Desert roadside vegetation in eastern Egypt and environmental determinants for its distribution

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Abstract. The purpose of this study was to describe the flora and vegetation at Qift-Qusier roadsides in the central part of the Eastern Desert of Egypt, and to relate floristic composition to edaphic conditions. A total of 61 species (28 annuals and 33 perennials) belonging to 50 genera and 27 families were recorded. On the basis of their presence values, classification of the 61 species recorded in 43 stands by cluster analysis yielded six vegetation groups. The results of CCA ordination indicated that the soil organic matter, Na, K, Ca, and pH were the most important factors for distribution of the vegetation pattern along the road verges in the study area. The DCA and CCA results suggested a strong correlation between vegetation and the measured soil parameters.

Key words: arid environments, Egypt, flora, multivariate analysis, roadside vegetation, soil-vegetation relationship

Introduction

The Eastern Desert of Egypt extends between the Nile Valley and the Red Sea. It is traversed by numerous canyon-like depressions (wadis) running to the Red Sea or to the Nile Valley and the Red Sea coast. The Qift-Qusier road connects Qift city on the Nile Valley with the city of Qusier on the Red Sea coast.

Road construction exercises a major anthropogenic impact on the composition of the flora and vegetation (Sharaf El-Din & Shaltout 1985; Holzapfel & Schmidt 1990). Construction and use of highways, tracks, railways, and airports involves many changes; some of them direct and others indirect. Direct influences include destruction of the existing habitats and provision of new ones with special characteristics. These are more or less continuous stretches of open habitats covering hundreds of miles and forming an extensive network, with opportunities for rapid colonization and spread.

The plant communities of roadside vegetation are influenced not only by anthropogenic factors but also by geographical differentiation, physiography and topography (Ullmann & al. 1990). The advantage of roadsides for study of species and vegetation performance along environmental gradients is widely recognized (Ullmann & Heindl 1989; Wilson & al. 1992). Such studies are well-documented in North America (Lausi & Nimis 1985), Europe (Stottele & Schmidt 1988; Heindl & Ullmann 1991), North Africa (Sharaf El-Din & Shaltout 1985; Shaltout & Sharaf El Din 1988; Abd El-Ghani 1998, 2000), Saudi Arabia (Batanouny 1979; Fayed & Zayed 1989; Abd El-Ghani 1996), the Judean Desert (Holzapfel & Schmidt 1990), and in New Zealand (Ullmann & al. 1995).

In Egypt, desert highways and agricultural roads that traverse the cultivated areas are adequately interconnected. Generally, the present road network totals 41.300 km, of which 19.6 % are in the Sinai Peninsula, followed by those in the Nile Delta (18.7 %) and Nile

Valley (15.7 %), while the lowest percentage (8 %) is in the Western and Eastern Deserts of the country (Abd El-Ghani & El-Sawaf 2005).

The purpose of this study is to describe the roadside flora and vegetation of Qift-Qusier road in the central part of the Eastern Desert of Egypt, and to relate floristic composition to soil properties.

Material and methods

Qift-Qusier road extends for about 180 km from Qift city in the west, along the Nile Valley, to Qusier city in the east at the Red Sea coast (Fig. 1). The road crosses several wadis that run from the higher Red Sea Zountain Chain to the west (Nile Valley) and to the east (Red Sea coast). The margin of the mountain chain has a strongly marked north-northwestern orientation. Elevation of the Red Sea Mountain Chain in the study area ranges from 500 m to 600 m, in contrast to the elevation of sedimentary rocks area at both sides of the mountain chain (to the west and east of it), which ranges from 0 m to 200 m (Said 1962) .

According to Abu Al-Izz (1971), the exposed sediments and rocks along this road from west (Qift city) to east (Qusier city) are Quaternary sediments (including the Nile deposits, alluvial sands and gravels and wadi deposits), Pliocene deposits (including lacustrine sediments representing the Durri Formation which is composed of marlstone and mudstone), an Upper Cretaceous/Lower Tertiary succession tilted towards the Nile Valley (West), basement complexes (representing the Red Sea Mountain Chain and composed of igneous and metamorphic rocks). Detailed elogical and geomorphological features are described by Ismaiel & al. (2012).

