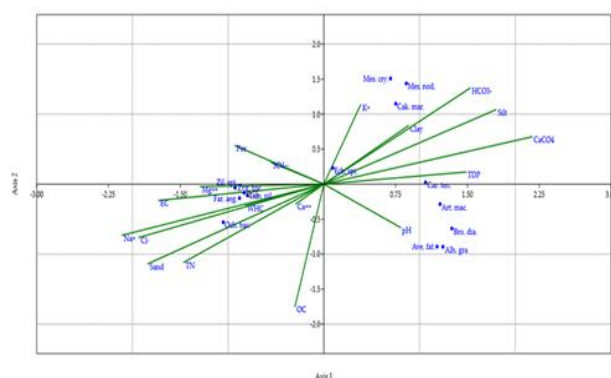


Fig. (6): CCA-ordination of the leading species (blue points) in each group (A, B and C) and soil variables (green arrows) in the present study. (Eigen value= 75%).

4. Discussion

In the 38 surveyed stands in the study area, the target *E. spinosissimus* and its associated plant species included 108 species from 89 genera and were related to 30 families. About 61% of these species fit into only six families. These families were the leading families in the Egyptian flora [2]. These results agreed with previous researches [6, 22–25]. The richness of a specific family reveals the capability of its members to persist under severe conditions, prevail in coastal-inland deserts (i.e. the study area) with high salinity and scanty rainfall.

The predominance of therophytes, Sahara-Sindian with Mediterranean-species was obvious in surveyed species. This indicates hot-dry conditions, and human factors in the study area [24]. The prevalence of Saharo-Sindian elements is a better indicator of harsh-conditions [26].

The composition of life-forms provides information that may aid in judging the reaction of plant-cover to environmental features [27]. The life-form spectrums are physiognomic traits that are broadly defined in floristic studies. The supremacy of therophytes was correlated to the Mediterranean climate, short life-cycle, and ecological elasticity [24– 25]. Therophytes are also less adapted to drought-salinity and their occurrence is sporadic; they grow only during the rainy-season [27]. Mashaly [22] reported that, about 55.6 % of therophytes are represented in the Deltaic Mediterranean coast vegetation. The high number of annuals could be attributed to the study's timing (Spring, 2022) where enough-rainfall, which gave a good chance for annuals

to appear. On the other hand, cryptophytes, hemicryptophytes, and chamaephytes have a part in the succession of vegetation in the coastal and inland deserts. The study area was clearly part of both Mediterranean territory and Saharo-Sindian-territory. This is clarified by the high contribution of Mediterranean and Saharo-Sindian chorotypes. This finding was confirmed by [23, 28–30] The current study contains a mixture of chorotype elements. This finding verifies the ability of a specific floristic category to invade the region from other neighbouring phytogeographic -regions [31].

A detailed description of vegetation is more important for providing a mental picture of a region and its vegetation, allowing for comparison and classification of vegetation units. Regarding classification, the vegetation that characterizes the study area was partitioned by the TWINSpan classification into three vegetation groups or community types. The obtained groups were: group (A): *Zilla spinosa*-*E. spinosissimus*, group (B): *E. spinosissimus*-*Carthamus tenuis* and group (C): *Avena fatua*-*E. spinosissimus*. The vegetation group-A represents the vegetation types of the coastal desert while the group B represents the inland-desert and the group C may represent a transitional stage, with close relevance to group (B). The identified groups were more or less similar to those reported in previous studies [12, 22–25].

Echinops spinosissimus and its associates in the inland desert habitat (vegetation group A) preferred soils with high sand content, porosity, water-holding capacity, electric conductivity, chlorides, sulphates, Ca^{++} and Mg^{++} . While, *E. spinosissimus* and its associates in coastal desert habitat (group B) favored soils with high values of silt, clay fraction, bicarbonates, TDP and potassium. These findings agreed with [22, 25, 32–33]. The prevalence of specific species (for example, *E. spinosissimus*, *Zilla spinosa*, *Carthamus tenuis*, *Mesembryanthemum crystallinum*) indicated that, these species are characterized by less grazing, high rates of growth under harsh conditions either in dry or salt habitats, wide ecological amplitudes and high competitive abilities.

