Species diversity of the ruderal habitats in the Nile Delta

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This study deals with species diversity of ruderal habitats in Nile Delta region. Over 400 stands, representing 18 habitats, were sampled in the study area. Of the 248 species encountered, few were common throughout all habitats. Annuals were more represented along the terraces of highway roads, solid refuse areas and trampled fields, while perennials were more represented along the slopes and depressions of old roads in railway yards. The diaspores of more than half of the recorded species are microschlerochores (light diaspores), ballochores (diaspores with explosion mechanisms) and pogonochores (diaspores with long hairs). For almost-all habitats, species diversity was higher in spring than in the other seasons, particularly summer and autumn. Communities of abandoned salinized fields, terraces and depressions of highway and railway roads had the highest species diversity, while those of trampled fields, trampled railway yards, terraces, slopes and depressions of old roads had the lowest.

Key words: Species diversity, ruderal habitats, Nile Delta; Egypt.

Introduction

Anthropogenous environments are generally characterized by higher thermic ranges and lower moisture regimes than those in the buffered undisturbed environments. This altered microclimate causes the selection of a unique flora with particular kinds of dispersal mechanisms and of morphological and physiological features that are adapted to the new niches available for plant life (Lausi & Nimis, 1985). The construction and use of tracks, roads, canals, railways, and airports have involved many changes such as the destruction of the existing habitats and the provision of new ones which have special characteristics.

The Nile Delta supports many types of habitat, some of which are natural and others man-made. Man has influenced the natural flora and vegetation of Egypt from prehistoric times, chiefly in a destructive manner. By draining marshes and lakes, marsh and aquatic communities have been reduced. New habitats have been provided by agriculture and by the more or less permanent occupation of sites for habitation. The natural habitats are widely distributed in the northern part of Nile Delta (coastal dunes, salt marshes and brackish shallow lakes). The man-mad habitats include irrigation and drainage canals, railway and motorway roads, railway yards, demolished houses, abandoned salinized and nonsalinized fields, solid and liquid refuse areas, and graveyards.

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Ruderal plant communities have received little ecological attention in Egypt. Published works were dealt with the floristic, phytosociological, and ecological aspects of irrigation and drainage canals, northern lakes, cultivated, and non-cultivated lands (e.g. Simpson, 1932; Hassib, 1951; Boulos, 1966; Batanouny & El-Fiky, 1984; Zahran *et al*., 1990; Shaltout & El-Sheikh, 1991 and 1993; Shaltout *et al*., 1992, 1994 and 1995).

Our study aims at determining the vegetation structure of the main ruderal habitats in the Nile Delta including seasonal variations in species diversity, abundance, and dispersal behaviour of the species. We hope that managers of ruderal areas can minimize damage by confining recreational use to vegetation types that can tolerate these impacts.

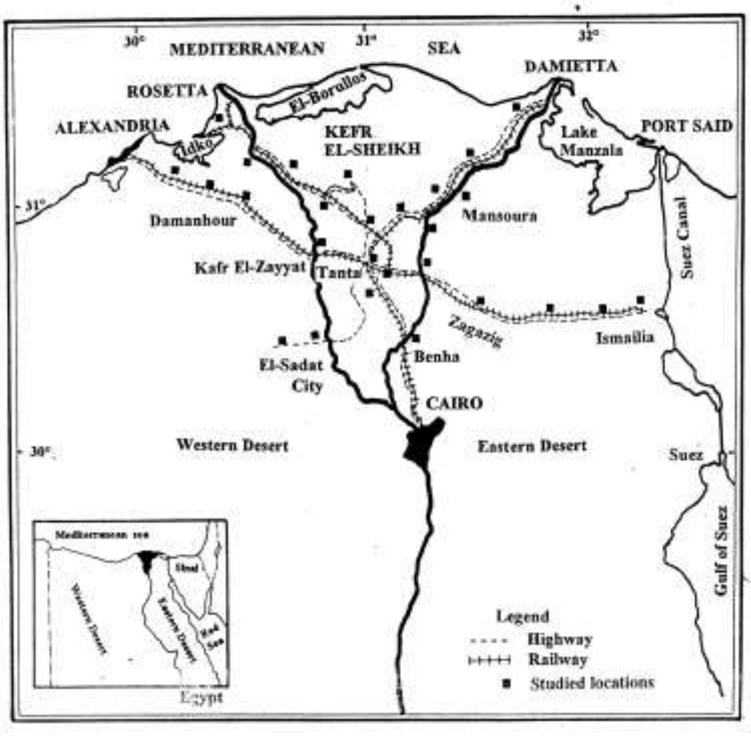

Fig. 1. Map of the Nile Delta indicating the studied locations (■)

Study area

The study area is located in the Nile Delta region of Egypt (Fig. 1), which has a classic triangular shape broader at its northern base than along the sides. Its surface in the south is relatively smooth compared to that in the north (Abu Al-Izz, 1971). Soils of the Nile Delta are mostly heavy in texture and rather compact at the surface. The humus content is moderate (El-Gabaly *et al*., 1969). All soils with exception of the northernmost part, are man-made and regarded as anthropogenic variants of the Gleysols and Fluvisols. Climatic conditions of the Nile Delta are similar to those of the northern part of Egypt. Summer is warm with an average temperature range of 20-30ºC, while winter is mild with an average temperature range of 10-20ºC (UNESCO, 1977). Most of the rain (70% or more) falls during winter. There is an obvious gradient in the annual rainfall from north (100 mm/year) to south (23 mm/year), associated with an increasing inverse gradient of evaporation.

Materials and Methods

Four hundred and five stands were sampled in the study area: 382 inside and 23 outside the Delta. These stands were distributed to cover 18 main ruderal habitats. The area of each stand ranged from 30 < 4 m to 50 < 30 m, and varied according to the extension of plant cover. The number of the sampled stands in each habitat varies between 7 for the slopes of old roads in railway yards and 38 for the terraces of highway yards.

A list of species was made seasonally in each stand. Nomenclature was according to Täckholm (1974), and updated according to Boulos (1995). Weed species were differentiated according to Boulos and El-Hadidi (1994), and Shaltout *et al*. (1992 and 1995). The recorded species were classified according to the life form scheme of Shelter and Skog (1978). A seed sample was collected from most of the species, and its dispersal type was assessed following the scheme of Dansereau and Lems (1957) which distinguishes dispersal types primarily by morphology of the diaspore. The absolute and relative cover of species with significant occurrence in the stands was estimated in spring using the line-intercept method (Canfield, 1941).

Three soil samples were collected as profiles (0-50 cm) from each of the sampled stands. Soil texture was measured by the hydrometer method. Total organic matter was determined by loss-on-ignition at 450°C. Calcium carbonate was estimated with a calcimeter. Soil water extracts at 1:5 were used for the determination of soil salinity (EC) and soil reaction (pH), using a direct indicating conductivity bridge (μmhos/cm) and soil glass electrode pH-meter, respectively. For the determination of some of the available nutrients, soil extracts of 5 gm air-dried soil samples were prepared using 2.5% v/v glacial acetic acid. The digested solution for total nitrogen was prepared using Micro-Kjeldahl apparatus. Flame photometery was used for the determination of K, Ca and Na. Molybdenum blue and Indo-phenol blue methods were used for the determination of P and N, respectively, Mg was determined by atomic absorption spectrometer. All these procedures are outlined by Allen *et al*. (1974).