The stands of the present study were chosen whenever some considerable vegetation cover was encountered. The stands were studied twice: in September 2010 (at the end of the hottest season) and in March 2011 (at the end of the coldest season). Multivariate analysis was applied to analyse the vegetation of the stands. Forty-three stands were found satisfactory to represent the roadside vegetation and were geo-referenced by GPS technique. Sixty-one plant species were collected, identified and deposited at the Herbarium of the Botany Department, Assiut University. Duplicates were checked for identification and also deposited at the Cairo University Herbarium. The recorded species were classified according to their life forms (Raunkiaer 1937; Hassib 1951). The number of species within each life form was expressed as percentage of the total number of species in the study area. Taxonomic nomenclature followed Täckholm (1974); Cope & Hosni (1991); El Hadidi & Fayed (1995) and

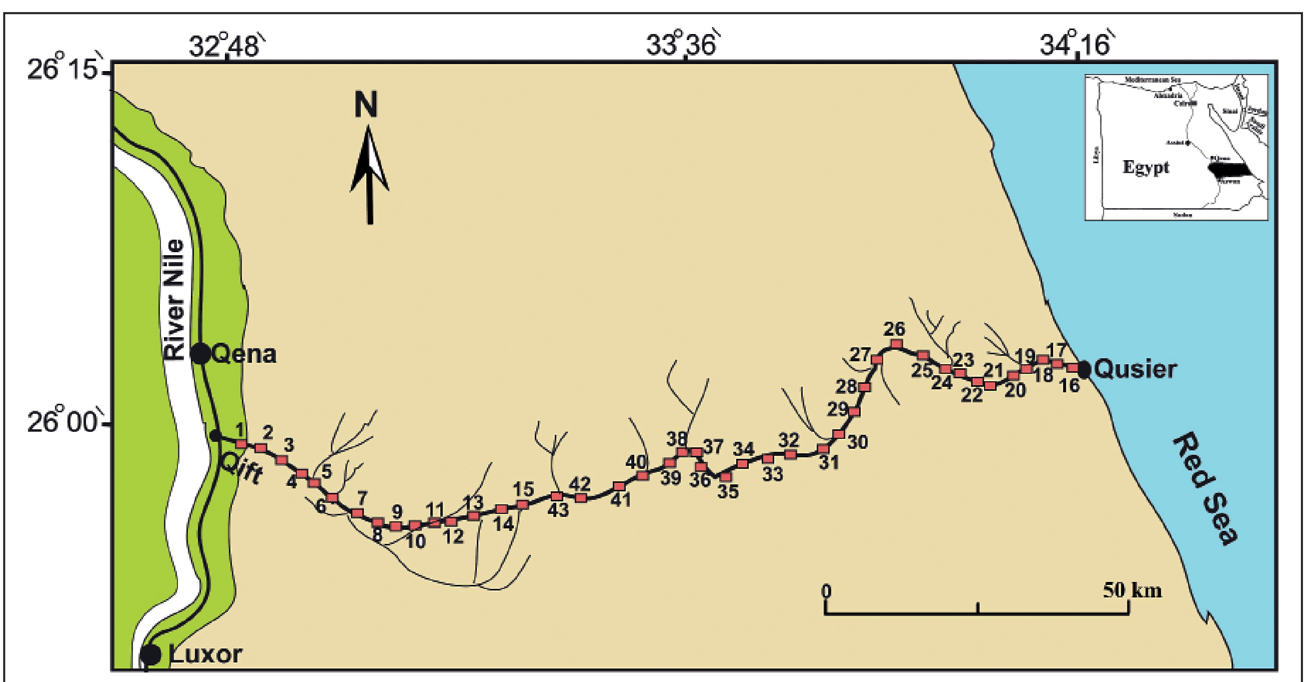

Fig. 1. Location map of Qift-Qusier road in the Eastern Desert of Egypt; the stands are given by their numbers.

Boulos (1995, 1999, 2000, 2002). Analysis of phytogeographical ranges was carried out according to Zohary (1966, 1972), Abd El-Ghani (1981 & 1985) and Hassan (1987).

Three soil samples were collected from each studied stand and then pooled together to form one composite sample. Soil texture was determined by the hydrometer method, and organic matter content was estimated by drying and then ignition at 600 °C for 3h (Sparks & al. 1996). Soil reaction (pH) and electric conductivity were evaluated in 1:5 soil-water extract, using a glass electrode pH-meter and electric conductivity meter, respectively. Estimation of chlorides was carried out by titration methods (Hazen 1989), sulphates were determined turbidimetrically, according to Verma & al. (1977). Calcium and magnesium were determined by Upadhyay & Sharma (2005) method, while flame photometer technique was applied for determination of sodium and potassium (Jackson 1962). Available phosphorus was gauged calorimetrically, as described by Watanabe & Olsen (1965).

