eISSN: 2357-044X *Taeckholmia 38 (2018): 107-122*

Associated species and threats upon *Lycium schweinfurthii* var. *schweinfurthii* in the Deltaic Mediterranean coast, Egypt

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Abstract

The present study evaluates the associated species in twelve sites including forty stands that were sampled to represent the variation among *Lycium schweinfurthii* var. *schweinfurthii* Dammer population in Egypt. The stands represent the distribution of this population in five habitats in the study area (coastal sand dunes, flat sand sheets, roadsides, island sand dunes and canal banks). Seventy associated species belong to 27 families were recorded, they comprise 38 perennials (54.2%) and 32 annuals (47.1%). Therophytes had the highest value (47%), followed by geophyte-helophytes (17%). Gramineae had the highest contribution (11 species = 15.7 %) followed by Compositae (9 species = 12.8 %). Thirteen vegetation groups were recognized in the study area after the application of TWINSPAN. *Echinops spinosissimus* and *Rumex pictus* (P=100 %) were the main associated in the thirteen groups. The significant edaphic variables which affected the distribution of this plant were Ca^{++}, Mg^{++}, HCO_3^-, SO_4^{--}, pH and organic matter. The threats upon its distribution in the study area were cutting (75 %), removing (62.5 %), fragmentation (37.5 %), grazing (25 %) and firing (20 %).

***Key words*:** Egypt, Habitats, *Lycium schweinfurthii* var. *schweinfurthii*, Threats, Multivariate analysis

Introduction

Egypt belongs to the Mediterranean basin and has a unique biodiversity that reflects its habitats, position and climate. It is a host of wide variety of terrestrial and aquatic habitats. Egypt has a rich natural heritage such as sand dunes, mountains, slopes, salt marshes, fresh and marine waters (Shaltout and Al-Sodany, 2002). It is a home of 120 families, 742 genera, and 2088 species and possesses many rare species (Khedr *et al.*, 2002). *Lycium schweinfurthii* var.*schweinfurthii* Dammer (Family: Solanaceae), is a cosmopolitan species known as a source of food, drugs, and commercial alkaloids and ornamentals (D'Arcy, 1991). Täckholm (1974) recorded *L. schweinfurthii* as endemic to Egypt; but Jafri and El-Gadi (1978) reported that its natural distribution extends along the African coastal area. In Egypt, the species is represented by two varieties: var. *schweinfurthii* known also from Sicily, Algeria, Egypt, Palestine, Cyprus and Crete; and var. *aschersohnii* (Dammer) Feinbrun, only known from Mediterranean coast of Egypt and Palestine (El Hadidi, 1994; Boulos, 2002).

Human beings and their activities such as habitat destruction or expansion for agricultural purposes are perhaps the most important causes of environmental degradation, loss of species and depletion of ecological communities (David and Burgman, 2005). Fragmentation of natural habitats or the breaking up of habitat into smaller pieces is a major challenge in conservation biology and one of the top threats to biodiversity. The negative effects of fragmentation result from the decrease in overall habitat availability and changes in spatial configuration and habitat quality (Fahrig, 2003). These effects seriously threaten the stability and persistence of wild plant population because the size and isolation of remaining increase the probability of extinction through demographic, environmental, or genetic stochasticity (Harris, 1984; (Ilpin and Hanski, 1991).

This study aims to record the associated species with *L. schweinfurthii* var. *schweinfurthii* along the Deltaic Mediterranean coast of Egypt and assess the habitats and soil characteristics in which it can grow. It aims also to assess the edaphic variables that affect its distribution, and evaluate the threats upon this species.

Received on 23/06/2018 and accepted on 26/08/2018

Study area

The study area occupies a part of Deltaic Mediterranean coast of Egypt forming a belt extending in the E-W direction for about 57 km between Qalabshu and Lake Burullus, and in the N-S direction for an average of 15 km and far from the seashore about 8 km (Fig. 1). This region is characterized by a morphological structure basically different from that to the west of Abu-Qir (Mareotis coast) and the east of Port-Said (Sinai coast). The western coast is formed from successive chains of oolitic limestone, while the eastern coast is mostly built up of limestone mixed with sand and silt. Sand dunes are the main geomorphic feature in the greatest part of the Deltaic coast, which has loose textured soils, thus they are considered as natural reservoirs of fresh water. When the rain falls, the dunes absorb the water which rapidly percolates and reaches deeply seated strata where it is protected from direct evaporation at the soil surface; in consequence the ground water level rises so that is easy to obtain fresh water from the hollows between dunes. Also this coast is characterized by three Northern shallow brackish lakes, namely from east to west: Manzalla (126,000 ha), Burullus (57,426 ha) and Idku (14,128 ha), which are joined to the Mediterranean by narrow gaps in the sandy bars (Abu Al-Azz, 1971).

Both the western and eastern section of Egyptian coast depend mainly on rainfall as the main source of water. On the other hand, the middle section (Deltaic coast) enjoy five water sources: winter rainfall, River Nile water (comes from Damitta and Rosetta branches), sea water, northern lakes and underground water. Climatologically, (Ayyad *et al.*, 1983, Zahran et al., 1985 and UNESCO, 1977), the Mediterranean coastal region of Egypt belongs to the dry arid climatic zone of Koppen's classification system (as quoted by Trewartha 1948), the arid mesothermal province of Thornthwaite (1948) and Mediterranean arid bioclimatic zone of (Emberger, 1955). The region lies in Meig's warm coastal desert Meig (1973): summer's warmest month with mean temperature less than 30^0C, and winter's coldest month with temperature above 10^oC, thought occasional rainstorms occur in winter, but most of days are sunny and mild.

Material and Methods

Twelve sites including forty stands were sampled from September 2015 to August 2016 to record the associated species and the threats upon *L. Schweinfurthii* var. *schweinfurthii* population in the study area. Stands represent its distribution in five urban habitats recognized according to Shaltout *et al.* (2010), Mashaly *et al*. (2008) and Zahran *et al*. (1990). Habitats are: coastal sand dunes (28 stands), flat sand sheets (4 stands), roadsides (4 stands), island sand dunes (3 stands) and canal banks (1 stand). The area of each stand ranged from 60 m^2 to 3800 m^2 according to the extension of the plant cover. In each stand, the present species and their life-forms were assessed following the system of Raunkiaer (1934). Latin names were updated following Boulos (2009) and IPNI. Three random distributed soil samples were collected from the active root zones of *L. schweinfurthii* var. *schweinfurthii* in each stand. Composite soil samples were collected as profiles of 0-50 cm depth below the soil surface. Organic carbon and total organic matter were determined by loss- in- ignition method at 550^0C for two hours in muffle furnane (Allen *et al*., 1974). The total porosity was determined as described by (Piper 1947), while water-holding capacity was determined using Hilgard pan boxes (see Piper, 1947).

One: five soil water extracts were prepared for determination of hydrogen ion concentration (pH) and electrical conductivity (EC) using pH and EC meters. Bicarbonates were determined by titration methods using 0.1 N hydrochloric acid and methyl orange as indicator for bicarbonates (Allen *et al*., 1976). Chlorides were determined by direct titration against 1/35.5 N silver nitrate solution and potassium chromate as indicator (Piper, 1947). Sulphates content were estimated gravimetrically using 5% barium chloride solution, where the sulphates precipitated as barium sulphate which ignited at 700-800 ^{0}C (Allen *et al*., 1974). The extractable Cations Na^+ and K^+ were determined using flame photometer; while Ca^{++} and Mg^{++} were determined by titration method according to Richards (1954). Available phosphorus in the soil was extracted with 0.5 N $NaHCO_3$ solutions (pH 8.5) and was determined using spectrophotometer at wavelength of 660 nm

(Olsen and Sommers 1982), available nitrogen was determined by Kjeldahl apparatus (Hesse, 1971).