Species richness (alpha-diversity) for each habitat was calculated as the average number of species per stand, and species turnover as the ratio between the total number of species recorded in a certain habitat and its alpha-diversity. Relative equitability or evenness of the importance value of species was expressed according to the Shannon - Wiener index:

$$H' = -\sum_{i=1}^{S} P_i \, (\mathrm{Log}\, P_i)$$

The heterogeneity dominance measure was expressed by the Simpson index:

$$C = \sum_{i=1}^{S} (P_i)^2$$

where S is the total number of species and Pi is the relative cover of the i^{th} species. (Pielou, 1969; Magurran, 1988). The variation in species diversity and soil variables in relation to the types of habitat was assessed using one-way analysis of variance (ANOVA) with SAS software (SAS, 1985).

Results

Some species were present in almostall habitats (≥ 16 out of 18 habitats) such as the perennials *Cynodon dactylon*, *Phragmites australis, Imperata cylindrica*, *Panicum repens*, *Convolvulus arvensis* and *Pluchea dioscoridis*, and the annuals *Bassia indica*, *Chenopodium murale*, *Hordeum murinum* ssp. *leporinum*, *Beta vulgaris* ssp. *maritima*, *Malva parviflora* and *Sisymbrium irio* (Table 1). Many others were present in only one habitat such as *Leptochloa fusca* in abandoned salinized fields (B), *Eichhornia crassipes* and *Ranunculus scleratus* in liquid refuse areas (L), *Beta vulgaris* ssp. *perennis* in graveyards (E), *Cyperus dives* and *Acacia nilotica* in depressions of old roads in railway yards (V), *Stipagrostis ciliata* in terraces of highway roads (T), and *Hyoscyamus muticus* in depressions of highway roads (d),

The application of the agglomerative clustering technique and polar ordination to the floristic composition of the 18 studied habitats revealed six groups of habitats: $C_1 – C_6$ (Fig. 2). C_1 comprises nine habitats: demolished houses, abandoned salinized and non-salinized fields, solid and liquid refuse areas, terraces, slopes and depressions of highway roads, and depressions of railway roads. Each of C_3 and C_4 includes three habitats (C_3 : railway yards, terraces and slopes of railway roads, and C_4 : grave yards, terraces and slopes of old roads in railway yards), while each of C_2, C_5 and C_6 comprises one habitat only.

The life-form spectra show that annuals constituted more than half of the recorded species (56.5%: Table 2). The annuals were relatively more represented in the terraces of highway roads, solid refuse areas and trampled fields (64.8 - 61.5%), and the perennials along the depressions of old roads in railway yards (65.5%).

Perennial grasses were the highest along trampled railway yards (20%), perennial sedges and rushes in the abandoned salinized fields (7.9%), perennial herbs and trees in the depressions of old roads in railway yards (20.7%, 65.5% respectively), and perennial shrubs along the slopes of old roads in railway yards (24%).

Table 1. Absolute cover (m/100 m) of the recorded species in the 18 habitats: A: demolished houses, B: abandoned salinized fields, C: abandoned non- salinized fields, D : solid refuses, L : liquid refuses, E : grave yards, F : trampled fields, K : trampled railway yards, H : railway yards, Z : terraces of old roads in railway yards, P : slopes of old roads in railway yards, V: depressions of old roads in railway yards, T : terraces of highway roads, S : slopes of highway roads, d : depressions of highway roads, W : terraces of railway roads, O : slopes of railway roads and Y : depressions of railway roads. r : rare species with cover < 1 m/100 m. Species with cover < 1 m/100 m in all the habitats are excluded.

a- Perennial species	**A**	**B**	**C**	**D**	**L**	**E**	**F**	**K**	**H**	**Z**	**P**	**V**	**T**	**S**	**d**	**W**	**O**	**Y**	**Total**
Cynodon dactylon	8.1	17.6	20.8	9.4	9.7	10.3	42	28.1	9.3	1.7	4.8	6.8	2.9	8.1	8.2	10.2	8.3	16.7	18
Phragmites australis	10.7	11.5	3.7	10.7	20.9	4.6		10.1	18.4	9.7	15.5	18.5	9	9.6	7.8	10.1	20.2	27.8	17
Imperata cylindrica		1.6	0.9	5.2	0.1	2.8	12.7	17.4	10.6	5.1	19.6	19.9	3.8	9.3	3.4	3.8	9.3	10.9	16
Panicum repens	0.9	5.2	1.2	1.1	4.2	1	34.6		1.1	r	2.3		r	0.9	3.9	3.6	1.3	1.2	16
Convolvulus arvensis	0.7	0.2	1	0.3	0.7	0.4	9.4	1.2	0.3		1.6	7.7	r	1	0.1		r	0.2	16
Pluchea dioscoridis	7.9	8.3	5.5	4.6	7.4			0.1	5.2	9.1	12.4	38.1	0.5	3	5.7	r	2.7	7.9	16
Alhagi graecorum		6.2	2	2.1	0.6	11.6		17.6	22.5	40.8	21.4	6.1	r	1.9		9.5	9.6	1.6	15
Cyperus rotundus	1.6	2.3	7.7	0.4	0.3	0.7	6.6		1.5				0.1	r	0.9		r	1.7	13
Polygonum equisetiforme		0.1	0.4		r		1.1		r	0.2			r	0.6	r	2	2.2	0.3	12
Aster squamatus	13.1	4.9	9.6	0.6	0.1				r	0.6				0.6	5.6		0.2	1.8	11
Cynanchum acutum		2.2		3.7					r	2.5	11	16	0.1	0.2		0.7	3.9	4.3	11
Desmostachya bipinnata				2.3		1.2		12	5.6				1.4	4.6	4	8.7	10.7	r	10
Paspalum distichum		0.5	3	2.9	12	0.1	1						0.1	2.3	5.1			2.4	10
Typha domingensis	0.3	0.8	1.7	0.1	2.7				2	0.5		0.1			0.6			0.7	10

Table 1. cont.

a- Perennial species	**A**	**B**	**C**	**D**	**L**	**E**	**F**	**K**	**H**	**Z**	**P**	**V**	**T**	**S**	**d**	**W**	**O**	**Y**	**Total**
Suaeda vermiculata		0.2				1.3				0.8	7.1		0.2	0.4	r	1.8	2.9	3.1	10
Tamarix nilotica	0.5	9.8	2.1	r					1.1					1.9	1.2	r	2.9	2.7	10
Polypogon viridis	0.2	r	0.1	0.1	r	0.1	0.8							r	1.1				9
Phyla nodiflora			0.4				14.5		0.4				1.1	0.7	1.2	1	1.9	4.9	9
Atriplex halimus									2.9	r	0.2		r	1.1	1.3	2.7	5.9	1.1	9
Suaeda pruinosa		0.9		1.3		15.4		1.5		2	12.5				0.3		0.7	0.2	9
Phoenix dactylifera	0.1	r	0.1	0.3		0.8			0.3	0.3		4.5						1.6	9
Arundo donax	0.3								1				4.3	8.2	4.8	2.5	5.1	4.6	8
Cressa cretica		1.2		0.8	0.2	0.1			2.1							0.1	1.6	0.4	8
Launaea nudicaulis				r		r		3.1	0.7	0.2			0.2		r	r			8
Ricinus communis	0.5			r	0.4	1.6				0.9	0.6	3.1		r					8
Lotus glaber		0.5	4.3		0.1		5								r		0.2	1.3	7
Plantago major			0.6	1.5	0.1		0.1							0.1	0.2			2.7	7
Silybum marianum		0.1	1.3	0.1		0.1	r							0.2				0.4	7
Juncus rigidus		0.9	1.1		0.2				1.1								0.1	0.7	6
Persicaria salicifolia			r		1.7							6		0.3	2.7			0.7	6