Classification and ordination methods were applied as multivariate analysis techniques. Cluster analysis was used to classify the floristic data matrix of 43 stands and 61 species, with the help of Community Analysis Package (CAP) version 1.2 (Henderson & Seaby, 1999), using squared Euclidean distance dissimilarity matrix with minimum variance as agglomeration criterion (Orloci 1978). Computer program CANOCO 4.5 (Ter Braak 2003) was used for all ordination analyses; whereas computer program SPSS 10.0 (SPSS 1999) was used for all statistical treatments. Detrended Correspondence Analysis (DCA) was applied to check the magnitude of change in species composition along the first axis. The default settings of Canonical Correspondence Analysis (CCA) were used to relate directly the vegetation data to the corresponding measured soil parameters (Ter Braak 2003). Electric conductivity and magnesium were excluded from the analysis as high inflation factors. Therefore, CCA was performed with 12 soil variables: coarse sand, fine sand, silt, clay, organic matter (OM), pH, sodium (Na), potassium (K), calcium (Ca), chlorides (Cl), sulphates (SO_4), and phosphates (PO_4). Significance of eigenvalues of the first canonical axis was tesed by the Monte Carlo Permutation Test (499 permutations; Ter Braak 1994). Intraset correlations from the CCA's were used to assess the importance of the measured soil variables.

Results

Floristic analysis and biological spectrum

A total of 61 species (28 annuals and 33 perennials) belonging to 50 genera and 27 families were recorded. The largest families were *Fabaceae* (8), *Zygophyllaceae* (7), *Asteraceae*, *Brassicaceae* and *Poaceae* (6 for each), *Asclepiadaceae* and *Resedaceae* (3 for each), *Amaranthaceae* and *Cleomaceae* (2 for each). They constituted about 70.5 % of the recorded species, and represented most of the floristic structure in the Eastern Desert of Egypt (Abd El-Ghani 1998; Salama & al. 2012). Eighteen families were represented by only one species. *Fagonia* was the largest genus represented by four species (Table 1).

Table 1. Floristic composition, presence value (P %), life forms (L.F), and chorology of the recorded species in the studied area. Per = Perennials, Ann = Annuals, Ph = Phanerophytes, H = Hemicryptophyte, Ch = Chemaephytes, Th = Theophytes, Cr = Cryptophytes, G = Geophytes, SA = Saharo-Arabian, SZ = Sudano-Zambezian, IT = Irano-Turanian, ME = Mediterranean, PAL = Palaeotropical, PAN = Pantropical, COSM = Cosmopolitan.

Species	Duration	Chorology	L.F	P%
Amaranthaceae				
Aerva javanica (Burm. f.) Juss. ex Schult.	Per	SA+SZ	Ch	9.30
Amaranthus graecizans L.	Per	ME+IT	Ch	2.33
Asclepiadaceae				
Calotropis procera (Aiton) W.T. Aiton	Per	SA+SZ	Ph	6.98
Leptadenia pyrotechnica (Forssk.) Decne.	Per	SA+SZ	Ph	4.65
Pergularia tomentosa L.	Per	SA+SZ	Ch	4.65
Asteraceae				
Cotula cinerea Delile	Ann	SA	Th	9.30
Ifloga spicata (Forssk.) Sch. Bip.	Ann	SA	Th	2.33
Launaea cassiniana	Ann	SA	Th	9.30
L. nudicaulis (L.) Hook. f.	Per	SA+IT	H	2.33
Pulicaria incisa (Lam.) DC.	Ann	SA	H	16.28
P. undulata (L.) C. A. Mey	Per	SA	H	41.86
Boraginaceae				
Trichodesma africanum (L.) R.Br.	Ann	SA+SZ	Ch	27.91
Brassicaceae				
Diplotaxis acris (Forssk.) Boiss.	Ann	SA	Th	13.95
D. harra (Forssk.) Boiss.	Ann	SA	H	4.65
Eruca sativa Mill.	Ann	ME+IT	H	2.33
Morettia philaeana (Delile) DC.	Ann	SA	H	60.47
Schouwia purpurea (Forssk.) Schweinf.	Ann	SA	Th	25.58
Zilla spinosa (L.) Prantl.	Per	SA	Ch	74.42
Cactaceae				
Opuntia ficus-indica (L.) Mill.	Per	SA	Ph	6.98

Table 1. Continuation.