5. Conclusions

The Mediterranean coastal region and inland deserts (e.g. inland wadis) of Egypt are subjected to the latest human-induced threats influencing the vegetation and habitats, so a conservation strategy for them is urgently required. In the 38 surveyed stands, the investigated *Echinops spinosissimus* and its associated plant species included 108 plant species, 89 genera, and 30 families. *E. spinosissimus* and its associates in the inland-desert (group A) preferred soils with high sand content, porosity, water-holding capacity, electric conductivity, chlorides, sulphates, total nitrogen, Ca^{++} and Mg^{++} . While, *E. spinosissimus* and its associates in the coastal desert (group B) favored soils with high values of silt, clay fraction, bicarbonates, total dissolved phosphorus and potassium. Calcium carbonates, sodium, silt fraction, bicarbonates, sand, chlorides, electric conductivity, total nitrogen and pH were the leading soil variables affecting *E. spinosissimus* and its associates.

References

1. Oosterveer, P. (2005). Global food governance. Wageningen University and Research.
2. Halim, A. F., Afify, M. S., Ahmed, A. F., Mira, A. S., & Mira, A. S. (2011). The fact about echinopsine and first isolation of echinorine from echinorine from *Echinops spinosus* L. *Journal of Environmental Sciences*, **40**(2), 173–181.
3. Boulos, L. (2009). Flora of Egypt Checklist. Al Hadara Publishing. Cairo, Egypt.
4. Bouzabata, A., Mahomoodally, F., & Tuberoso, C. (2018). Ethnopharmacognosy of *Echinops spinosus* L. in North Africa: a mini review. *Journal of Complementary Medicine Research*, **8**(1), 40–40.
5. Agyare C., Obiri D. D., Boakye Y. D. and Osafo N. (2013). Anti-inflammatory and analgesic activities of African plants. In: (eds). Medicinal plant research in Africa pharmacology and chemistry. 1st edition, Elsevier, London, pp 725–52, 2013.
6. Shaltout K., Ahmed D. A. (2012). Ecosystem services of the flora of