Table 1. cont.

a- Perennial species	**A**	**B**	**C**	**D**	**L**	**E**	**F**	**K**	**H**	**Z**	**P**	**V**	**T**	**S**	**d**	**W**	**O**	**Y**	**Total**
Inula crithmoides		1.2		r										0.3	0.4		1.6	0.3	6
Dichanthium annulatum			8.8						2			0.3		r				1	5
Leersia hexandra					0.5		0.5							1.7	7.9			4	5
Saccharum spontaneum					0.1								r	0.2	0.5			1	5
Cyperus alopecuroides	0.5		0.2		8.4										0.6			1.1	5
Tamarix tetragyna	0.2	7.3	0.5														0.4	0.3	5
Brachiaria mutica							0.7						r	0.2	1.8				4
Echinochloa stagnina					5.7									0.3	0.5			0.4	4
Juncus acutus		1.7							4.8						0.1			0.7	4
Scirpus maritimus	0.2	4.2	0.1											1.1					4
Mentha longifolia							1.1							0.4	1.2			0.8	4
Arthrocnemum macrostachyum		0.3		r										r	1.4				4
Atriplex leucoclada						0.5		11.1		2	3.9								4
Cornulaca monacantha													r		0.4	4.3	5		4
Paspalidium geminatum									1					1			0.1		3
Carex divisa		r							0.3			2.6							3

Table 1. cont.

a- Perennial species	**A**	**B**	**C**	**D**	**L**	**E**	**F**	**K**	**H**	**Z**	**P**	**V**	**T**	**S**	**d**	**W**	**O**	**Y**	**Total**
Epilobium hirsutum	r								r			1.1							3
Calligonum polygonoides													1	0.2	r				3
Sesbania sesban	0.2				0.5	r													3
Zilla spinosa									r				0.4		1				3
Zygophyllum aegyptium															r	2.6	2.4		3
Zygophyllum album	1.1	3.2													r				3
Cyperus laevigatus		2.7																0.2	2
Artemisia monosperma													1.8		0.4				2
Ipomoea carnea	1.7																	0.2	2
Leptochloa fusca		3.8																	1
Stipagrostis ciliata													1						1
Cyperus cf. *dives*												2.7							1
Hyoscyamus muticus															1				1
Acacia nilotica												2.1							1
Eichhornia crassipes					4.5														1

Table 1. cont.

b: Annual and biennial Species	**A**	**B**	**C**	**D**	**L**	**E**	**F**	**K**	**H**	**Z**	**P**	**V**	**T**	**S**	**d**	**W**	**O**	**Y**	**Total**
Bassia indica	13.3	5.7	5.2	33.5	11.4	12.8		3.5	9.9	5.4	3.3	4.6	28.6	16.3	12.7	16.7	15.4	11.8	17
Chenopodium murale	6	1.7	3.6	7.9	5.1	9.9	2.2	0.7	3.8	6.8	10.8		10.2	9.2	4.7	13.5	2.5	1.9	17
Hordeum murinum ssp. *leporinum*	0.1	6	10.3	0.7	0.2	7.5	0.2	9	2.3	6.6	4.5		4.8	2.3	0.3	9.2	1.2		16
Beta vulgaris ssp. *maritima*	4.3	0.5	4	1.9	1.4	1.1	0.1		1.1	0.4	0.3		1.4	2	0.9	0.2	0.1	0.2	16
Malva parviflora	0.9	0.8	1.9	3.1	0.6	4	3.3		1.4	3.2	7.5		9.4	5.4	1.5	0.2	r	0.1	16
Sisymbrium irio	0.9		1.3	1.6	2.5	3.3		0.1	0.8	2.7	3.1	1.7	1.6	2.5	1.7	0.8	0.5	0.3	16
Polypogon monspeliensis	4.2	13	13.1	2.9	6.5	0.7	5.6		0.2	0.3		0.6	1.3	1.2	4.5	r		2.9	15
Amaranthus viridis	6.5	0.4	0.3	3.9	3.7	1.8	0.1		3	1.6		3.3	1	0.5	0.3	0.1		0.7	15
Sonchus oleraceus	3.6	0.7	0.5	1.1	1	1	1.8	r	0.1	0.9			0.9	1.8	1.4	0.2		0.9	15
Rumex dentatus	3.5	2.1	2.5	5.5	8	0.2	3.8		r	0.3		1.7	0.5	0.9	7.4			1.5	14
Urospermum picroides	2	0.1	0.4		r	1.1		r	0.1	2			0.5	0.1	0.7	0.1	0.1	0.4	14
Lolium perenne		0..2	0.1	r	r		2.7						4.5	1.8	0.7	2.8	0.1	1	11
Spergularia marina	0.1	7	0.4	0.4	r	0.2	0.7						r			0.1	0.1	0.7	11
Portulaca oleracea	0.2	0.2	1.7	1.2	0.4		0.2						0.1	0.1	0.1	r			10
Senecio glaucus	r		r			0.5	r		r	0.2			2		1.3	r		0.1	10

Table 1. cont

b: Annual and biennial Species	**A**	**B**	**C**	**D**	**L**	**E**	**F**	**K**	**H**	**Z**	**P**	**V**	**T**	**S**	**d**	**W**	**O**	**Y**	**Total**
Solanum nigrum	0.2			3.3	0.7	0.5			r	1.1			r	r	0.8			0.6	10
Torilis arvensis		r	0.6	0.6					r				r	0.7	3.5	0.1	0.8	4.6	10
Phalaris paradoxa	r	0.1	1	0.2			1						1	0.5	1			0.1	9
Conyza bonariensis	1.6	0.1	0.1	r	0.1				0.1				r	r	r				9
Avena fatua			0.1	r	r	0.3	r	0.4					1	0.2					8
Chenopodium album	3.2			4.2	r		r						1.1	0.5	0.2			r	8
Phalaris minor	r	0.1	0.2				0.5						2.6	0.3	r				7
Melilotus messanensis	r	1.6			0.1		0.4		r				r		r				7
Coronopus squamatus	0.1	0.2		r			r		r	1.2			r						7
Melilotus indicus		r				0.1	1						0.1	0.1				r	6
Ammi visnaga	0.1		4.8		0.1	r			r				r						6
Medicago polymorpha		0.1					1						0.9		0.1	r			5
Sonchus asper		r											0.4	1	0.1			0.2	5
Trifolium resupinatum		1	1.2				2.8								0.3				4
Chenopodium opulifolium					0.1								1.4	0.2	0.1				4
Plantago lagopus				r				7					r					r	4

Table 1. continued

b: Annual and biennial Species	**A**	**B**	**C**	**D**	**L**	**E**	**F**	**K**	**H**	**Z**	**P**	**V**	**T**	**S**	**d**	**W**	**O**	**Y**	**Total**
Reichardia tingitana						0.6		1.8					0.2		r				4
Lolium multiflorum													2.1	1.1	r				3
Medicago intertexta var. ciliaris	0.4	0.4	1.7																3
Atriplex semibaccata										1.5	3.8		r						3
Calendula arvensis																r	0.2	1.5	3
Carduus pycnocephalus								2.1					r			r			3
Dinebra retroflexa					r		1												2
Mesembryanthemum. nodiflorum						2.8		r											2
Rumex pictus													r	1.8					2
Xanthium strumarium			r		1														2
Beta vulgaris ssp. *perennis*						1.9													1
Ranunculus sceleratus					1.4														1