Species	Duration	Chorology	L.F	P%
Caryophyllaceae				
Polycarpaea robbairea (Kuntze) Greuter & Burdet	Ann	SA	Th	4.65
Casuarinaceae				
Casuarina equisetifolia L.	Per	Cultivated	Ph	2.33
Chenopodiaceae				
Salsola imbricata Forssk. subsp. *imbricata*	Per	SA	Ch	51.16
Cleomaceae				
Cleome amblyocarpa Barratte & Murb.	Ann	SA+SZ	Th	2.33
C. droserifolia (Forssk.) Delile	Per	SA+IT	H	2.33
Cucurbitaceae				
Citrullus colocynthis (L.) Schrad.	Per	ME+SA+IT	H	41.86
Fabaceae				
Astragalus hamosus L.	Ann	ME+IT	Th	6.98
A. vogelii (Webb) Bornm.	Ann	SA	Th	2.33
Crotalaria aegyptiaca Benth.	Per	SZ	H	9.30
Lotus deserti Tackh. & Boulos	Ann	SA	H	4.65
Lotus hebranicus Hochst. ex Brand	Ann	SA	H	16.28
Retama raetam (Forssk.) Webb & Berthel.	Per	SA+IT	Ph	2.33
Senna italica Mill.	Per	SA	H	6.98
S. occidentalis (L.) Link	Per	SZ	Ch	9.30
Geraniaceae				
Monsonia heliotropoides (Cav.) Boiss.	Per	SA	H	2.33
Juncaceae				
Juncus rigidus Desf.	Per	IT+SA	H	2.33
Mimosaceae				
Acacia tortilis (Forssk.) Hayne subsp. *raddiana* (Savi) Brenan	Per	SA	Ph	20.93
Myrtaceae				
Eucalyptus globulus Labill.	Per	Cultivated	Ph	2.33
Palmae				
Phoenix dactylifera L.	Per	SA+SZ	Ph	9.30
Plantaginaceae				
Plantago ovata Forssk.	Ann	ME+SA+IT	Th	4.65
Poaceae				
Cynodon dactlyon (L.) Pers.	Per	PAN	G	2.33
Digitaria ciliaris (Retz.) Koeler	Ann	PAN	Th	2.33
Echinochloa colona (L.) Link	Ann	PAN	G	2.33
Phragmites australis (Cav.) Trin. ex Steud.	Per	PAL	G	6.98
Polypogon monospelliensis (L.) Desf.	Ann	COSM	Th	2.33
Stipagrostis plumosa (L.) Munro ex T. Anderson	Ann-Per	SA+IT	H	2.33
Polygonaceae				
Rumex vesicarius L.	Ann	ME+SA+IT	Th	2.33
Portulacaceae				
Portulaca oleracea L.	Ann	COSM	Th	2.33

Table 1. Continuation.

Species	Duration	Chorology	L.F	P%
Resedaceae				
Ochradenus baccatus Delile	Per	SA	Ph	2.33
Oligomeris linifolia (Hornew) J. F. Macbr.	Ann	SA+SZ	Th	2.33
Reseda pruinosa Delile	Ann	SA	Th	27.91
Rhamnaceae				
Zizyphus spina-christi (L.) Desf.	Per	ME+SA+SZ+IT	Ph	6.98
Solanaceae				
Solanum nigrum L.	Ann	COSM	Th	2.33
Tamaricaceae				
Tamarix nilotica (Ehrenb.) Bunge	Per	ME+SA+SZ	Ph	20.93
Urticaceae				
Forsskaolea tenacissima L.	Per	SA+SZ	H	30.23
Zygophyllaceae				
Fagonia arabica L.	Per	SA	Ch	9.30
F. bruguieri DC.	Per	SA+IT	H	13.95
F. indica Burm.	Per	SA	Ch	27.91
F. thebaica Bioss.	Per	SA	Ch	18.60
Tribulus pentandrus Forssk.	Ann	SA+SZ	Th	6.98
Zygophyllum coccineum L.	Per	SA	Ch	90.70
Z. simplex L.	Ann	SA+SZ	Th	37.21

Zygophyllum coccineum was the only ubiquitous species with a wide ecological range of distribution and the highest presence value of P=90.70%. Among the perennials, *Morettia philaeana*, *Salsola imbricata* subsp. *imbricata, Pulicaria undulata,* and *Citrullus colocynthis,* showed the highest presence values: 60.47, 51.16, 41.86, and 41.86%, respectively. Among the annuals, *Zygophyllum simplex* and *Forsskaolea tenacissima* showed the highest presence of 37.21% and 30.23%. Thirty-three species, or about 54.1% of all recorded species, were perennials and demonstrated a certain degree of constancy. The presence of *Juncus rigidus, Tamarix nilotica* and *Salsola imbricata* subsp. *imbricata* referred to salinization.

Figure 2 showed the life forms of the recorded species according to the Raunkiaer system (1937). The 61 recorded species belonged to five different life forms. Therophytes (31.15%) constituted the main bulk of species (19 species), followed by hemicryptophytes (28%), and chamaephytes and phanerophytes (each 18%). Geophytes were the lowest (4.92%) among the life forms.

Results of the total chorological analysis of the surveyed flora (59 species, after excluding the two cultivated species) that presented in Figure 3, revealed that 27 species (45.8% of all recorded species) were monoregional, of which twenty-five species (42.4%) were native to the Saharo-Arabian chorotype. Second ranked was the Sudano-Zambezian chorotype, with 3.4%. About 42.4% of the recorded species were biregional and pluriregional, extending their distribution across the Saharo-Arabian, Sudano-Zambezian, Irano-Turanian, and Mediterranean regions. As part of the Saharo-Arabian region, the Saharo-Arabian chorotype (bi- and pluri-) claimed 33.9% and 8.5% of the recorded species, respectively. *Phragmites australis* was the only palaeotropical species, while pantropical and cosmopolitan taxa were represented by equal shares (5.1% each).