- southern Mediterranean desert of Egypt. *Ethno Res App*; **10**:403-422.
7. Abdelaal, M., Fois, M., & Fenu, G. (2018). The influence of natural and anthropogenic factors on the floristic features of the northern coast Nile Delta in Egypt. *Plant Biosystems*, **152**(3), 407-415.
 8. Abd El-Moaty H. I. (2016). Chemical constituents of *Echinops spinosissimus* Turra. *International Journal of Advanced Research*, **4**(7):1129–36.
 9. Dong, M., Cong, B., Yu, S. H., Sauriol, F., Huo, C. H., Shi, Q. W., ... & Kiyota, H. (2008). Echinopines A and B: sesquiterpenoids possessing an unprecedented skeleton from *Echinops spinosus*. *Organic letters*, **10**(5), 701-704.
 10. Kheder O., Moussaoui Y., Bensalem R. (2014). Solvent effects on phenolic contents and antioxidant activities of the *Echinops spinosus* and the *Limoniastrum monopeltatum*. *Research Journal of Pharmaceutical, Biological and Chemical Sciences*, **5**(2):66–76.
 11. Parhat, R., Makabel, B., Nurhabek, U., Tohonrbek, A., Song, F. F., Baysanbek, A., & Zou, Z. M. (2014). Overview of application and research of *Echinops* genus in Chinese medicine. *Journal of Chinese Materia Medica*, **39**(19), 3865-3869.
 12. Mashaly, I. A. (1996). On the phytosociology of Wadi Hagul, Red Sea coast, Egypt. *Journal of Environmental Sciences*, **12**: 31-54.
 13. Shukla, R.S. and Chandel, P.S. (1989). *Plant Ecology and Soil Science*. S. Chand & Company LTD. Ram Nagar, New Delhi, India.
 14. Täckholm, V. (1974). *Student's Flora of Egypt*. 2nd ed. Cairo Univ. Press (Publ.), Cooperative Printing Company, Beirut.
 15. Raunkiaer, C. (1934). *The Life Forms of Plants and Statistical Plant Geography*. Translated by Carter, Fausboll and Tansley, Oxford University Press, London.
 16. Zohary, M. (1966 and 1972). *Flora Palaestina*. Parts 1 and 2. The Israel Academy of Sciences and Humanities, Jerusalem.
 17. Feinbrun-Dothan, N. (1978 and 1986). *Flora Palaestina*, Parts. 3 and 4. The Israel Academy of Sciences and Humanities, Jerusalem.
 18. Hill, M. O. (1979a). DECORANA-a FORTRAN Program for Detrended Correspondence Analysis and Reciprocal Averaging. Section of Ecology and Systematic, Cornell Univ., Ithaca, New York.
 19. Hill, M. O. (1979b). TWINSpan-a FORTRAN Program for Arranging Multivariate Data in an Ordered Two Way Table by Classification of Individual and Attributes. Section of Ecology and Systematic Cornell Univ., Ithaca, New York.
 20. Ter Braak, C. J. F. (2003). CANOCO, version 4.52. Wageningen University and Research Centre, Wageningen, Netherlands.
 21. AOAC (1990). *Official Methods of Analysis*, 15th ed. Association of Official Analytical Chemists, Arlington, Virginia, USA.
 22. Mashaly, I. A., El-Halawany, E. F. and Omar, G. (2001). Vegetation analysis along irrigation and drain canals in Damietta Province, Egypt. *Online Journal of Biological Sciences*, **1**(12):1183-1189.
 23. Galal TM, Fawzy M. (2007). Sand dune vegetation in the coast of the Nile Delta, Egypt. *J Environ Res* 2007; **1**:74-85.
 24. Mashaly, I. A., Abdelaal, M. and Dawood, N. (2015). Floristic composition and vegetation analysis and species diversity of some Brassica species associates in north of Nile Delta Region, Egypt. *Catrina*, **14**(1): 45-52.
 25. Mashaly I. A., Abdelaal M, Aldesuquy H. S., Mahdee B.A. (2016). Floristic perspective for some medicinal plants growing in the coastal and inland deserts of Egypt. *Int J Curr Res* 2016; **8**:24917-24925.
 26. Abd El-Ghani, M. M. and Amer, W. M. (2003). Soil–vegetation relationships in a coastal desert plain of southern Sinai, Egypt. *Journal of Arid Environments*, **55**(4): 607-628.
 27. Ayyad M. A., El-Ghareeb R. M. (1982). Salt marsh vegetation of the Western

- Mediterranean desert of Egypt. *Vegetatio*; **49**:3-19.
28. Al-Sodany, Y. M. (1992). Vegetation Analysis of the Northern Part of Nile Delta Region. M.Sc. Thesis, Faculty of Science, Tanta University, Egypt.
 29. Shaltout, K. H., El-Kady, H. F. and Al-Sodany, Y. M. (1995). Vegetation analysis of the Mediterranean region of Nile Delta. *Vegetatio*, **116**: 73-83.
 30. El-Halawany, E. F. (2003). Vegetation changes in north Nile Delta within two decades. *Journal of Environmental Science, Mansoura University*, **26(2)**:153-180.
 31. 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. 178 pp.
 32. Zahran M. A., Willis A. J. (2009). The Vegetation of Egypt. 2nd ed. Springer. Netherlands.
 33. Abdelaal, M. (2017). Current status of the floristic composition in Wadi Hagul, northwest Suez gulf, Egypt. *Rendiconti Lincei*, **28(1)**, 81-92.