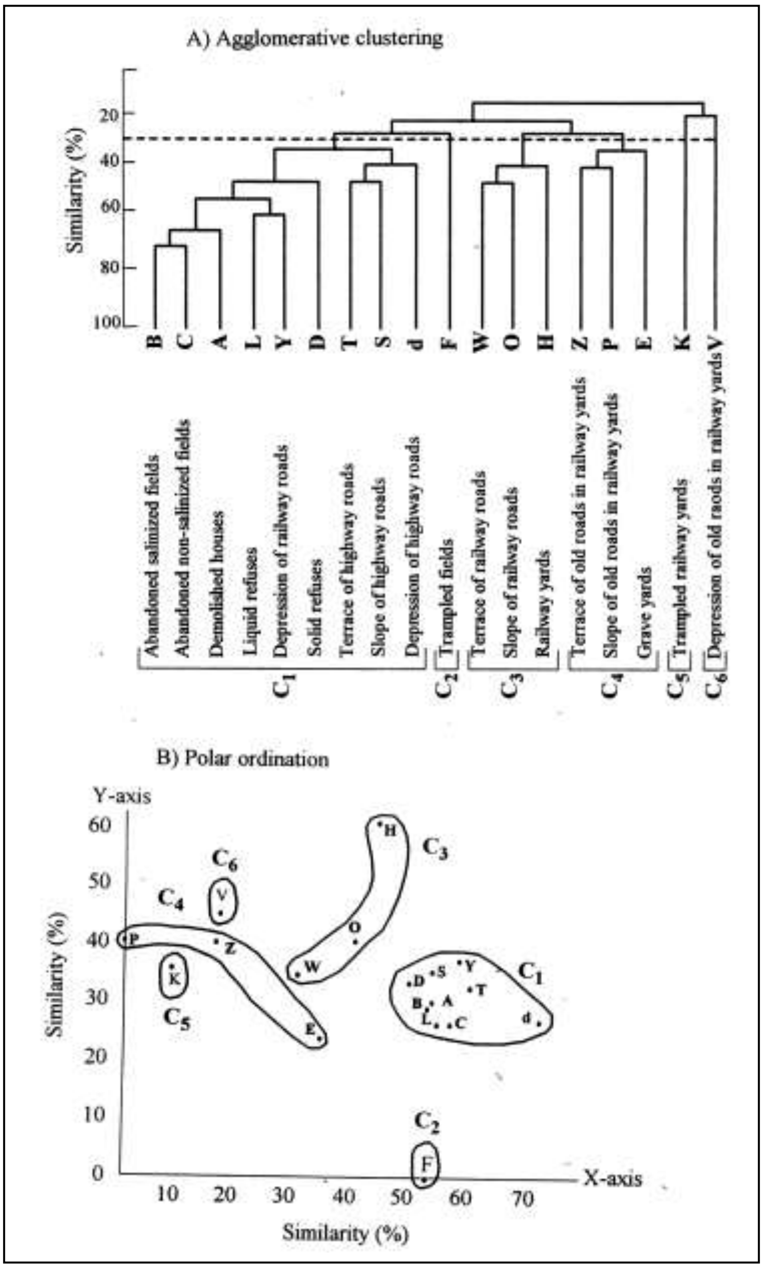

Fig. 2. Dendrogram resulting from the agglomerative clustring technique (A) and polar ordination (B) of the plant communities of the 18 sampled habitats.

Table 2. Life form spectra of the plant communities of the 18 habitats. A: demolished houses, B: abandoned salinized fields, C: abandoned non salinized fields, D: solid refuses, L: liquid refuses, E: grave yards, F: trampled fields, K: trampled railway yards, H: railway yards, Z: terraces of old roads in railway yards, P: slopes of old roads in railway yards, V: depressions of old roads in railway yards, T: terrace of highway roads, S: slopes of highway roads, d: depressions of highway roads, W: terraces of railway roads, O: slopes of railway roads, and Y: depressions of railway roads. Ac: actual number of species, Re: relative number of species. The maximum and minimum relative values are underlined.

Life Form		**A**	**B**	**C**	**D**	**L**	**E**	**F**	**K**	**H**	**Z**	**P**	**V**	**T**	**S**	**d**	**W**	**O**	**Y**	**Total**
I- Annuals																				
Annual Grasses	Ac	9	10	13	12	8	10	11	2	4	4	2	2	19	15	13	4	4	5	33
	Re	10.6	11.2	14.6	13.8	10.0	14.7	16.9	8.3	5.6	10.2	8.0	6.9	14.8	16.3	9.4	7.4	6.0	4.9	13.2
Legumes	Ac	6	6	6	6	6	3	5	-	3	2	-	-	10	4	8	2	2	4	11
	Re	7.1	6.7	6.7	6.9	7.5	4.4	7.7	-	4.2	5.1	-	-	7.8	4.3	5.8	3.7	3.0	3.9	4.4
Sedges & Rushes	Ac	1	2	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	2
	Re	1.2	2.2	-	-	-	-	-	-	-	-	-	-	-	-	1.4	-	-	-	0.8
Other annual herbs	Ac	31	27	32	36	30	28	24	8	21	13	7	7	54	30	39	24	20	38	94
	Re	36.5	30.3	36.0	41.4	37.5	41.2	36.9	33.3	29.2	33.3	28.0	24.1	42.2	32.6	28.3	44.4	29.9	37.3	37.9
Total	Ac	47	45	51	54	44	41	40	10	28	19	9	9	83	49	62	30	26	47	140
	Re	55.3	50.6	57.3	62.1	55.0	60.3	61.5	41.6	38.9	48.7	36.0	31.0	64.8	53.3	44.9	55.6	38.8	46.1	56.5
II- Biennials	Ac	2	2	2	2	1	2	3	1	4	2	1	1	2	3	4	3	3	1	6
	Re	2.4	2.2	2.2	2.3	1.3	2.9	4.6	4.1	5.6	5.1	4	3.4	1.6	3.3	2.9	5.6	4.5	0.9	2.4

Table 2. continued.

