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A preliminary study on the vegetation of the Mediterranean coastal land at Bousseli (Egypt)

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ABSTRACT

The study area encompasses a number of habitats, each of which shelters a fairly distinct vegetation. The unstabilised dunes are dominated by *Elymus farctus*, and the stabilized dunes and sand shadows by *Echinops spinosissimus, Echium sericeum, Artemisia monosperma, Stipagrostis lanata* and *Ephedra alata*. The most common species in the abandoned fields are *Inula crithmoides, Cynodon dactylon* and *Phragmites australis*. Salt marshes covered by sand deposits from adjacent dunes are codominated by *Stipagrostis lanata* and *Inula crithmoides*. Salt flats are codominated by *Halocnemum strobilaceum, Schanginia aegyptiaca* and *Salicornia fruticosa*. Close to the water level in the canal banks, *Phragmites australis, Typha domingensis* and *Conyza dioscoridis* dominate. In orchards, the most common species are *Polypogon monspeliensis, Echinops spinosissimus, Stipagrostis lanata, Lolium perenne, Rumex pictus* and *Conyza linifolia*. In the fields cultivated for vegetables, *Cakile maritima* and *Rumex pictus* dominate.

The vegetation composition of the study area is more related to the deltaic coastal vegetation than to that of the coastal region west of Alexandria, probably due to the greater similarities in soil characteristics and human activities.

INTRODUCTION

The Mediterranean coastal land of Egypt may be distinguished into three main geographical provinces: a western province between Sallum and Rosetta, a deltaic province between Rosetta and Damietta (Fig. 1), and an eastern province between Damietta and Rafah. The ecology of the area in the eastern province between Damietta and Port Said had been studied by Serag (1986), and that of the deltaic province had been surveyed by Zahran *et al.* (1985). The western province may be differentiated into two zones, east and west of Alexandria, which differ distinctly in the nature of their deposits. Vegetation and environment of the zone west of Alexandria had been extensively studied (Migahid & Ayyad 1959; Tadros & El-Sharkawy 1960; Rezk 1970; Migahid *et al.* 1971; Ayyad & Hilmy 1974; Ayyad & El-Bayyoumy 1980; Ayyad & El-Ghareeb 1982, 1984; Kamal 1982; Abdel-Razik *et*

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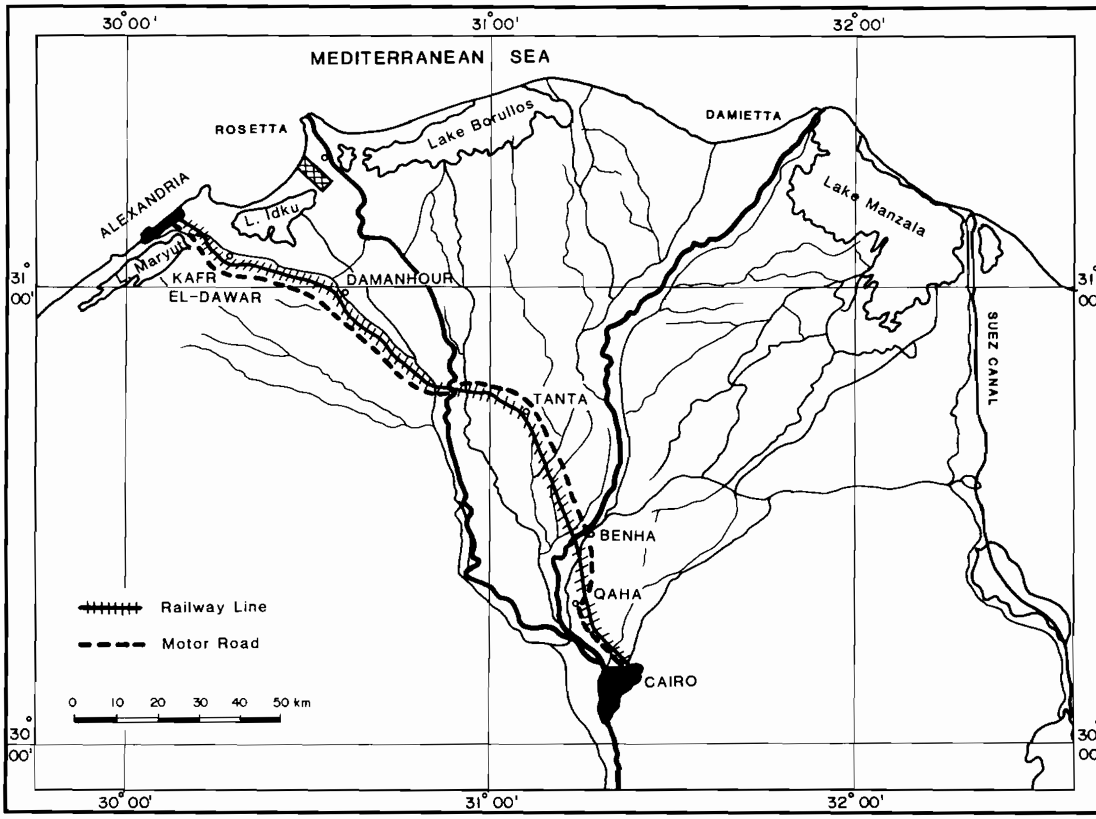