The threats upon *L. schweinfurthii* var. *schweinfurthii* were assessed in each stand based on the following impacts: cutting, removing, fragmentation, grazing and firing. The percentage of each threat was calculated in all habitats as follow: (No. of stands subjected to each impact / Total No. of stands) X100; while the percentage of each threatened habitat was assessed as follow: (No. of threatened stands / Total number of stands) x100.

Data analysis

Two-way indicator species analysis (TWINSPAN) and detrended correspondence analysis (DCA) were applied to the matrix of the presence /absence of 70 species in 40 stands (Hill, 1979a and b). The DCA axes and environmental variables were correlated after the ordination procedure. The direct ordination was performed using CANOCO program for windows version (4.5); which is a constrained ordination technique, where results are simultaneously trained based on species abundance and environmental variables (Kent and Coker, 1992). Species richness (α-diversity) for vegetation groups was calculated as the average of species per stand. Species turnover (β-diversity) was calculated as the ratio between the total number of species recorded in a certain vegetation group and its species richness (Magurran, 1988). The variation in the soil variables in relation to vegetation groups was assessed using one-way analysis of variance (ANOVA-1). This technique was according to IBM SPSS program V. 20 (SPSS 2009).

Results

The species associated with the distribution of *L. schweinfurthii* var. *schweinfurthii* in 40 sampled stands represents five habitats in Nile Delta coast were 70 species belong to 27 families (Fig. 2). They comprise 38 perennials (54.3%) and 32 annuals (45.7 %), Therophytes have the highest percentage (47%), followed by geophyte-helophytes (17%), hemicryptophytes (14%), chamaephytes (11%), phanerophytes (9%) while Parasites have the lowest value (1%), Fig. (3). Gramineae has the highest contribution to the total associated species (11 species = 15.7%) followed by Compositae (9 species =12.8 %) and Chenopodiaceae (8 species = 11.4%). The species inhabiting the coastal sand dunes had the highest contribution to the total associated species (44 species = 62. 9%), followed by the roadsides (34 species = 48.6 %), flat sand sheets (30 species = 42.9 %), island sand dunes (29 species = 41.4%) and canal banks (15 species = 21.4%). Coastal sand dunes had the highest values of total species and species richness (0.6 species stand^{-1}) while canal banks had the lowest total species and species richness (0.2 species stand^{-1}). Flat sand sheets and canal banks had the highest species turnover (75.0), while the roadsides had the lowest (68.0) (Fig. 4 & 5).

The dendrogram resulting from the TWINSPAN classification technique based on the presence/absence of 70 plant species recorded in 40 stands led to classify them into 13 vegetation groups (G1 – G13) at level 6 (Fig. 6). G1 consists of 4 stands representing island sand dunes and dominated by *Lotus halophilus*, and has the highest pH value. G2 consists of 3 stands representing the flat sand sheets and dominated by *Alhagi graecorum*, it has the highest value of water holding capacity but the lowest K^+. G3 consists of 3 stands and represents roadsides and dominated by *Thymelaea hirsuta*, it has the lowest organic matter, highest EC, Ca^{+2}, Cl^- and HCO_3^-; G4 consists of 2 stands represents the canal banks and roadsides and dominated by *Limbarda crithmoides*, it has highest Mg^{+2}, K^+, P and N; G5-13 consist of 28 stands occupying the coastal sand dunes and co-dominated by *Stipagrostis lanata*, *Echinops spinosissimus*, *Rumex pictus*, *Moltkiopsis ciliata*, *Pancratium maritimum*, and *Frankenia hirsuta.* G5 has the highest SO_4^{-2}, Na^+ but the lowest N; G7 has the highest K^+. G8 has the lowest porosity and organic matter. G10 has the lowest water holding capacity, Ca^{+2} and Mg^{+2}; G11 has the highest organic matter but the lowest HCO_3^- and P; G12 has the highest porosity but the lowest EC and Cl^- ,Na^+ and G13 has the lowest pH. Segregation between the 13 groups along DCA axes 1 and 2 is indicated (Fig. 7). The species composition of the 13 vegetation groups identified at level 6 of TWINSPAN and their main characteristics are presented in (Tables 1 and 2). *Echinopus spinsissmusus*, *Rumex pictus* and *Mesembryanthemum crystallinum* (100%) are the main associated species in thirteen groups, each of *Lobularia arabica, Erodium lanciniatum, Paronychia arabica* and *Malva pariflora* (P=92.3 %) in twelve groups. It's clear that G1 has the highest species richness (0.6 species stand^{-1}), while G8 had the lowest (0.2 species stand^{-1}). On the other hand, G9 had the highest species turnover (80.0), while G13 had the lowest (62.5).

The means of soil characteristics of the 5 habitats supporting the 40 stands of *L. schweinfurhii* var. *schweinfurthii* population are recorded (Table 3), while those of the 13 vegetation groups (1-13) derived after the application of TWINSPAN are indicated in Table (4). The CANOCO ordination plot indicates that calcium, magnesium, sulphates, chlorides, organic matter and pH are the factors that mainly affect the distribution of associated species with the studied species (Fig. 8). Stand 13 (flat sand sheets) was located at high position along the gradient of sodium, nitrogen and water holding capacity. On the other hand, stand 19 (roadsides) was located at high position along EC, chlorides and magnesium gradient (Fig. 8).

In general, cutting of *L. schweinfurhii* var. *schweinfurhii* woody shrubs is the most pronounced type of disturbance (75.0 %), followed by habitat removing (62.5 %), fragmentation (37.5 %), grazing (25.0 %) and firing (20.0 %). Coastal sand dunes was the most threatened habitat (71.4 %) followed by flat sand sheets (50.0 %), roadsides and island sand dunes (25.0 %) (Fig. 9 &10).