Life Form		**A**	**B**	**C**	**D**	**L**	**E**	**F**	**K**	**H**	**Z**	**P**	**V**	**T**	**S**	**d**	**W**	**O**	**Y**	**Total**
III- Perennials																				
Grasses	Ac		11	8	10	10	8	8	5	8	4	4	4	12	14	16	7	10	15	19
	Re	10.7	12.4	9.0	11.5	12.5	11.8	12.3	20.8	11.1	10.2	16.0	13.8	9.4	15.2	11.6	13.0	14.9	14.7	7.7
Legumes	Ac	2	3	3	1	2	2	1	1	2	1	1	1	3	2	5	1	3	3	5
	Re	2.4	3.4	3.4	1.1	2.5	2.9	1.5	4.1	2.8	2.6	4.0	3.4	2.3	2.2	3.6	1.9	4.5	2.9	2.0
Sedges and Rushes	Ac	4	7	5	2	4	1	2	-	5	-	-	2	1	2	6	-	3	7	9
	Re	4.7	7.9	5.6	2.3	5.0	1.5	3.1	-	6.9	-	-	6.9	0.8	2.2	4.3	-	4.5	6.8	3.6
Other perennial herbs	Ac	10	11	14	8	12	6	9	4	12	6	3	6	10	10	21	5	9	16	29
	Re	11.8	12.4	15.7	9.2	15.0	8.8	13.8	16.7	16.7	15.4	12.0	20.7	7.8	10.9	15.2	9.3	13.4	15.7	11.7
Shrubs	Ac	8	7	2	6	3	6	2	3	6	6	6	3	14	8	20	7	9	7	26
	Re	9.4	7.9	2.2	6.9	3.8	8.8	3.1	12.5	8.3	15.4	24.0	10.3	10.9	8.7	14.5	13.0	13.4	6.8	10.8
Trees	Ac	3	3	4	4	1	2	-	-	6.0	1	1	3	3	4	4	1	4	6	10
	Re	3.5	3.4	4.5	4.6	1.3	2.9	-	-	8.3	2.6	4.0	10.3	2.3	4.3	2.9	1.9	6.0	5.9	4.0
Total	Ac	36	42	36	31	32	25	22	13	39	18	15	19	43	40	72	21	38	54	98
	Re	42.4	47.2	40.4	35.6	40.0	36.8	33.8	54.1	54.2	46.1	60.0	65.5	33.6	43.5	52.2	38.9	56.7	52.9	39.5
IV- Hydrophytes	Ac	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	3
	Re	-	-	-	-	3.8	-	-	-	-	-	-	-	-	-	-	-	-	-	1.2
V- Parasites	Ac	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1
	Re	-	-	-	-	-	-	-	-	1.4	-	-	-	-	-	-	-	-	-	0.4
Total species		85	89	89	87	80	68	65	24	72	39	25	29	128	92	138	54	67	102	248

The dispersal types of most species were microsclerochores (53:21.4%), ballochores (46:18.5%) and pogonochores (42:16.9%). Cyclochores and megasclerochores have relatively low proportions (Table 3). Salinized fields, solid refuses, trampled fields, terraces, slopes, and depressions of highway roads have the highest number of microsclerochoric species. Demolished houses, non-salinized fields, grave yards, trampled railway yards, railway yards, terraces, slopes and depressions of old roads in railway yards and terraces, slopes, and depressions of railway roads have the highest number of pogonochoric species. On the other hand, ballochoric species are characteristic to the liquid refuse areas.

The total number of the recorded species varies between 114 species for the community of the terraces of highway roads in spring, and 12 for that of the trampled railway yards in autumn (Table 4). In spring, the abandoned non-salinized fields have the highest species richness (13.7 species/stand), while in autumn, the terraces of highway roads have the lowest (3.3 species/stand). The highest value of species turn-over is that of terraces and depressions of the highway roads in spring (9.5 and 9.7 respectively), while the lowest is that of the trampled railway yards in winter (2.0). The trampled railway yards in autumn have the highest relative concentration of dominance (C = 0.11) and the lowest relative evenness (H` = 0.99). In spring, the terraces of highway roads have the lowest C value (0.02) associated with the highest H` value (1.71).

Soils of the demolished houses (**A**) have the highest values of sand (85.2%) and phosphorus (0.16 mg/g) and the lowest of silt (9.5%) and potassium (07 mg/g) (Table 5). The abandoned non-salinized fields (**C**) have the lowest value of salinity (1.4 mmhos/cm), while the solid refuses (**D**) have the highest of calcium carbonate (18.9 %), organic matter (10.9 %), clay (8.9%), calcium (54.8 mg/g), nitrogen (4.4 mg/g) and magnesium (9.0 mg/g). The grave yards (**E**) have the highest values of salinity (8.5 mmhos/cm), sodium (8.2 mg/g) and potassium (1.9 mg/g), but the lowest of pH (7.29). The trampled fields (**F**) have the highest value of silt (38.6 %), but the lowest of sand (56.7%), calcium (11.8 mg/g) and phosphorus (0.05 mg/g). The railway yards (**H**) have the lowest of magnesium (5.0 mg/g), the depressions of old roads in railway yards (**V**) have the lowest of calcium carbonate (1.9%) and the terraces of highway roads (**T**) have the lowest of organic matter (4.3%), clay (3.2%) and sodium (2.9 mg/g).

Table 3. Dispersal spectra of the plant communities of the 18 habitats. Ac: actual number of species, Re: relative number of species. The maximum and minimum relative values are underlined.

Dispersal Type	Auxo-chore		Cyclo-chore		Ptero-chore		Pogono-chore		Desmo-chore		Sarco-chore		Microscl-erochore		Megascl-erochore		Ballo-chore		Total Species
Habitat	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac
Demolished houses	5	5.9	3	3.5	3	3.5	20	23.5	13	15.3	9	10.6	18	21.2	1	1.2	13	15.3	85
Abandoned salinized fields	5	5.6	2	2.2	7	7.9	16	18.0	10	11.2	8	9.0	26	29.2	4	4.5	11	12.4	89
Abandoned nonsalinized fields	4	4.5	2	2.2	5	5.6	20	22.5	12	13.5	4	4.5	19	21.3	3	3.4	20	22.5	89
Solid refuses	5	5.7	4	4.6	5	5.7	16	18.4	13	14.9	7	8.0	22	25.3	2	2.3	13	15.0	87
Liquid refuses	8	10.0	3	3.8	3	3.8	13	16.3	12	15.0	3	3.8	18	22.5	1	1.3	19	23.8	80
Grave yards	3	4.4	1	1.5	5	7.4	16	23.5	10	14.7	7	10.3	12	17.6	1	1.5	13	19.1	68
Trampled fields	5	7.7	3	4.6	5	7.7	10	15.4	10	15.4	2	3.1	17	26.2	1	1.5	12	18.5	65
Trampled railway yards	2	8.3	1	4.2	3	12.5	8	33.3	1	4.2	1	4.2	3	12.5	1	4.2	4	16.7	24
Railway yards	4	5.6	2	2.8	3	4.2	17	23.6	5	6.9	9	12.5	16	22.2	5	6.9	11	15.3	72
Terraces of old roads in railway yards	2	5.1	1	2.5	5	12.8	11	28.2	4	10.3	4	10.3	7	17.9	__	__	5	12.8	39
Slopes of old roads in railway yards	2	8.0	2	8.0	4	16.0	4	16.0	2	8.0	3	12.0	4	16.0	__	__	4	16.0	25
Depressions of old roads in railway yards	1	3.5	1	3.5	__	__	9	31.0	2	6.9	4	13.8	5	17.2	1	3.5	6	20.7	29
Terraces of highway roads	6	4.7	4	3.1	10	7.8	27	21.1	24	18.8	7	5.5	28	21.9	1	0.8	21	16.4	128
Slopes of highway roads	7	7.6	3	3.3	6	6.5	18	19.6	14	15.2	6	6.5	24	26.1	2	2.2	12	13.0	92
Depressions of highway roads	9	6.5	4	2.9	7	5.1	26	18.9	18	13.0	13	9.4	31	22.5	7	5.1	23	16.7	138
Terraces of railway roads	5	9.3	1	1.9	5	9.3	18	33.3	6	11.1	3	5.6	9	3.7	__	__	7	13.0	54
Slopes of railway roads	7	10.5	1	1.5	4	6.0	20	30.0	6	9.0	5	7.5	11	16.4	3	4.5	10	15.0	67
Depressions of railway roads	8	8.5	2	2.1	4	4.3	26	27.7	7	7.4	8	8.5	12	25.6	6	6.4	16	17.0	94
Total species	13	5.2	7	2.8	17	6.9	42	16.9	34	13.7	22	8.9	53	21.4	14	5.6	46	18.5	248