Fig. 1. Map of the Nile Delta region showing the location of the study area (cross-hatched rectangle).

al. 1984). On the other hand, the zone between Alexandria and Rosetta has received lesser attention. The present study aims at providing a description of the vegetation variations in various habitats of this zone. It also attempts to discuss some of the factors involved.

THE STUDY AREA

The area selected for the present study is in the form of a belt transect, 5 km broad, and about 7 km long, extending from the Alexandria-Rosetta railroad at Bousseli town to the sea shore. It lies between Long. 30° 15′ and 30° 27′ E and Lat. 31° 15′ and 31° 25′ N (Fig. 2).

Geological studies on the western Mediterranean coast of Egypt (including the study area) suggest that the formations are essentially Quaternary and Tertiary (Shukry *et al.* 1956; Shata 1957; Said 1962). The geological map prepared by Shata (1957) indicates that the subsurface is formed of Miocene strata, about 30 m thick, overlain by pink limestone, tentatively assigned to Pliocene; surface deposits are Pleistocene.

The shore is characterised by an abundance of black sand which is deposited mainly on the beaches near Damietta and Rosetta (Said 1962). Black sand is carried

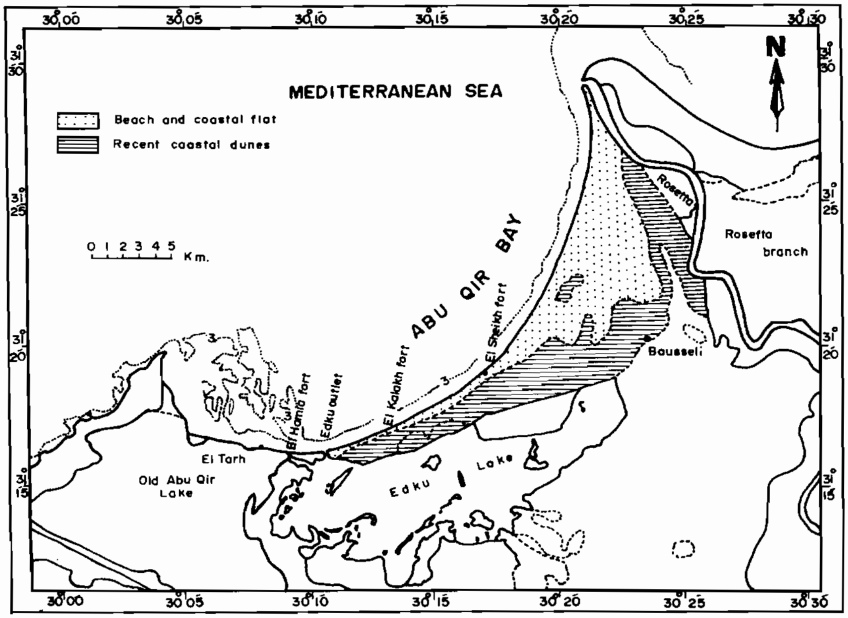

Fig. 2. Map of the eastern subregion of the western Mediterranean coast of Egypt showing the position of Bousseli (after Frihy 1975).

with the Nile alluvium and deposited at its mouths. The sand is elutriated by the prevailing northwesterly winds which spread them over the Rosetta branch, and carry the light-weight quartz particles to the deltaic flats beyond.

The Mediterranean coastal zone between Abu-Qir and the Rosetta Nile branch may be divided into the following geomorphological units: (a) beach and coastal flats; (b) recent coastal dunes; (c) lake Edku; (d) old dunes, and (e) lake deposits (Frihy 1975).

The study area is included in Emberger's Mediterranean isoclimatic zone (Le Houérou 1981), the dry arid zone (Bwh) of Köppen's system (Trewartha 1954), and the mesothermal province of Thornthwaite (1948). The bioclimatic map of UNESCO (1979) designates its climate as arid with mild winter and warm summer.

The soils of the study area were analysed by Tadros & Rezk (1969), and were found to have low content of calcium (0.2%), and magnesium (0.08%), and high content of fine sand (85%).