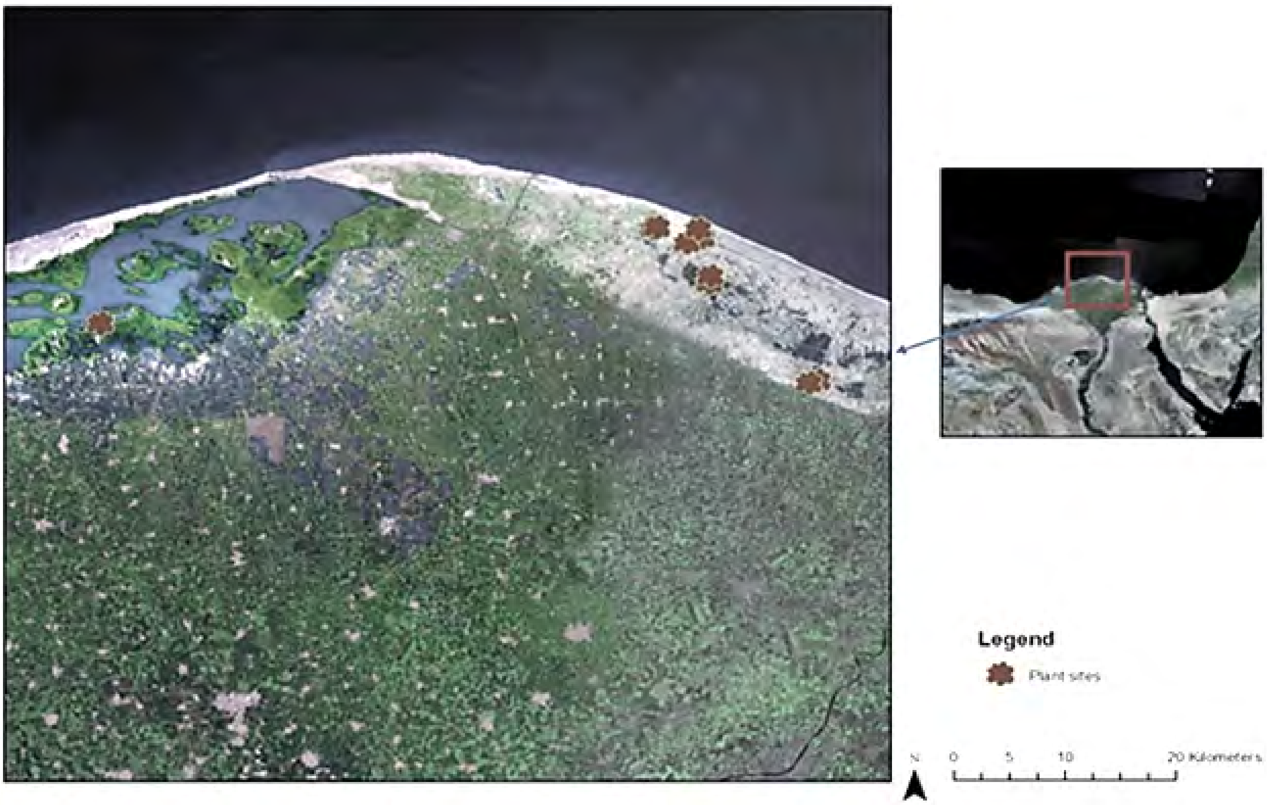

Fig. 1. Part of Deltaic Mediterranean Coast of Egypt represents the study area including the sampling site.

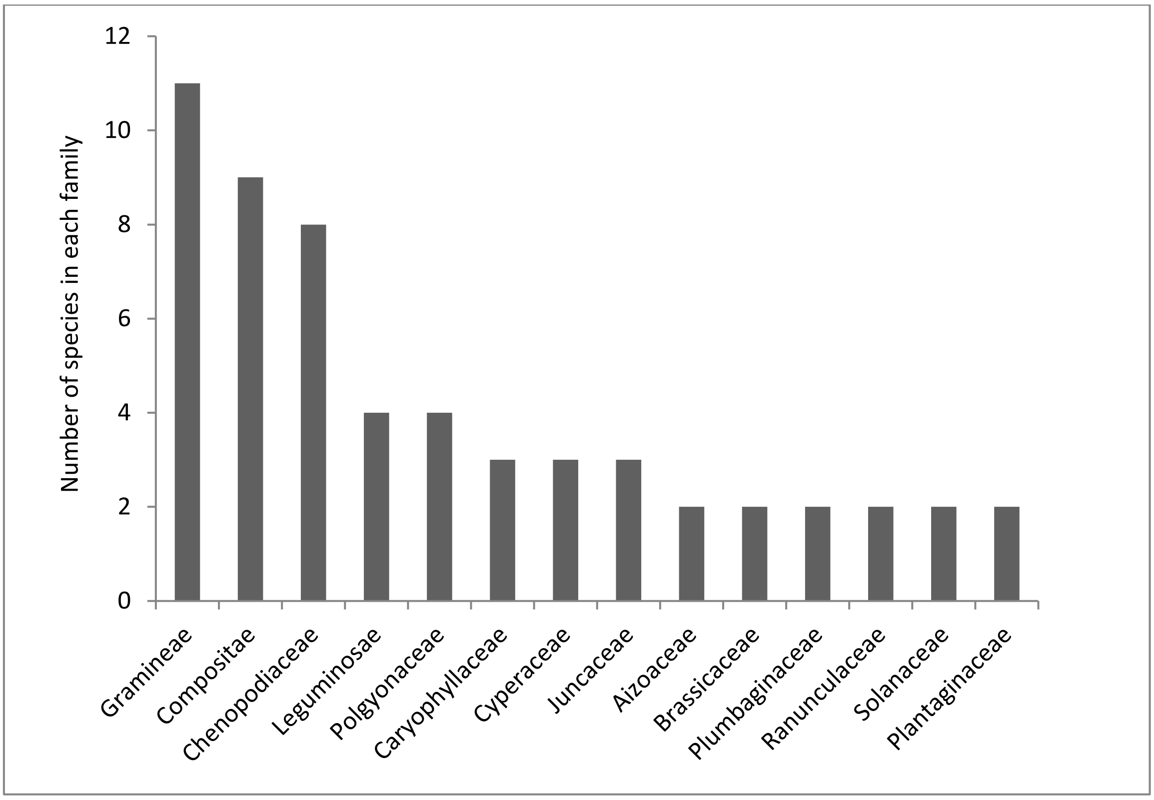

Fig. 2. Family representation of the species associated with the distribution of *L. Schweinfurthii* var. *schweinfurthii* (families with only one species are excluded)

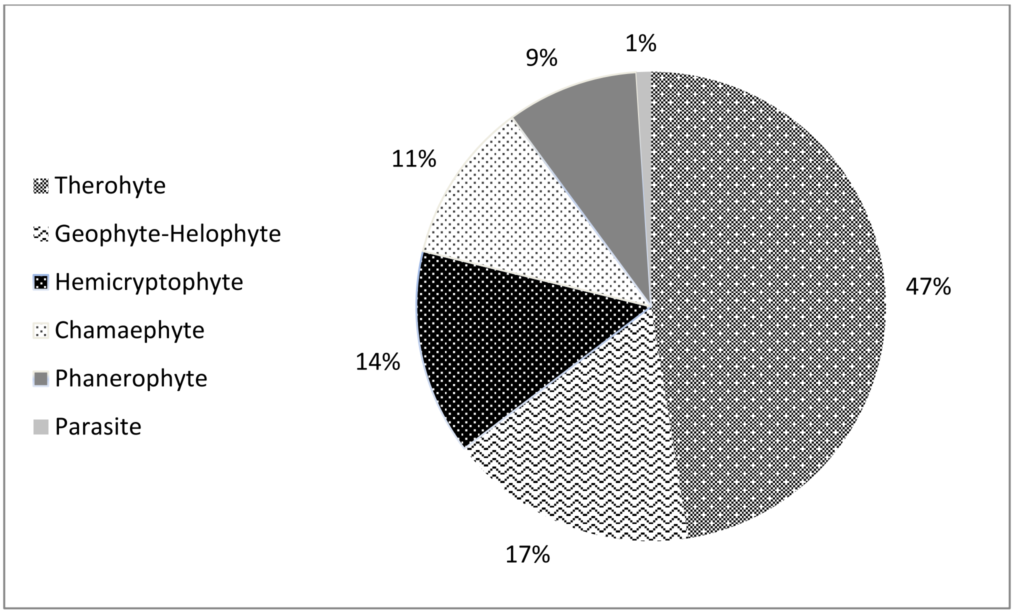

Fig. 3. Percentage of life-forms of associated species with *L. schweinfurthii* var. *schweinfurthii*