Table 4. Seasonal variations in some diversity indices calculated for the plant communities of the 18 studied habitats. A: demolished houses, B: abandoned salinized fields, C: abandoned non salinized fields, D: solid refuses, L: liquid refuses, E: grave yards, F: trampled fields, K: trampled railway yards, H: railway yards, Z: terraces of old roads in railway yards, P: slopes of old roads in railway yards, V: depressions of old roads in railway yards, T: terrace of highway roads, S: slopes of highway roads, d: depressions of highway roads, W: terraces of railway roads, O: slopes of railway roads, and Y: depressions of railway roads. The values between brackets are the coefficient of variation of the species richness. The minimum and maximum values are underlined

Habitat	Total species		Species richness		Species turn over		Relative conc. of dominance		Relative evenness	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
A	31 - 65	49.0	7.3 - 12.8	10.3	4.1 - 5.6	4.8	0.02 - 0.06	0.04	1.32 - 1.58	1.50
B	48 - 65	57	9.1 - 12.7	11.3	4.6 - 5.4	5.1	0.03 - 0.04	0.03	1.46 - 1.61	1.60
C	51 - 62	57	9.5 - 13.7	12.4	4.4 - 5.4	4.7	0.02 - 0.05	0.03	1.58 - 1.63	1.56
D	46 - 62	53	8.3 - 11.0	9.4	5.5 - 5.8	5.7	0.03 - 0.05	0.04	1.40 - 1.54	1.49
L	44 - 65	52	8.7 - 11.5	9.5	5.1 - 5.8	5.5	0.03 - 0.04	0.03	1.43 - 1.58	1.48
E	33 - 52	42	7.2 - 11.8	9.6	4.1 - 4.6	4.4	0.03 - 0.05	0.04	1.37 - 1.56	1.47
F	28 - 53	40	7.1 - 11.6	9.0	3.9 - 4.7	4.4	0.03 - 0.07	0.05	1.25 - 1.52	1.40
K	12 - 22	16	3.5 - 6.5	4.98	2.0 - 3.9	3.3	0.06 - 0.11	0.08	0.99 - 1.25	1.11
H	37 - 60	50	6.1 - 9.0	7.6	6.1 - 6.9	6.6	0.04 - 0.07	0.05	1.27 - 1.46	1.38
Z	20 - 34	27	4.8 - 9.0	6.8	3.7 - 4.4	4.1	0.03 - 0.07	0.05	1.20 - 1.45	1.32
P	13 - 20	16.5	3.4 - 6.0	4.8	3.3 - 3.8	3.5	0.07 - 0.11	0.08	1.02 - 1.22	1.13
V	21 - 24	22	6.6 - 7.0	6.9	3.0 - 3.5	3.2	0.06 - 0.07	0.06	1.21 - 1.27	1.24
T	23 - 114	56	3.3 - 12.0	6.8	6.5 - 9.5	8.0	0.02 - 0.12	0.07	1.07 - 1.71	1.38
S	40 - 70	53	5.0 - 9.5	6.9	6.9 - 8.6	7.7	0.03 - 0.07	0.05	1.34 - 1.56	1.44
d	64 - 107	77	8.1 - 11.0	9.0	8.1 - 9.7	8.5	0.02 - 0.03	0.03	1.57 - 1.66	1.61
W	21 - 47	30	3.4 - 6.9	4.8	5.4 - 6.8	6.0	0.05 - 0.11	0.08	1.08 - 1.39	1.22
O	27 - 47	36	4.0 - 6.0	5.0	6.4 - 7.8	7.1	0.04 - 0.08	0.06	0.99 - 1.36	1.25
Y	59 - 81	70	7.0 - 9.1	8.2	7.8 - 9.1	8.5	0.02 - 0.04	0.03	1.51 - 1.65	1.60

Table 5. Means of the soil characters of the 18 studied habitats. A: demolished houses, B: abandoned salinized fields, C: abandoned non salinized fields, D: solid refuses, L: liquid refuses, E: grave yards, F: trampled fields, K: trampled railway yards, H: railway yards, Z: terraces of old roads in railway yards, P: slopes of old roads in railway yards, V: depression of old roads in railway yards, T: terraces of highway roads, S: slopes of highway roads, d: depressions of highway roads, W: terraces of railway roads, O: slopes of railway roads, Y: depressions of railway roads. * = P≤0.01, **= P≤0.001 according to F-test The maximum and minimum mean values are underlined.

Soil characters		A	B	C	D	L	E	F	K	H	Z	P	V	T	S	d	W	O	Y	Total mean	F- value
pH		7.7	7.8	7.8	7.8	7.6	7.3	7.6	7.5	8.1	8.1	8.2	8.2	7.9	7.9	7.9	7.9	7.9	7.9	7.9	4.0**
EC (mmhos/cm)		1.4	6.5	1.4	4.9	3.1	8.5	1.5	3.1	2.8	3.3	2.5	4.0	1.4	1.7	3.0	2.9	3.8	3.8	3.2	5.3**
$CaCO_3$	%	5.2	6.8	3.5	18.9	14.2	7.4	4.3	5.9	5.2	4.4	4.9	1.9	3.9	4.8	3.2	6.5	6.5	3.6	6.6	3.5**
O.M.	%	5.3	6.0	6.2	10.9	7.1	5.7	9.8	7.8	6.8	5.7	4.7	5.7	4.3	5.4	6.2	5.6	5.4	7.5	6.4	5.7**
Sand	%	85.2	77.2	72.4	69.5	64.9	68.2	56.7	76.5	73.3	70.9	68.9	68.9	79.2	71.2	66.3	76.5	75.7	67.5	72.3	4.9**
Silt	%	9.5	14.3	21.9	21.6	29.0	25.8	38.6	19.3	22.4	24.8	27.6	24.9	17.4	25.1	29.4	19.5	19.0	28.2	22.7	5.0**
Clay	%	5.3	7.8	5.7	8.9	6.0	6.0	4.4	4.7	4.2	4.3	3.5	6.1	3.2	3.6	4.2	4.0	5.3	4.3	5.0	4.9**
Ca	mg/g	29.7	3.2	22.0	54.8	27.4	33.0	11.8	15.0	26.7	25.6	2.8	7.0	2.3	20.8	20.8	30	27.76	23.5	27.4	4.4**
Na	mg/g	3.7	6.3	3.4	6.7	4.6	8.2	3.6	4.7	3.8	5.0	4.3	5.1	2.9	3.4	4.5	40.1	5.3	4.9	4.6	4.6**
K	mg/g	0.7	0.7	0.8	1.7	1.1	1.9	1.2	1.5	1.2	1.0	0.9	1.8	1.1	1.1	1.2	1.3	1.6	1.6	1.2	2.1*
N	mg/g	1.0	1.5	1.9	4.4	2.5	2.9	2.7	3.1	2.3	1.9	1.7	2.3	1.9	1.6	2.4	2.6	30	40	2.5	4.0**
P	mg/g	0.2	0.1	0.04	0.1	01	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.07	0.1	0.1	0.1	0.1	0.9	3.1**
Mg	mg/g	5.3	7.7	5.3	9.0	8.7	7.7	6.6	4.2	5.0	6.2	6.0	5.0	5.8	6.3	6.8	5.7	0.74	7.4	6.6	2.7**

Discussion

The present study shows that the habitat of solid refuses, has the highest content of calcium carbonate, calcium, organic matter, clay, magnesium and nitrogen (soil fertility). This could be a result of discharge of organic and inorganic refuses (e.g. dumps, rubbish heaps, debries from buildings, garden refuses, vegetal refuses from kitchens and shops and solid refuses from factories). On the other hand, the terraces of highway roads have the lowest values of organic matter, clay and sodium. This may be due to the movement of vehicles which create air turbulence and remove the debris of organic materials of plants and animals far away from terraces. This agrees with results obtained by Frenkel (1970) and Spencer *et al*. (1988). Soils of trampled fields have high content of silt, as the treading often leads to a process of soil structure destruction produced by trampling of moist soil and leads to deflocculation of clay particles and the soil upon drying (Frenkel, 1970). Soil of demolished houses have high content of sand which could be attributed to the raw materials used in the construction of houses (Brande *et al*., 1990).