METHODS

Forty-two stands were selected for sampling the vegetation in the study area. These stands covered the main physiographic variations. In selecting each stand, care was taken to secure a reasonable degree of physiographic and physiognomic homogeneity. Eight main physiographic categories were distinguished: (1) unstabilised dunes, lying close to the seashore; (2) stabilised dunes distinguished into the leeward side, the windward side, and the summit; (3) fields abandoned owing to rise of underground saline water; (4) salt marshes covered by sand deposits from adjacent dunes; (5) salt flats; (6) canal banks; (7) cultivated orchards; and (8) cultivated crop fields. Each of these categories was represented by at least five stands.

A floristic list was prepared for each stand. Species abundance was assessed visually and given an abundance rating using the Domin scale (Kershaw 1973).

RESULTS

The total number of perennial species recorded in the various habitats of the study area is forty-two (Table 1). In general, the most common perennial species are *Echium sericeum*, *Echinops spinosissimus*, *Artemisia monosperma* and *Lotus creticus* (recurrence >60%). However, these species are not necessarily the most abundant in their stands. Less common perennials (recurrence >30%) are *Launaea nudicaulis*, *Inula crithmoides*, *Stipagrostis lanata*, *Cynodon dactylon*, *and Ephedra alata*.

The number of annuals encountered in the present study is fifty-two (Table 1). Of these *Rumex pictus*, *Plantago squarrosa* var. *brachystachys*, and *Daucus litoralis* are recorded in at least 83% of the stands. *Senecio desfontainei*, *Reichardia tingitana* and *Mesembryanthemum crystallinum* are recorded in at least 60% of the stands. Less common annuals are *Aegilops bicornis*, *Centaurea glomerata*, *Conyza linifolia*, *Cutandia memphitica*, *Erodium gruinum*, *E. laciniatum*, *Ifloga spicata*, *Cakile maritima*, *Sonchus oleraceus* and *Salsola kali*; each attains a recurrence of not less than 40%.

About 27% of the species encountered in the present study are restricted to a narrow coastal strip (about 15 km broad) along the Mediterranean (Täckholm 1974). About 19% of the species are also present in this coastal strip, and extend their distribution to the Nile delta and the newly reclaimed lands of the Libyan and Eastern deserts. Other species (54% of the total) have wider amplitudes and extend their ranges to other regions in Egypt (Table 1).

The windward slopes of the unstabilised dunes are devoid of vegetation, possibly due to the mobility of the substrate. The leeward slopes of these dunes, however, shelter 7 species of which *Elymus farctus* and *Ifloga spicata* are the more common.

The stabilised dunes provide a richer habitat (42 species). The most common perennials are *Echinops spinosissimus*, *Echium sericeum*, *Ephedra alata*, and *Artemisia monosperma*. The most common annuals in this habitat are *Rumex pictus*, *Ifloga spicata*, *Daucus litoralis*, *Centaurea glomerata* and *Plantago squarrosa* var. *brachystachys*.

The most common perennials in the abandoned fields are *Inula crithmoides*, *Cynodon dactylon*, and *Phragmites australis*. Less common perennials are *Tamarix nilotica* and *Aeluropus lagopoides*. *Schanginia aegyptiaca* and *Spergularia diandra* are the most abundant annuals in this habitat.

New sand deposits cover vast salt marsh areas and are codominated by *Stipagrostis lanata* and *Inula crithmoides*. The most common annual species are *Ifloga spicata*, *Ononis serrata* and *Erodium gruinum*.

The coastal salt marshes extending from the foot of the youngest dunes to the sea shore are codominated by *Halocnemum strobilaceum* and *Salicornia fruticosa*. The most common annuals are *Halopeplis amplexicaulis*, *Spergularia marina* and *Senecio desfontainei*.

The inland salt marshes (bordering the irrigation canals) are dominated by *Salicornia fruticosa*. Less common perennials are *Inula crithmoides* and *Cynodon*

Table 1. Recurrence percentages, life forms and average ratings of abundance of species recorded in various habitats of the study area (spring 1986). — = absent; 1 = scarce, cover < 1%; 2 = very scattered, cover 1–5%; 3 = scattered, cover > 5–10%; 4 = abundant, cover > 10–15%; 5 = very abundant, cover > 15%. Th. = therophyte; Cr. = cryptophyte; Hc. = hemicryptophyte; Ch. = chamaephyte; Ph. = phanerophyte. (+ +) = Mediterranean species restricted to the coastal strip; (+) = Mediterranean species penetrating deeper in the Nile delta; (0) = species extending their range of distribution to other phytogeographical regions. Species are arranged in decreasing order of recurrence.