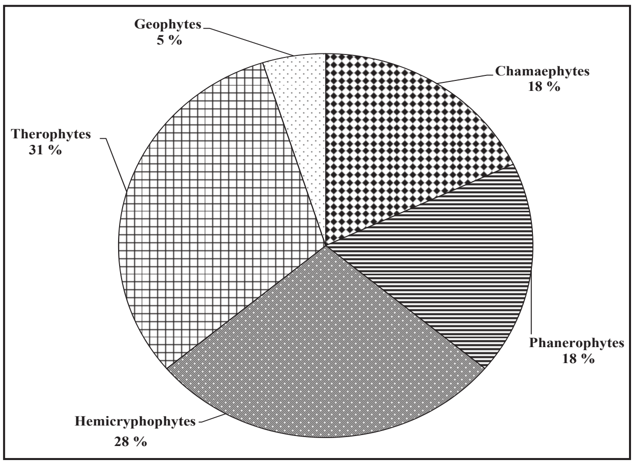

Fig. 2. Plant life forms of the recorded species along the Qift-Qusier road, in percentage.

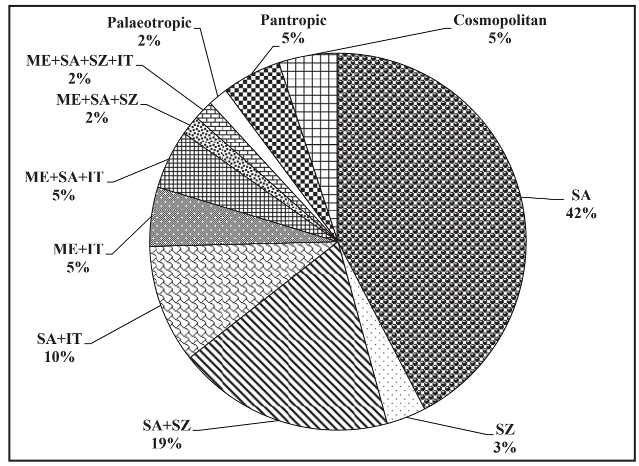

Fig. 3. Chorological analysis of the recorded species along the Qift-Qusier road, in percentage.

Multivariate analysis

On the basis of their presence values, classification of the 61 species recorded in 43 stands by means of the cluster analysis has yielded six vegetation groups at the third hierarchical level (Fig. 4, Table 2). The groups named after the first and second dominant species are as follows: (1) *Calotropis procera-Opuntia ficus-indica*, (2) *Morettia philaeana-Salsola imbricata* subsp. *imbricate*, (3) *Zygophyllum coccineum-Tamarix nilotica*, (4) *Zilla spinosa-Citrullus colocynthis,* (5) *Lotus hebranicus-Pulicaria undulata,* and (6) *Forsskaolea tenacissima-Reseda pruinosa*. The greatest number of species (29) were recorded in Group 1, followed by Group 5 (27 species) and Group 6 (23 species), where-