Egyptian neophytes differ from each other not only in time and way of their introduction but also in the establishment degree in various habitats. The neophytes which are important components of the autumnal aspect in the ruderal habitats of the present study are: *Paspalum distichum*, *Aster squamatus*, *Bassia indica*, *Eichhornia crassipes* and *Azolla filiculoides.* The naturalized species in the present study are *Atriplex semibaccata, Bidens pilosa, Cenchrus biflorus, Chenopodium ambrosioides, Datura innoxia, Datura stramonium, Eruca sativa, Euphorbia prostrata, Gynandropsis gynandra, Ipomoea carnea, Lathyrus sativus, Lepidium sativum, Linum usitatissimum, Medicago sativa,* and *Sesbania sesban (*Simpson, 1932; Drar, 1952; El-Hadidi & Kosinovâ, 1971; Täckholm, 1974; Hejny, & Kosinovâ, 1977; Boulos, 1995). On the other hand, some species are native to the Egyptian desert and have invaded the Nile Delta. Such invasion may be associated with the transport of sand, gravel and ballast from the desert for the construction of roads and houses in the Nile Delta region. Examples include: *Zilla spinosa*, *Rumex cyprius*, *Rumex pictus*, *Salsola kali*, *Ermobium aegyptiacum* and *Cornulaca monacantha*. Shaltout (1994) reported the desert annual *Ifloga spicata* as a new record in the Nile Delta.

The two-dimensional polar ordination (Bray and Curtis, 1957) indicates a clear aggregation between the vegetation clusters of demolished houses, abandoned salinized and non-salinized fields, solid and liquid refuse areas, terraces, slopes and depressions of highway roads and depressions of railway roads. Most species in these habitats have the pioneer nitrophilous and ephemeral characters of weed communities that are closely related to high disturbance and colonize the heavy fertilized damp soil rich in organic matter, ammonia and nitrates. On the other hand, many of the species that represent the other habitats belong to the thermophilous plant communities of anthropogenic activities and/or semi-natural conditions; soils are poor in nitrogen and humus, and subjected to secondary succession. Similar conclusions have been made by Eliâs (1984), Mucina (1987), Lausi and Nimis (1985), and Rose and Webb (1994).

Therophytic species (annuals) are more represented along the terraces of highway roads, solid refuses and trampled fields. The members of this life form are successful colonizers for many of the highly disturbed areas as they have higher reproductive capacity, and more ecological, morphological and genetic plasticity (Frenkel, 1970; Harper, 1977; Grime, 1979). The prevailing climatic conditions, water availability and soil nature of such habitats bring shelter to the occurrence of therophytes during the favourable seasons and escape from the competition from tall perennial herbs. On the other hand, the perennials, are more represented in slopes and depressions of old roads in railway yards. The unifying ecological factors for many sites in these habitats are the absence of severe anthropogenic effects and accessibility to natural succession. Similar suggestions were made by Eliâs (1984) and Brande *et al.* (1990). Perennial grasses are higher in the trampled railway yards than the other perennial forms. This could be related to the resistance of the grass community to treading damage (Frenkel, 1970).

Microsclerochores dispersal type (light diaspores) characterizes the plant communities of the terraces, slopes and depressions of highway roads, abandoned salinized fields, solid refuses and trampled fields. This is suggesting that the dispersal of the species in these habitats is affected mainly by air movement (wind). Microsclerochores are light enough to be carried by breeze that usually happens by local turbulence associated with the traffic. However, microsclerochores are easily incorporated into soil and mud which suggests that this mode of transport may be important near the roads (See Clifford, 1959). Another factor, the texture of substrate, is apparently correlated with the size of the sclerochoric dispersal type. The small light sclerochores are associated with the fine grained material (which is abundant in these habitats). The habitats of railways are dominated by pogonochores (diaspores with long hairs) and sporochores (extremely light diaspores). Thus wind dispersal appears to operate with increasing importance along the railways habitats, since local turbulence related to traffic may hinder the deposition of diaspores close to the road. The habitats of liquid refuse areas and abandoned non-salinized fields are dominated by ballochores (have explosion mechanisms). Of interest is the fact that most of the ballochoric species are therophytes. Here the explosive nature of this dispersal type is often related to rapid desiccation, occurrence of annual habit, rapid drying and efficient local seed dispersal would lead to high proportion of therophytic ballochores. (Frenkel, 1970).

No doubt that the ruderal habitats in the Nile Delta are usually affected by the seepage of water from the network of irrigation and drainage canals as well as from the continuous irrigation of the adjacent fields. This process usually leads to improvement of their moisture availability throughout the year (El-Ghandour *et al*., 1983; Shaltout & El-Beheiry, 1996). However, the high temperature during summer and early autumn may lead to severe dryness of the superficial layer of soil and thus hindering the growth of annual species. In view of this, one can interpret why in the present study the species diversity indices, particularly the total species and species richness, are higher in spring (season of favourable temperature and moisture regimes) than in the other seasons, particularly summer and autumn.

The present study indicates that the plant communities of abandoned non-salinzed fields, terraces and depressions of highway roads, and depressions of railway roads, have high species diversity and low relative concentration of dominance. The communities of these habitats are exposed to medium disturbance and hence considerable substrate heterogeneity, more annuals of arable weeds which grow during spring and summer seasons (Houssard *et al.*, 1980). This may be related to the regional vegetation of arable land and cropping cultivation which affect the structure of weeds in these ruderal habitats. There is often a layer of spent ballast retaining moisture in depressions of highway and railway roads (Sargent, 1984). Moreover, the irrigation water sometimes reaches these habitats, while the depressions receive additional water due to the run-off from the road edge (Hejny & Kosinovâ, 1977). In the desert areas, these habitats act as a transition ecotonic zone between the natural and ruderal vegetation (Shaltout & El-Halawany, 1992).

On the other hand, communities of trampled fields, trampled railway yards, terraces, slopes and depressions of old roads in railway yards, and terraces of railway roads are characterized by low species diversity and high relative concentration of dominance. The trampled fields and railway yards, terraces of old roads in railway roads and terraces of railway roads are related to extreme factors such as the trampling effect which lead to high soil compaction. Many species are damaged by heavy trampling, but such type of vegetation has high dominance of individuals of a single or few tolerant species.

Some plant communities in the present study show strong dominance of some species and confirm the hypothesis of niche- preemption which is often exhibited by vascular plants with low species diversity (Whittaker, 1972). As examples of strong dominance of some species, during summer and autumn, are *Bassia indica, Alhagi graecorum, Imperata cylindria and Phragmites australis* which contribute about 70% of the total cover of the communities that characterize the habitats of trampled railway yards, terraces, slopes, depressions of old roads in railway yards and terraces and slopes of railway roads. The habitats of railways are usually more disturbed by human impacts such as mowing, cutting and firing due to the maintenance practices in summer season. Railway yards are stressed habitats as they often become compacted by trampling and polluted by oil, organic material and rubble (Grime, 1979).