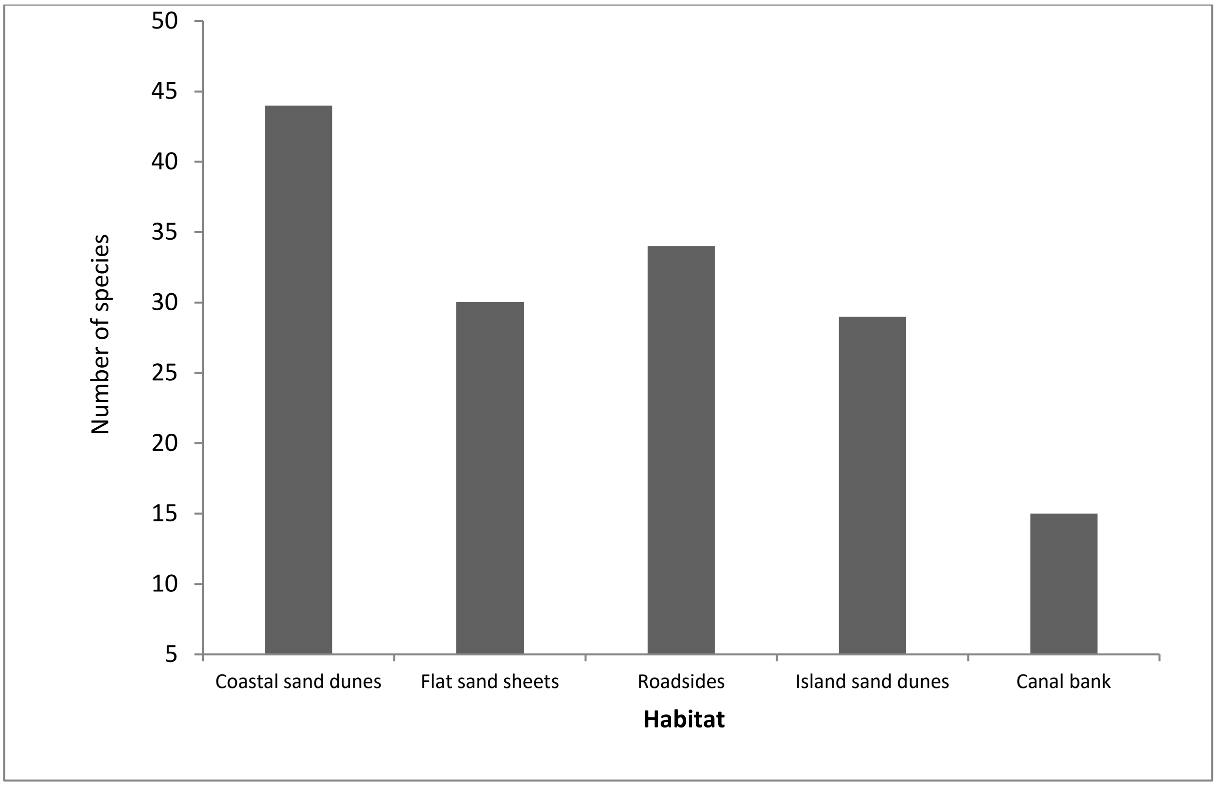

Fig. 4. Number of species associated with the distribution of *L. schweinfurthii* var. *schweinfurthii* in the 5 different habitats

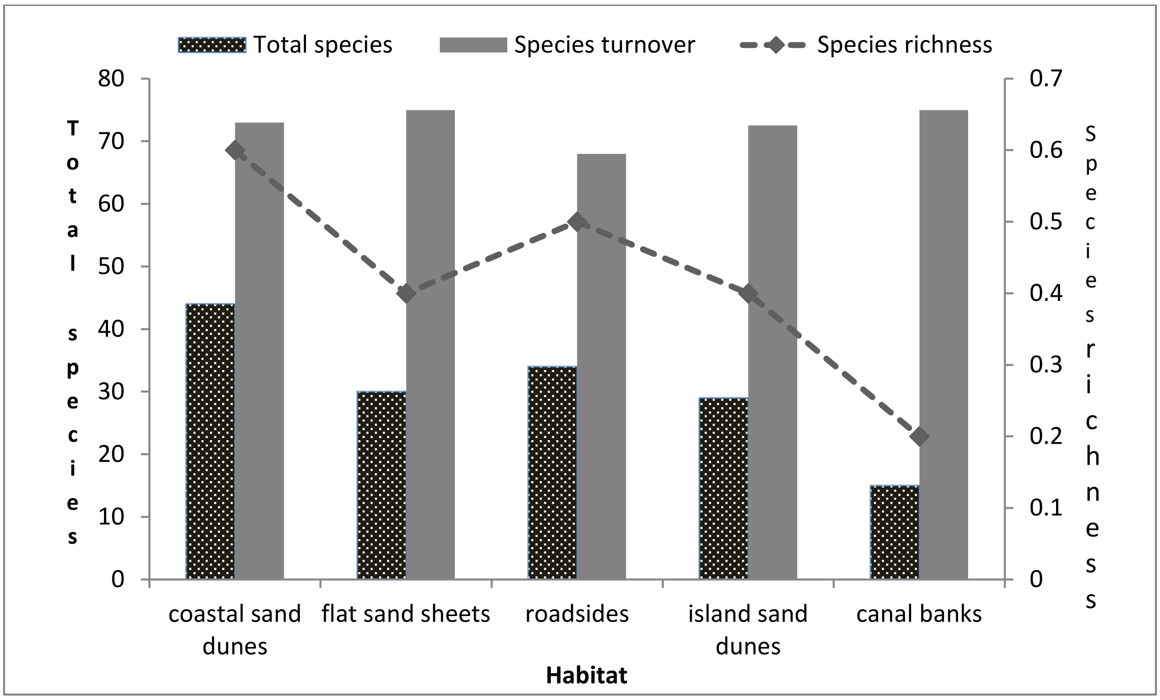

Fig. 5. Total species, species richness (species stand-1) and species turnover of the associated species with *L. schweinfurthii* var. *schweinfurthii* population in the different habitats.

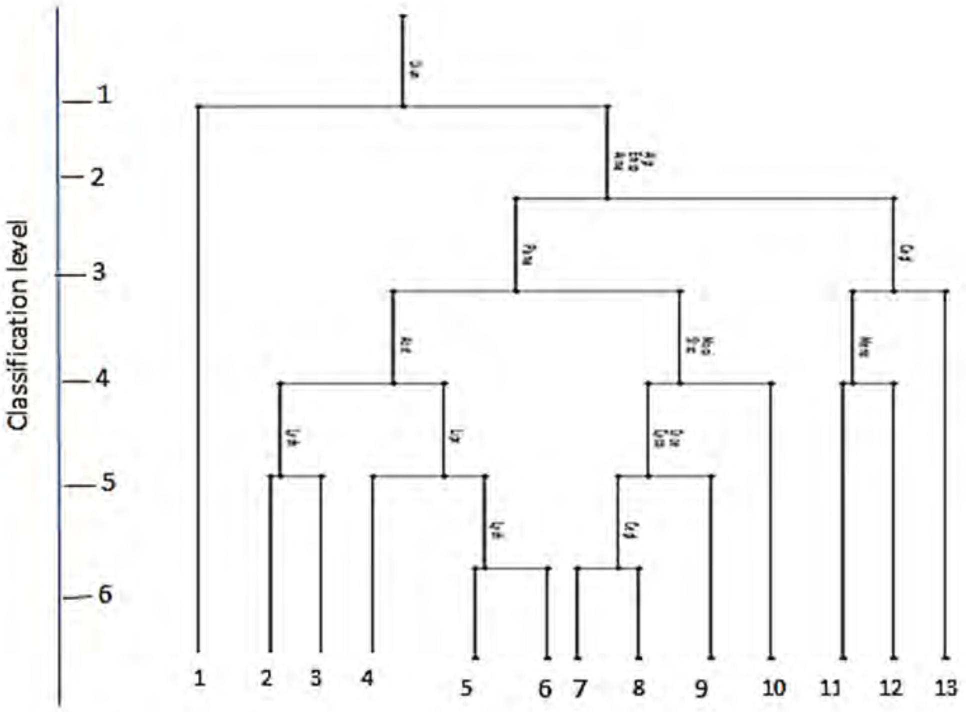

Fig. 6 Dendrogram resulting after the application of the two –way Indicator Species Analysis (TWINSPAN) on the species composition of the 40 stands of *L. schweinfurthii* var. *schweinfurthii.* Thirteen vegetation groups are indicated at level 6.