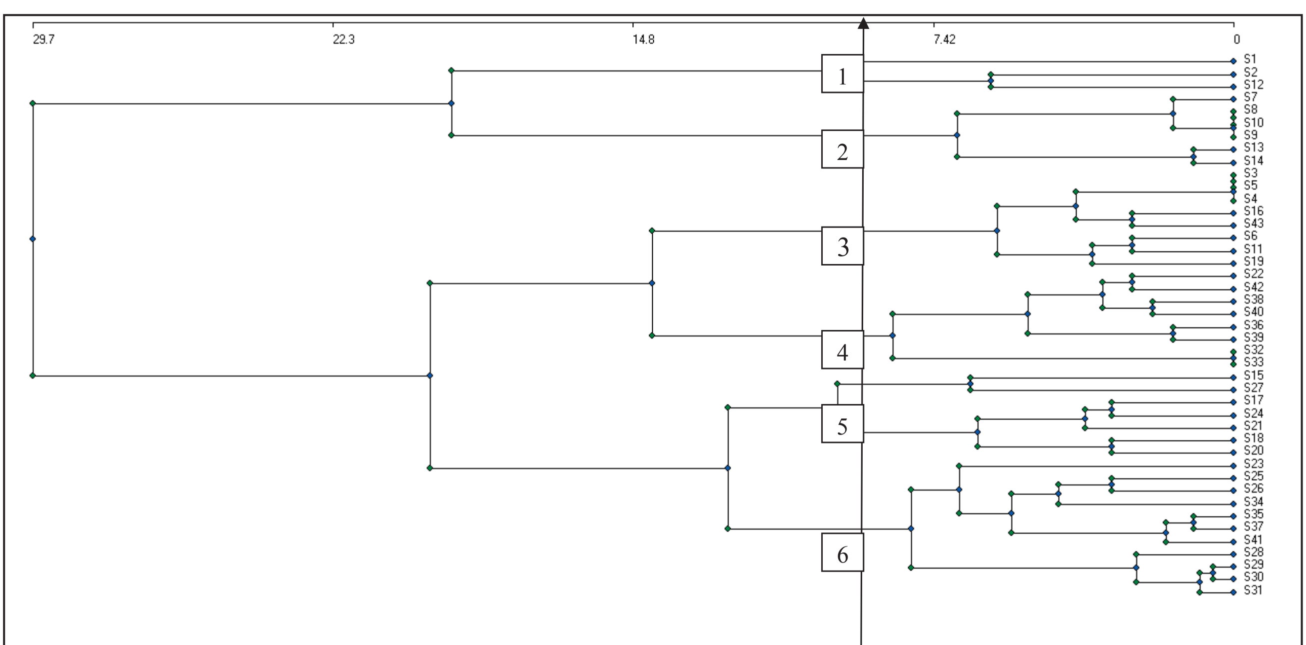

Fig. 4. Classification of the 43 studied stands by cluster analysis; 1–6 are the vegetation groups.

as the lowest number of species were in Group 2 (14 species; Table 2). Figure 5 indicated that the stands of Group 1 were located near the Nile Valley at Qift city, while those of Group 5 located near the Red Sea shore at Qusier city (Fig. 1). Group 1 included the highest number of weeds, as compared to other groups. According to the one-way ANOVA test (Table 3), significant differences of the soil variables among the recognized six groups were in pH (F-ratio = 7.82, P = 0.001) and PO_4 (F-ratio = 3.26, P = 0.015).

Table 2. Presence percentages of the dominant species (highest values in bold) of the six vegetation groups obtained from classification.

Species	Vegetation groups					
	1	2	3	4	5	6
Number of stands	**3**	**6**	**8**	**8**	**7**	**11**
Number of species	**29**	**14**	**16**	**16**	**27**	**23**
Calotropis procera	**100**					
Opuntia ficus-indica	**100**					
Morettia philaeana		**100**				
Salsola imbricata subsp. *imbricata*		**100**				
Zygophyllum coccineum			**62.5**			
Tamarix nilotica			**37.5**			
Zilla spinosa				**75**		
Citrullus colocynthis				**62.5**		
Lotus hebranicus					**71.43**	
Pulicaria undulata					**71.43**	
Forsskaolea tenacissima						**63.64**
Reseda pruinosa						**63.64**

Figure 5 shows the Detrended Correspondence Analysis (DCA) ordination plot of the 43 stands on axes 1 and 2, with the superimposed six vegetation groups.

Table 3. Results of ordination for the first three axes of CCA (Canonical Correspondence Analysis). Inter-set correlations of the soil variables, together with eigenvalues and species–environment correlation coefficients, and ANOVA (Analysis of Variance) F values. * = P < 0.05, ** = P < 0.01.

		F-ratio	CCA axis 1	2	3
Eigenvalues			0.483	0.314	0.227
Species–environment correlation coefficients			0.924	0.939	0.820
pH		7.82**	0.398	-0.523	0.464
Coarse sand (CS)	(%)	0.97	-0.110	-0.037	-0.685
Fine sand (FS)	(%)	2.23	0.347	-0.208	0.197
Silt	(%)	0.56	-0.028	0.202	0.657
Clay	(%)	0.83	-0.085	0.098	0.446
Organic matter	(%)	1.67	0.514	0.408	0.008
Na	mg/L	0.84	0.465	0.770	-0.006
K	mg/L	0.92	0.570	0.729	-0.058
Ca	mg/L	0.71	0.510	0.747	-0.080
Cl	mg/L	0.86	0.376	0.747	-0.212
SO_4	mg/L	1.13	0.366	0.397	-0.172
PO_4	mg/L	3.26*	0.446	-0.390	0.080