References

Abu-Al-Izz, M.S. (1971). *Land forms of Egypt*. Cairo: *Dar Al-Maaref*. 281 pp.

Allen, S. E., Grimshaw, H. M., Parkinson, J.A. and Quarmby, C. (1974). *Chemical analysis of ecological materials*. *Oxford: Blackwell Scientific Publications*. 565 pp.

Batanouny, K.H. and El-Fiky, A.M. (1984). Water hyacinth in Egypt: distribution and problem magnitude. *Proc. of the Inter. Conf. on Water Hyacinth, Hyderabad*: 127 - 144.

Boulos, L. (1966). Flora of the Nile region in Egyptian Nubia. *Feddes Repert,* **73**: 184-215.

Boulos, L. (1995). *Flora of Egypt*: c*hecklist*. Cairo: *Al Hadara Publishing*. 287 pp.

Boulos, L. and El-Hadidi, M.N. (1994). *Weed flora of Egypt*. *Cairo*: *The American Univ. in Cairo press*. 361 pp.

Brande, A., Böcker, R., and Graf, A. (1990). Changes of flora, vegetation and urban biotopes in Berlin (West). In Sukopp, H. and Hejny, S., (Eds.), *Urban Ecology*, pp. 155 - 165. The Hague: *SPB Academic Publishers* bv. 282 pp.

Bray, R.J. and Curtis, J.T. (1957). An ordination of the upland forest communities of Southern Wisconsin. *Ecol. Monog*, **27**: 325-349.

Canfield, R. (1941). Application of the line-intercept method in sampling range vegetation. *J. For*., **39**: 288-394.

Clifford, H.T. (1959). Seed dispersal by motor vehicles *J. Ecol*. **47**, 311 - 315.

Dansereau, P. and K. Lems. (1957). *The grading of dispersal types in plant communities and their ecological significance*. Montrèal:, *Contrib. Inst. Bot., Univ. Montrèal*, **71**: 1 - 52.

Drar, M. (1952). A report on *Kochia indica* Wight in Egypt. *Bull. Inst. Dèsert. Egypte*, **2**: 54 - 58.

El-Gabaly, M.M., Gewiafel, I.M., Hassan, M.V. and Rozanov, B.G. (1969). Soil and soil regions of U.A.R. *Inst. of Land Reclam. Res. Bull.*, **21**: 1 - 28.

El-Ghandour, M.F.M., Hefny, K., Khalif, J.B. & Atta, S.A. (1983). Suitability of ground water in the Nile Delta region "Egypt" for irrigation. *Middle East Water and Sewage*, **7**: 109 - 120.

El-Hadidi, M.N. and Kosinová, J. (1971). Studies on the weed flora of cultivated land in Egypt. Preliminary survey. *Mitt. Bot. Staatssamml. München*, **10**: 354 - 367.

Eliâs, P. (1984). A survey of the ruderal plant communities of Western Slovakia I. *Feddes Repert.* **95**, 251 - 276.

Frenkel, R.E. (1970). *Ruderal vegetation along some California roadsides*. *Berkeley: Univ. of California* Press. 163 pp.

Grime, J.P. (1979). *Plant Strategies and Vegetation Processes*. *Chichester: J. Wiley & Sons*. 222 pp.

Harper, J. L. (1977). *Population Biology of Plants*. *London: Academic Press*. 892 pp.

Hassib, M. (1951). Distribution of plant communities in Egypt. *Bull. Fac. Sci., Fouad I Univ*., **29**: 59 - 261.

Hejny, S. and Kosinova, J. (1977). Contribution to synanthropic vegetation of Cairo. *Pub. from Cairo Univ. Herb.*, **7 & 8**: 273-286

Houssard, C. Escarrè, J. and Romane, F. (1980). Development of species diversity in some Mediterranean plant communities. *Vegetatio*, **43**: 59-72.

Lausi, D. and Nimis, P.L. (1985). Roadside vegetation in boreal South Yukon and adjacent Alaska. *Phytocoen.*, **13(1):** 103-138.

Magurran, A.E. (1988). *Ecological Diversity and its Measurement*. *London: Chapman and Hall*. 179 pp.

Mucina, L. (1987). The ruderal vegetation of the northwestern part of the Podunajskâ nizina lowland 5. *Malvion neglectae*, *Folia Geobot*. et *Phytotax.*, **22**: 1 - 23.

Pielou, E. C. (1969). *An introduction to mathematical ecology*., *New York: Wiley Interscience*. 286 pp.

Rose, R. J. and Webb, N.R. (1994). The Effect of temporary ballast roadways on heathland vegetation. J. of *Appl*. *Ecol*., **31**: 642 - 650.

Sargent, C. (1984). Britain's *railway vegetation*. *Cambridge: Institute of Terrestrial Ecology*. 34 pp.

SAS (1985). *SAS / STAT User's Guide*. *Cary: SAS Institute Inc.* 956 pp.

Shaltout, K.H. (1994). Post-agricultural succession in the Nile Delta region. *J. Arid Environ*., **28**: 31 - 38.

Shaltout, K.H. and El-Beheiry, M.A. (1996). Phytomass and nutrient status of *Kochia indica*, a promising fodder plant in Egypt. Flora, 191: 1 - 7.

Shaltout, K.H. and El-Halawany, E.F. (1992). Weed communities of date plam in Eastern Arabia. *Qatar Univ. Sci*. J., **12**: 105-111.

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.

Shaltout, K. H., Sharaf El-Din, A. and El-Fahar, R. A. (1992). Weed communities of the common crops in the Nile Delta region. *Flora*, **187**: 329 - 339.

Shaltout, K. H. and El-Shiekh M.A. (1991). Gradient analysis of canal vegetation in Nile Delta region. *Feddes Repert.*, **102**: 639 - 645.

Shaltout, K. H. and El-Shiekh, M.A. (1993). Vegetation environment relations along water courses in the Nile Delta region . *J. Veg. Sci*., **4**: 567 - 570.

Shaltout, K. H., Sharaf El-Din, A. and El-Shiekh M. A.: (1994). Species richness and phenology of vegetation along irrigation canals and drains in the Nile Delta, Egypt. *Vegetatio*, **112**: 35 - 43.

Shelter, S.G. and Skog, L.E. (1978). *A provisional checklist of species for flora of North America*.: *MABIFNA Missouri Botanical Garden*.

Simpson, N. D. (1932). *A report on the weed flora of the irrigation channels in Egypt. Cairo: Ministry of Public Works, Government Press*.

Spencer, H. J., Scott, N. E., Port, G. R. and Davison A. W. (1988). Effects of roadside conditions on plants and insects. I. Atmospheric conditions *J. Appl. Ecol.*, **25**: 699-707.

Täckholm, V. (1974). *Students' flora of Egypt*. *Cairo: Cairo Univ*. Press. 888 p.

UNESCO (1977). Map of the w*orld distribution of arid regions*. *MAB Technical Notes 7*.

Whittaker, R. H. (1972). Evolution and measurement of species diversity. *Taxon*, **21**: 213-251.

Zahran, M. E., El-Demerdash, M.A. and Mashaly. I. A. (1990). Vegetation types of the deltaic Mediterranean coast of Egypt and their environment. *J. Veg. Sci.*, **1**: 305-310.