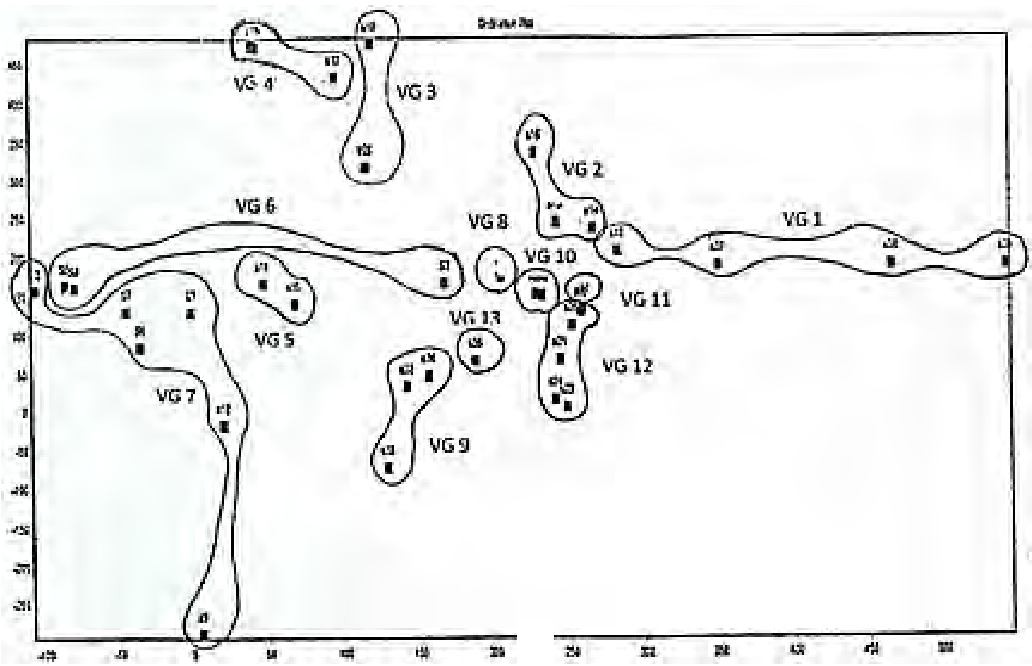

Fig. 7. DCA ordination of the 40 stands of *L. schweinfurthii* var. *schweinfurtii* population. The 13 vegetation groups (VG) identified according to TWINSPAN are encircled together.

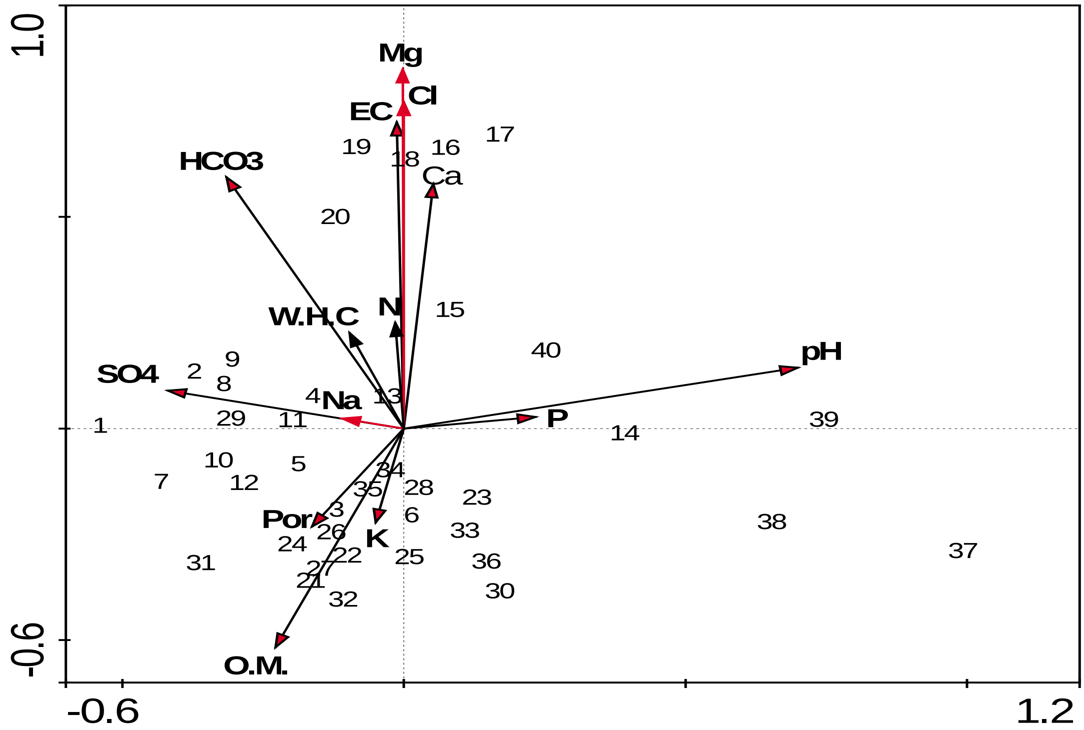

Fig. 8. CANOCO ordination plot for the edaphic variable and the stands (1- 40) of *L. schweinfurthii* var. *schweinfurthii* population.

Table 1. Species presence in the 13 vegetation groups (1-13) generated after the application of TWINSPAN on the floristic composition of 40 stands of *L. schweinfurthii* var. *schweinfurthii.*

Species	Vegetation group													P (%)
	1	2	3	4	5	6	7	8	9	10	11	12	13	
Lycium schweinfurthii Dammer	+	+	+	+	+	+	+	+	+	+	+	+	+	100
Echinops spinosissimus Turra	+	+	+	+	+	+	+	+	+	+	+	+	+	100
Rumex pictus Forssk.	+	+	+	+	+	+	+	+	+	+	+	+	+	100
Mesembryanthemum crystallinum L.	+	+	+	+	+	+	+	+	+	+	+	+	+	100
Lobularia arabica (Boiss.) Muschl.	+		+	+	+	+	+	+	+	+	+	+	+	92.3
Erodium lanciniatum (Cav.) Willd.		+	+	+	+	+	+	+	+	+	+	+	+	92.3
Paronychia arabica (L.) DC..	+	+	+	+	+	+	+	+	+	+		+	+	92.3
Malva parviflora L.	+	+	+	+		+	+	+	+	+	+	+	+	92.3
Senecio glaucus L.	+	+	+	+	+	+	+		+	+	+	+	+	92.2
Centaurea glomerata Vahl	+	+			+	+	+	+	+	+		+	+	84.6
Moltkiopsis ciliata (Forssk.) I.M.Johnst.				+	+	+	+		+	+	+	+	+	76.9
Launaea nudicaulis (L.) Hook.f.	+	+	+	+					+	+	+	+	+	69.2
Salsola kali L.		+	+	+		+	+	+			+	+		61.5
Launaea fragilis (Asso) Pau.			+		+	+	+	+		+	+	+		61.5
Tamarix nilotica (Ehrenb.) Bunge			+	+	+	+	+		+			+	+	61.5
Orobanche cernua Loefl.	+	+	+			+	+	+		+				53.8
Shismus barbatus (L.) Thell.	+	+	+	+	+	+		+						53.4
Pancratium maritimum L.	+								+	+	+	+	+	46.2
Atriplex halimus L.	+		+						+	+		+	+	46.2