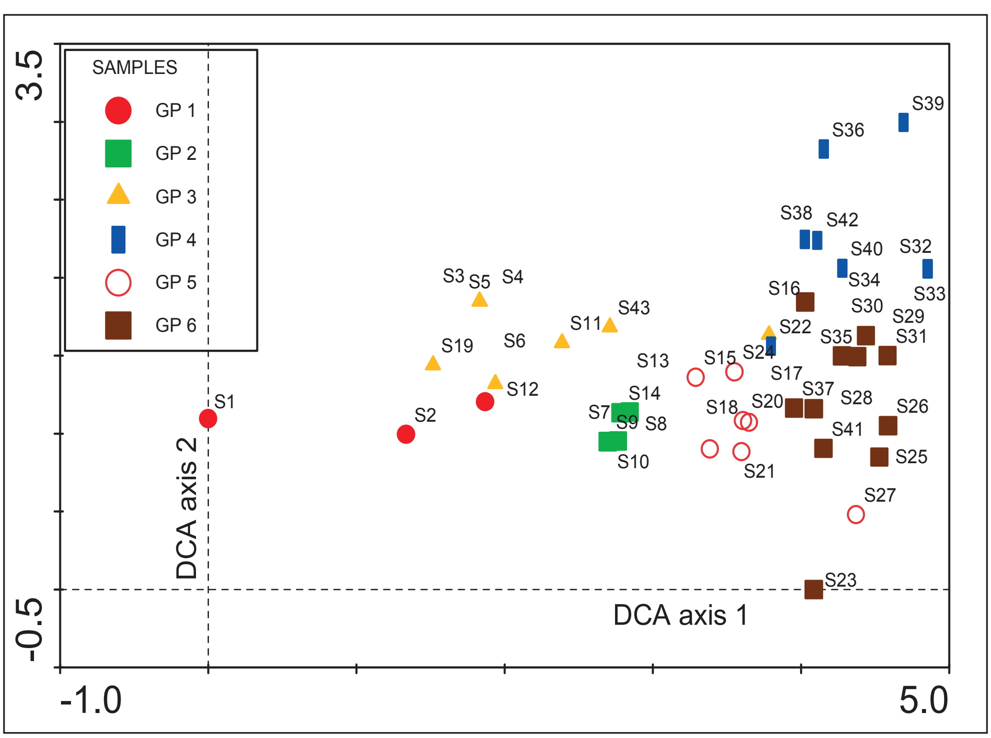

Fig. 5. DCA ordination diagram of the 43 stands on axes 1 and 2, as classified by cluster analysis; 1–6 are the six vegetation groups.

The stands extended to 4.85 SD-units of the first axis (eigenvalue = 0.69), expressing the high floristic variation among the vegetation groups and indicating a complete turnover in the species composition. The stands of Groups 4, 5 and 6 were separated at the positive end of DCA axis 1, while those of Groups 1 and 3 separated at the other end. DCA axis 2, with eigenvalue of 0.32 and gradient length of 2.99, was less important.

The species-environment correlations were higher for the first three canonical axes, explaining 54.6.4 % of the cumulative variance (Table 3). From the intra-set correlations of the environmental variables and the first three axes of CCA, it could be inferred that CCA axis 1 was positively correlated to the organic matter, Na, K, and Ca, and negatively correlated with coarse sand. This axis can be defined as K-coarse sand gradient. CCA axis 2 was positively correlated with Na, K and Ca, and negatively correlated with pH. Therefore, CCA axis 2 could be defined as Na-pH gradient. This fact becomes evident from the ordination biplot (Fig. 6). A test for significance with unrestricted Monte Carlo Permutation Test has found the F-ratio for the eigenvalue of CCA axis 1 and the trace statistics to be significant (P = 0.01), indicating that the observed patterns did not arise by chance (Jongman & al. 1987).

Discussion

Vegetation in the study area, as in other hyper-arid regions, is restricted to wadis, runnels and depressions with deep fine sediments that receive adequate water supply (Monod 1954; Zohary 1962; Walter 1963). As Parker (1991) has already suggested that distribution of the dominant species and variations in the distributional patterns over a small geographic area in a desert ecosystem may be related to edaphic factors and local topography. Classification of floristic data in the present study has revealed six vegetation groups: (1) *Calotropis procera-Opuntia ficus-indica*, (2) *Morettia philaeana-Salsola imbricata* subsp. *imbricata*, (3) *Zygophyllum coccineum-Tamarix nilotica*, (4) *Zilla spinosa-Citrullus colocynthis,* (5) *Lotus hebranicus-Pulicaria undulata,* and (6) *Forsskaolea tenacissima-Reseda pruinosa*. Some characteristic species of the identified groups were salt-tolerant species, indicating the saline nature of the study area. Detrended Correspondence Analysis (DCA) supports the distinction between these groups. Some of the identified vegetation groups have very much in common with those recorded along the Western Mediterranean