Species*	Life form	Recurrence (%)	Unstabilised dunes	Stabilised dunes: Windward slopes	Stabilised dunes: Leeward slopes	Stabilised dunes: Summit	Abandoned fields	Sand sheets over salt marshes	Coastal salt marshes	Canal banks	Cultivated fields	Orchards
(A) Perennials												
Echium sericeum Vahl (+)	Hc.	64·6	—	4	3	3	—	2	—	—	—	1
Artemisia monosperma Del. (0)	Ch.	60·8	—	1	5	3	—	—	—	—	—	—
Echinops spinosissimus Turra (0)	Ch.	60·8	2	2	5	4	—	—	—	—	—	3
Lotus creticus L. (+)	Cr.	60·8	—	—	2	4	—	2	—	—	2	—
Stipagrostis lanata (Forssk.) De Winter (0)	Cr.	34·2	—	—	5	—	—	5	—	—	—	3
Cynodon dactylon (L.) Pers. (0)	Cr.	30·4	—	—	—	—	4	—	—	4	—	—
Ephedra alata Decne (0)	Ph.	30·4	—	—	4	4	—	—	—	—	—	—
Inula crithmoides L. (0)	Ch.	30·4	—	—	—	—	5	5	1	4	—	—
Launaea nudicaulis (L.) Hook. f. (0)	Hc.	30·4	2	—	—	4	—	—	—	—	—	—
Phragmites australis (Cav.) Trin. ex Steud. (0)	Cr.	19·0	—	—	—	—	4	2	1	5	—	—
Tamarix nilotica (Ehrenb.) Bge. (0)	Ph.	19·0	—	—	—	2	—	4	2	—	—	—
Conyza dioscoridis (L.) Desf. (0)	Ch.	15·2	—	—	—	—	1	—	—	5	3	—
Alhagi maurorum Medic. (0)	Hc.	11·4	—	—	—	—	2	—	—	2	—	—
Cyperus capitatus Vand. (+)	Cr.	11·4	—	—	3	3	—	—	—	—	—	—
Lolium perenne L. (0)	Cr.	11·4	—	—	2	—	—	—	—	1	2	3
Lotus corniculatus L. (0)	Cr.	11·4	—	—	—	2	2	—	—	—	3	—
Polygonum equisetiforme Sibth. & Sm. (0)	Cr.	11·4	—	—	—	—	2	2	—	2	—	—
Salicornia fruticosa (L.) L. (+)	Ch.	11·4	—	—	—	—	—	—	5	5	—	—
Sporobolus spicatus (Vahl) Kunth (0)	Cr.	11·4	—	—	—	—	—	2	1	—	—	—
Aeluropus lagopoides (L.) Trin. ex Thw. (0)	Cr.	7.6	—	—	—	—	—	4	2	—	—	—
Elymus farctus (Viv.) Runem. (+ +)	Cr.	7·6	5	—	—	—	—	—	—	—	—	—
Cyperus laevigatus L. (0)	Cr.	7·6	—	—	—	—	2	—	—	1	—	—
Juncus acutus L. (0)	Cr.	7·6	—	—	—	—	2	—	—	—	—	—
Lippia nodiflora (L.) Michx. (0)	Cr.	7·6	—	—	—	—	2	—	—	2	—	—
Lycium europaeum L. (+)	Ch.	7·6	—	—	—	2	—	—	—	—	—	—
Polygonum salicifolium Brouss. ex Willd. (0)	Cr.	7·6	—	—	—	—	—	—	—	4	—	—
Saccharum spontaneum L. (0)	Cr.	7·6	—	—	4	1	—	—	—	2	—	—