Suaeda vera Forssk. ex J.F. Gmelin	+		+	+						+	+	+		46.2
Trisetaria linearis Forssk.	+	+	+	+					+				+	46.2
Neurada procumbens L.									+	+	+	+	+	38.7
Asparagus stipularis Forssk.	+		+							+	+	+		38.5
Helianthemum Lippii (L.) Dum.Cours.									+	+	+	+	+	38.5
Ifloga spicata (Forssk.) Sch. Bip.	+	+								+	+	+		38.5
Cyprus conglomeratus Rottb.	+	+			+	+	+							38.5
Plantago squarrosa Murray			+	+						+	+	+		38.5
Suaeda maritima (L.) Dumort.			+	+	+	+								30.7
Cyprus capitatus Vand.			+						+	+			+	30.7
Aeluropus lagopoides (L) Trin. ex Thwaites		+							+	+			+	30.7
*Calligonum comosum L´*Hér					+	+	+					+		30.7
Emex spinosa (L.) Campd.	+	+	+	+										30.7
Limoniastrum monopetalum (L.) Boiss.	+	+							+				+	30.7
Alhagi graecorum Boiss.	+	+	+	+										30.7
Lycium shawii Roem & Schult.	+											+	+	23.1
Carduus getulus Pomel									+			+	+	23.1
Brassica tournefortii Gouan	+										+	+		23.1
Limbarda crithmoides (L.)Dumort.		+	+	+										23.1
*Arthrocnemum macrostachyum (*Moric.)K.Koch		+	+	+										23.1
Stipagrostis scoparia (Trin. & Rupr.) De winter					+	+	+							23.1
Stipagrostis lanata (Forssk.) De Winter					+	+	+							23.1
Zygophyllum aegyptium Hosny,		+	+	+										23.1
Cynodon dactylon (L.) Pers.		+	+	+										23.1
*Atractylis carduus (*Forssk.) C.Chr.										+	+	+		23.1
Chenopodium album L.		+	+	+										23.1
Mesembryanthemum nodiflorum L.			+	+										15.4
Frankenia hirsuta L.											+	+		15.4
Atriplex portulacoides L.	+										+			15.4
Juncus subulatus Forssk.			+	+										15.4
Juncus rigidus Desf.		+			+									15.4
Thymelaea hirsuta (L.) Endl.			+	+										15.4
Phragmites australis (Cav.) Trin. ex Steud*.*			+	+										15.4
Carex extensa Good.									+				+	15.4
Parapholis incurva (L.) C. E. Hubb									+				+	15.4
Adonis dentata Delile	+	+												15.4
Lotus halophilus Boiss. & Spruner	+	+												15.4
Chenopodium murale L.			+	+										15.4
Rumex dentatus L.	+	+												15.4
Limonium pruinosum (L.) Chaz.										+				7.7
Drimia undulata (Desf.) Stearn	+													7.7
Astragalus boeticus L.	+													7.7
Medicago polymorpha L.	+													7.7
Hordeum marinum Huds.	+													7.7
Sporobolus pungens (Schreb.) Kunth	+													7.7
Plantago crassifolia Forssk.	+													7.7
Rununculus sceleratus L.	+													7.7
Spergula fallax (Lowe)E.H.L.Krause	+													7.7
Silene rubella L.	+													7.7
Phalaris minor Retz.	+													7.7
Juncus acutus L.	+													7.7

Table 2. Characteristics of the 13 vegetation groups identified after the application of TWINSPAN on the 40 stands of *L. schweinfurthii* var. *schweinfurthii*, The Habitat are CD: coastal sand dunes, FS: flat sand sheets, RS: roadsides, ID: island sand dunes and CB: canal banks.

VG	No of stands	% of stands	Habitat type	No of species	% of species	First dominant species (P % = 100)
1	4	10.0	ID	39	55.7	*Lotus halophilus*
2	3	7.5	FS	30	42.9	*Alhagi graecorum*
3	3	7.5	RS	34	48.6	*Thymelaea hirsuta*
4	2	5.0	RS&CB	30	42.9	*Limbarda crithmoides*
5	2	5.0	CD	19	27.4	*Stipagrostis lanata*
6	3	7.5	CD	21	30.0	*Echinops spinosissimus*
7	6	15	CD	19	27.4	*Echinops spinosissimus*
8	1	2.5	CD	13	18.6	*Rumex pictus*
9	4	10.0	CD	24	34.3	*Moltkiopsis ciliata*
10	4	10.0	CD	26	37.1	*Pancratium maritimum*
11	2	5.0	CD	23	32.6	*Echinops spinosissimus*
12	5	12.5	CD	28	40.0	*Frankenia hirsuta*
13	1	2.5	CD	25	35.7	*Pancratium maritimum*

Table 3. Mean and standard deviation (SD) of the soil characteristics of the 5 habitats supporting *L. schweinfurhii* var. *schweinfurthii* population. W.H.C.: water holding capacity, O.M.: organic matter. The values between brackets are the number of stands in each habitat. Maximum and minimum values are underlined. F values are indicated at P ≤ 0.05. The habitats are CD: coastal sand dunes, FS: flat sand sheet, RS: roadsides, ID: island sand dunes and CB: canal banks.

character	CD (28)		FS (4)		RS (4)		ID (3)		CB (1)	Total (40)		F
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	Mean	SD	
W.H.C (%)	24.7	2.5	27.3	0.5	24.0	0.3	23.7	1.6	21.5	24.3	1.0	2.7
Porosity (%)	30.7	2.4	30.9	0.4	30.1	0.4	29.5	1.3	31.3	30.5	1.0	0.3
O.M. (%)	0.2	0.0	0.3	0.0	0.2	0.0	0.2	0.0	0.1	0.2	0.0	4.4
pH	8.0	0.2	8.4	0.2	8.1	0.4	8.6	0.2	7.8	8.2	0.1	9.6
EC($mS\ cm^{-1}$)	0.3	0.3	0.40	0.4	1.0	0.4	0.4	0.0	0.5	0.5	0.2	4.8
HCO_3^- (meq / 100 g soil)	0.2	0.1	0.3	0.1	0.4	0.1	0.1	0.0	0.2	0.2	0.1	2.2
Cl^- (meq / 100 g soil)	0.4	0.3	1.2	1.4	3.5	2.1	0.4	0.1	0.5	1.2	0.9	15.2
SO_4^{-2} (meq / 100 g soil)	1.2	1.1	0.5	0.5	1.0	0.2	0.2	0.3	0.3	0.6	0.4	1.4
Ca^{+2} (meq / 100 g soil)	0.3	0.2	0.5	0.3	1.7	1.8	0.5	0.1	0.7	0.7	0.8	5.1
Mg^{+2} (meq / 100 g soil)	0.6	0.5	1.3	1.3	2.1	0.6	0.6	0.1	0.7	1.1	0.5	6.7
Na^+ (meq / 100 g soil)	0.8	0.9	0.2	0.3	0.8	0.5	0.7	0.1	1.2	0.8	0.4	0.7
K^+ (meq / 100 g soil)	0.3	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.1	0.0	4.9
P ppm	17.7	4.4	15.8	2.1	16.4	2.8	21.0	3.0	28.5	19.9	1.0	4.4
N ppm	36.8	9.1	35.4	9.8	43.0	9.6	35.9	6.8	47.3	39.7	1.4	2.0

Table 4. Mean and standard deviation (SD) of the soil characteristics of the 13 vegetation groups generated after the application of TWINSPAN on the floristic composition of the 40 stands of *L. schweinfurthii* var. *schweinfurthii*. W.H.C: water holding capacity, O.M.: organic matter. Maximum and minimum values are underlined. F values are indicated at P ≤ 0.05.