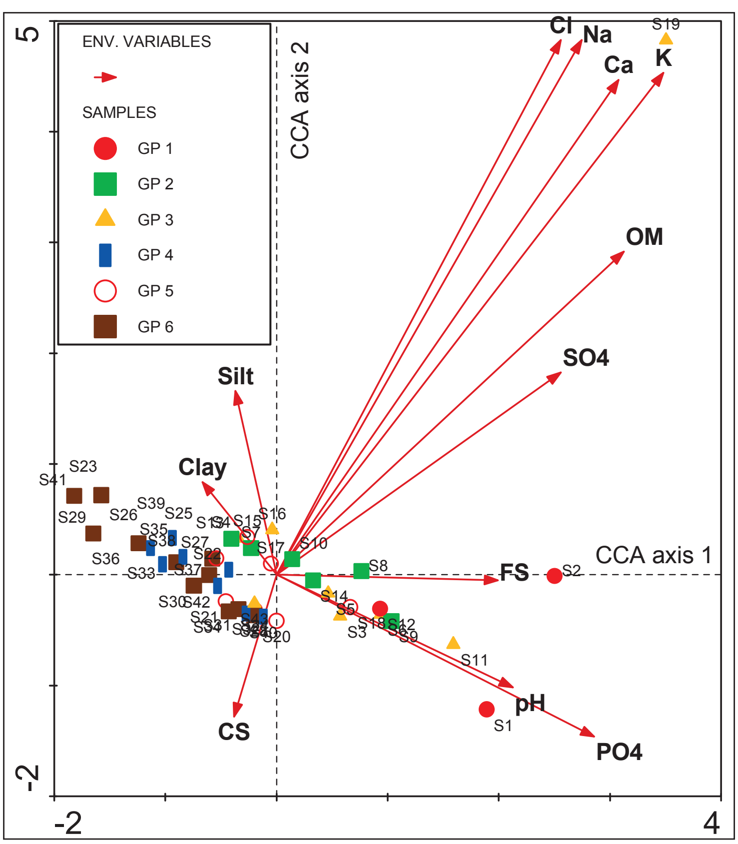

Fig. 6. CCA ordination biplot of the 43 studied stands and soil variables, together with their vegetation groups.

coastal region (Shaltout & El-Ghareeb 1992), South Sinai (El-Ghareeb & Shabana 1990; Abd El-Ghani & Amer 2003), in some wadis of the Eastern (Salama & Fayed 1989; Fossati & al. 1998) and Western Desert of Egypt (Bornkamm & Kehl 1985; Abd El-Ghani 2000; Abd El-Ghani & Marei 2006), and in the Negev Desert of Israel (Olsvig-Whittaker & al. 1983; Tielbörger 1997). Owing to the specific environment of the study area, many species with nitrophilous (e.g., *Cynodon dactylon* and *Phragmites australis*), psammophilous (e.g., *Acacia tortilis* subsp. *raddiana, Zygophyllum coccineum*, *Schouwia purpurea*, *Launaea cassiniana*, *Zilla spinosa* and *Pulicaria undulata*), halophilous (e.g. *Juncus rigidus*) and psammohalophilous (e.g., *Salsola imbricata* subsp. *imbricata* and *Tamarix nilotica*) characters occurred in the differentiated vegetation groups.

Results of the Canonical Correspondence Analysis (CCA) indicated that organic matter, Na, K, Ca, and pH, were the most important factors for distribution of the vegetation pattern along the road verges in the study area. Similar results were obtained by Batanouny (1979), Salama & Fayed (1989) and Abd El-Ghani (1998). Distribution of the vegetation groups reflects these relations: Groups 4, 5 and 6 were located near the Red Sea shore, while Groups 1, 2 and 3 were near the Nile Valley. The soil characteristics of stands of the latter groups showed relatively high salinity as compared to those near the Red Sea. This may be attributed to the fact that most of these salts were leached out by rainfall and torrent waters toward the sea, which can be detected in the dominance of some salt-tolerant species, such as *Salsola imbricata* subsp. *imbricata* and *Tamarix nilotica.* On the other hand, Groups 1, 2 and 3 included some weed species (e.g. *Amaranthus graecizans, Digitaria ciliaris, Echinochloa clona, Polypogon monspeliensis,* and *Portulaca oleracea*) from the arable lands, as compared to the other groups. These weeds belonged to the common weeds of Egypt (El Hadidi & Kosinova 1971; Abd El-Ghani & El-Sawaf 2005). That could be explained by the proximity of the study area to the boundaries of the agro-ecosystem of the Nile Valley at Qift city, where many land stretches have been reclaimed and recently considered under cultivation. Thus weeds have found new favourable conditions for their growth and their invasion has expanded. Therefore, according to this study, the road verges near the Nile Valley could be considered as a transitional phase in the succession process between the habitat of the old cultivated lands and that of the desert. In line with this, several authors have reported similar conclusions (Staniforth & Scott 1991; Shaltout & El-Halawany 1992; Bazzaz 1996; Gomaa 2002; Shaheen 2002).

Prevalence of the Saharo-Arabian element in the studied flora confirms distinctly its consistency to the Saharo-Arabian region of the Holarctic Kingdom. Whereas the Sudano-Zambezian element is not represented, the Mediterranean taxa are very modestly represented in the therophyte and chamaephyte layers. Accordingly, species of the Saharo-Arabian region are good indicators of the harsh desert conditions (Hegazy & al. 1998; Abd El-Ghani & Amer 2003).

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