	Vegetation group																								
character	1		2		3		4		5		6		7		8	9		10		11		12		13	F
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	
W.H.C (%)	24.5	2.0	27.5	0.5	23.9	0.2	22.9	2.0	27.3	1.0	27.2	0.8	26.9	1.0	26.9	22.6	1.0	20.6	0.3	24.0	0.1	24.7	0.5	23.8	16
Porosity (%)	29.8	1.2	31.0	0.4	30.0	0.3	30.9	0.5	31.3	0.2	27.7	2.5	29.9	3.0	26.7	30.7	0.6	30.8	0.8	32.9	0.5	33.2	1.1	31.2	4
O.M. (%)	0.2	0.0	0.2	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.2	0.0	0.2	0.0	0.1	0.2	0.0	0.2	0.0	0.3	0.0	0.2	0.0	0.2	2
pH	8.5	0.3	8.4	0.1	8.0	0.4	8.1	0.4	8.2	0.0	7.8	0.0	8.0	0.3	8.0	8.0	0.1	7.9	0.1	7.9	0.0	8.0	0.1	7.7	3
EC(mS cm⁻	0.4	0.0	0.4	0.5	1.0	0.4	0.7	0.2	0.7	0.1	0.4	0.1	0.5	0.2	0.3	0.3	0.1	0.3	0.4	0.2	0.0	0.1	0.0	0.15	4
HCO_3^- (meq /100 g soil)	0.1	0.0	0.3	0.1	0.4	0.1	0.2	0.1	0.4	0.1	0.3	0.1	0.3	0.1	0.3	0.1	0.1	0.3	0.2	0.1	0.0	0.1	0.0	0.1	5
Cl^- (meq /100 g soil)	0.6	0.4	1.3	1.7	3.8	2.5	1.6	1.7	0.3	0.0	0.3	0.1	0.4	0.1	0.3	0.3	0.1	0.8	0.6	0.3	0.1	0.1	0.1	0.5	4
SO_4^{-2} (meq /100 g soil)	0.3	0.3	0.5	0.5	1.0	0.3	0.6	0.5	3.0	0.6	1.5	0.5	2.0	1.2	1.1	1.1	0.7	1.2	1.3	0.2	0.1	0.1	0.0	0.2	4
Ca^{+2} (meq /100 g soil)	0.5	0.1	0.4	0.4	2.0	2.1	0.7	0.1	0.7	0.2	0.5	0.1	0.4	0.2	0.6	0.3	0.1	0.2	0.1	0.2	0.1	0.18	0.1	0.3	2
Mg^{+2} (meq /100 g soil)	0.8	0.4	1.3	1.6	1.7	0.1	1.8	1.8	1.5	0.1	0.9	0.1	1.1	0.3	0.6	0.2	0.1	0.1	0.0	0.1	0.0	0.1	0.0	0.3	4
Na^+ (meq /100 g soil)	0.6	0.4	0.2	0.3	1.0	0.3	0.7	0.7	1.5	0.1	0.8	0.8	1.1	0.9	0.4	1.0	0.6	1.4	1.9	0.2	0.1	0.1	0.0	0.2	1
K^+ (meq /100 g soil)	0.2	0.0	0.1	0.0	0.2	0.0	0.3	0.0	0.2	0.0	0.2	0.0	0.3	0.0	0.3	0.2	0.0	0.2	0.0	0.2	0.0	0.2	0.0	0.2	4
P ppm	20.3	2.9	15.0	1.7	15.3	2.4	24.0	6.4	20.5	1.4	20.5	3.1	20.3	5.6	21.0	18.5	3.0	17.8	1.3	12.0	0.0	13.5	3.3	13.5	3
N ppm	36.3	5.6	34.7	11.9	38.5	3.8	52.0	6.7	34.0	12.0	40.2	6.3	31.7	7.6	42.5	36.4	3.2	40.8	1.7	38.6	1.1	37.6	17.1	34.6	2

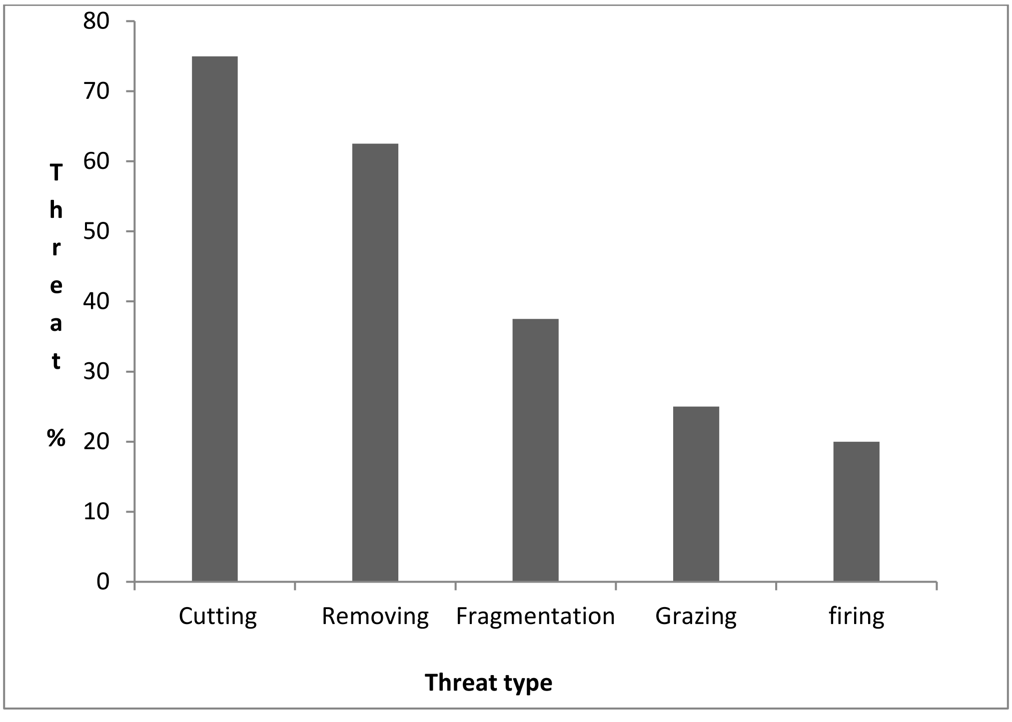

Fig. 9. Percentage of threats upon *L. schweinfurthii var. schweinfurthii* population.

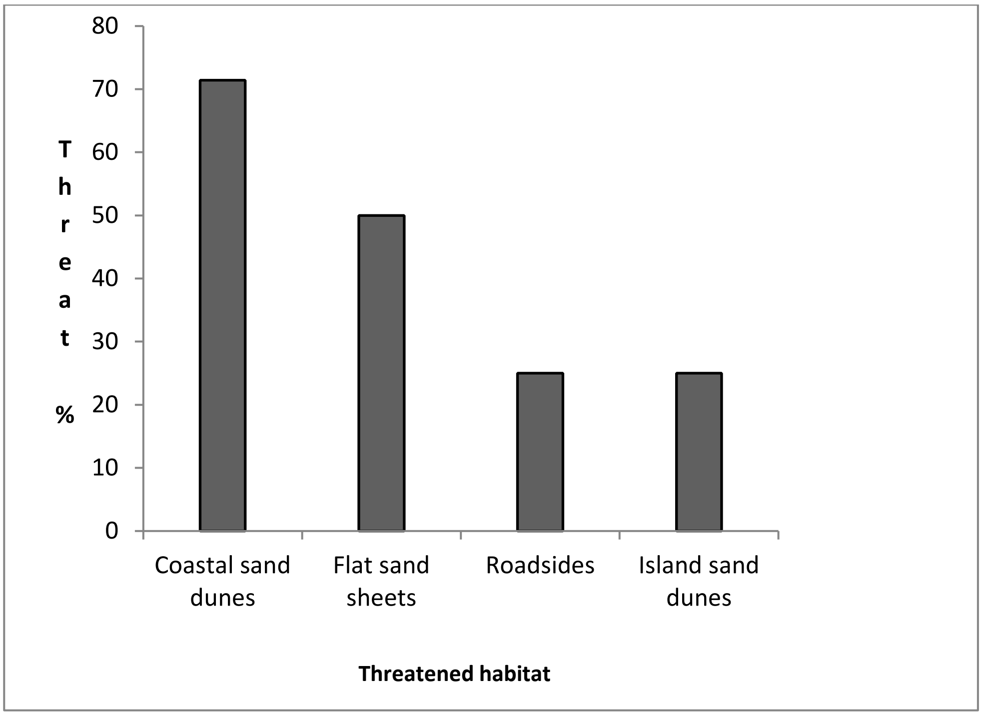

Fig. 10. Percentage of threatened habitats of *L. schweinfurthii* var. *schweinfurthii* population.

Discussion

L. schweinfurthii var. *schweinfurthii* was recorded in 40 stands that reflect their distribution in five habitats in the coast of Nile Delta: coastal and island sand dunes (Mashaly, 1987 and Khader, 1999), flat sand sheets, roadsides, and canal banks. Coastal sand dunes were represented by 28 stands (70.0 % of the total stands), while canal banks was represented by only one stand (2.5 %); indicating that this plant prefers to grow along coastal sand dunes (Meikle, 1985). The life-form spectra are important physiognomic attributes which have widely used by ecologists and chorologists in the vegetation and floristic studies (Cain and Castro 1959). In the present study, the life-form spectrum is predominantly therophytes (43 % as reported by Mashaly *et al.*, 2008).

The vegetation of the present study was classified by TWINSPAN into thirteen groups. G1 was dominated by *Lotus halophilus* and represent island sand dunes Mashaly (2008). G2 and G 5 dominated by *Alhagi graecorum, Stipagrostis lanata* respectively. G6, G7 and G11 dominated by *Echinops spinosissimus*. G8 and G9 dominated by *Rumex pictus, Moltkiopsis ciliata* respectively.G10 and G13 dominated by *Pancratium maritimum*. G12 dominated by *Frankenia hirsuta*; these groups represent the sand formation habitats (flat sand sheets and coastal sand dunes) and may be related to the alliances and associations described by Mashaly *et al*. (2008), Mashaly (2002), Shaltout *et al*. (1995) and Zahran *et al.* (1990). The species composition of the 13 vegetation groups identified at level 6 of TWINSPAN indicated that the *Echinops spinosissimus, Rumex pictus and Mesembryanthenum crystallinum* are the main associated species in 13 groups, on the other hand each of *Limonium pruinosum, Drimia undulata, Astragalus boeticus, Medicago polymopha, Hordeum marinum, Sporobolus pungens, Plantago crassifolia, Spergula fallax, Silene rubella, Phalaris minor and Juncus acutus* (P 7.7%) occur in only one group. G1 had highest species richness (0.6 species stand^{-1}) where it represent island sand dunes which subjected to moderate disturbance by grazing animals and local fishermen through cutting, where this disturbance often leads to distinct local variation in soil properties which meet the edaphic requirements of many species within communities (Whittaker and Levin,1977). Soil variables that correlated with the distribution of vegetation in the study area as recognized by El-Halawany (2003), Zahran *et al*. (1990) and Mashaly (1987) were: soil salinity (EC), moisture content, and soil reaction. In the present study, the application of Canonical Correspondence Analysis (CCA-biplot) indicated that, the most correlated soil variables with the distribution and abundance of the vegetation in the Deltaic Mediterranean Coast habitat are: pH, EC, organic matter, HCO_3^-, SO_4^{--} and Mg^{++}.

Threats to the world's plants continue to increase as a result of human activities (Raven, 1971; Naveh 1967, 1970; Naveh & Dan, 1973 and Ayyad & Fakhry, 1994) reported that the Mediterranean coast of Egypt has long been subjected to human activities through cultivation, grazing and urbanization. (Ayyad and Le Floc'h, 1983 and El-Sadek and Ayyad, 2000) added that this region provides a clear example of anthropogenic disturbance that resulted in habitat loss and fragmentation leading to diminish the germplasm reservoir. In addition, Kheder & Lovett-Doust (2000) mentioned that the existing vegetation inlands in Lake Burullus are subjected to moderate disturbance by grazing animals and local fishermen through cutting or burning large patches on the inlands. *L. schweinfurthii* var. *schweinfurthii* shrub is one of species that suffers from two types of threats, which affected its distribution, density, types of habitat among others. The high impacting threats concerned with the population of this plant are (cutting, grazing and firing) in addition to habitat destruction as removal and fragmentation. Habitat destruction for agriculture (specially watermelon and beet crops) or for sell sand are the major threats face *L. schweinfurthii* var. *schweinfurthii*, where Gilpin and Hanski (1991) reported that as these threats cause declining in species richness and threatens stability and persistence of wild population, because the size and isolation of remaining habitats increase the probability of extinction. Habitat removal by man is the fastest throughout the evolutionary history of life, which leads to the strongest damages on natural ecosystems. The most important cause of extinction in the present days should be habitat destruction directly or not directly (Frankel and Soule, 1981).

Habitat fragmentation for establishment of new roads and drains is a major challenge in conservation biology and one of the top threats to biodiversity (Hanski, 1999). The negative effects of fragmentation results from the decrease in overall habitat availability and changes in spatial configuration and habitat quality of fragments (Ezard and Travis, 2006). After fragmentation, small population and low genetic diversity lead to genetic drift with higher risks of inbreeding and lower evolutionary potential and consequently higher risk of extinction (Avise *et al.*, 1987). Cutting shrubs of *L. schweinfurthii* var.*schweinfurthii* by local fishermen for putting them in drains to surround the fishes or by local inhabitants to get rid of it as weed is one of the severe impacts upon this shrub. Robinson *et al*. (1992) and Forman and Godron (1986) reported that these threats can result in direct loss of individuals from altered habitats. In addition, Heneidy and El-Darier (1995) recorded that human activities i.e. (over-collecting of natural vegetation) are more severe than the over-grazing. Over-grazing and firing are other threats upon the plant, where Le Houérou and Gillet (1990) reported that the crop expansion, over-grazing and fire wood are the most harmful, and are responsible for 80% of the havoc. Therefore, we need more efforts to conserve the remaining patches of this habitat where some scattered individuals of the studied species still existing. In general, it is important to conserve the flora of this region and determine what kind of conservation program should be applied.

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