Table 1. *(continued)*

Species*	Life form	Recurrence (%)	Unstabilised dunes	Stabilised dunes: Windward slopes	Stabilised dunes: Leeward slopes	Stabilised dunes: Summit	Abandoned fields	Sand sheets over salt marshes	Coastal salt marshes	Canal banks	Cultivated fields	Orchards
Zygophyllum album L. f. (0)	Ch.	7·6	—	—	—	—	—	—	2	—	—	—
Aegialophila pumila (Jusl.) Boiss. (+ +)	Cr.	3·8	—	—	2	3	—	—	—	—	—	—
Astragalus tomentosus Lam. (+)	Cr.	3·8	—	—	2	—	—	—	—	—	—	—
Atriplex halimus L. (+)	Ch.	3·8	—	—	—	2	—	—	—	—	—	—
Carex extensa Good. (0)	Cr.	3·8	—	—	—	—	—	—	—	2	—	—
Ceratophyllum demersum L. (+)	Cr.**	3·8	—	—	—	—	—	—	—	2	—	—
Cistanche phelypaea (L.) Cout. (0)	Ch.	3·8	—	—	—	—	—	—	2	—	—	—
Cynanchum acutum L. (+)	Ch.	3·8	—	—	—	—	—	—	—	—	2	—
Halocnemum strobilaceum (Pallas) M. Bieb. (0)	Ch.	3·8	—	—	—	—	—	—	5	—	—	—
Heliotropium curassavicum L. (+)	Cr.	3·8	—	—	—	1	—	—	—	—	—	—
Imperata cylindrica (L.) Beauv. (0)	Cr.	3·8	—	—	—	—	2	—	—	—	—	—
Juncus rigidus C. A. Mey. (0)	Cr.	3·8	—	—	—	—	2	—	—	—	—	—
Panicum turgidum Forssk. (0)	Cr.	3·8	—	—	3	—	—	—	—	—	3	—
Sporobolus virginicus (L.) Kunth (0)	Cr.	3·8	—	—	—	—	—	—	1	—	—	—
Typha domingensis Pers. (0)	Cr.	3·8	—	—	—	—	—	—	—	5	—	—
(B) Annuals												
Daucus litoralis Sibth. & Sm. (+)	Th.	83·6	—	5	2	2	—	2	—	—	3	3
Rumex pictus Forssk. (+)	Th.	83·6	2	1	5	4	—	2	2	—	5	5
Plantago squarrosa var. *brachystachys* Boiss. (+)	Th.	83·6	—	—	4	5	—	1	—	—	1	2
Mesembryanthemum crystallinum L. (+ +)	Th.	60·8	—	—	4	1	—	—	—	2	4	2
Reichardia tingitana (L.) Roth (0)	Th.	60·8	—	2	2	3	—	1	—	—	3	3
Senecio desfontainei Druce (0)	Th.	60·8	2	—	4	2	—	—	4	2	4	2
Aegilops bicornis (Forssk.) Jaub. & Sp. (0)	Th.	46·0	—	—	4	2	—	—	—	—	2	—
Erodium laciniatum (Cav.) Willd. (+ +)	Th.	46·0	—	—	—	4	—	2	—	—	—	1
Ifloga spicata (Forssk.) Sch. Bip. (0)	Th.	46·0	5	3	4	3	—	3	—	—	—	—
Conyza linifolia (Willd.) Täckh. (0)	Th.	45·6	1	—	—	—	—	—	—	2	1	5
Launaea tenuiloba (Boiss.) Kuntze (+)	Th.***	45·6	—	—	—	—	—	2	2	—	3	3
Centaurea glomerata Vahl (+)	Th.	42·2	—	—	3	4	—	—	—	—	—	—
Erodium gruinum (L.) L'H'er. (+)	Th.	42·2	—	—	—	4	—	3	—	—	—	2
Cakile maritima Scop. (+)	Th.	41·8	—	—	1	—	—	—	—	—	5	3
Cutandia memphitica (Spreng.) Benth. (+)	Th.	41·8	2	—	2	2	—	1	2	—	2	2
Salsola kali L. (+)	Th.	41·8	—	—	—	—	—	—	2	—	3	3
Sonchus oleraceus L. (0)	Th.	41·8	—	—	—	—	—	—	—	2	3	3
Ononis serrata Forssk. (+)	Th.	30·4	—	—	—	3	—	3	—	—	1	3
Bromus scoparius Jusl. ap. L. (+)	Th.	22·8	—	4	1	—	—	—	—	1	—	—

Species*	Life form	Recurrence (%)	Unstabilised dunes	Stabilised dunes: Windward slopes	Stabilised dunes: Leeward slopes	Stabilised dunes: Summit	Abandoned fields	Sand sheets over salt marshes	Coastal salt marshes	Canal banks	Cultivated fields	Orchards
Chenopodium murale L. (+ +)	Th.	22·8	—	—	—	—	—	—	—	—	2	1
Chenopodium ambrosioides L. (0)	Th.	15·2	—	—	—	—	1	—	2	4	3	3
Melilotus indica (L.) All. (0)	Th.	15·2	—	—	—	—	2	—	—	4	3	—
Picris radicata (Forssk.) Less. (+)	Th.	15·2	—	—	—	1	—	—	—	—	—	—
Schanginia aegyptiaca (Hasselq.) Aellen (+)	Th.	15·2	—	—	—	—	5	—	—	5	2	—
Amaranthus ascendens Lois. (+ +)	Th.	11·4	—	—	—	—	—	—	—	3	1	2
Brassica tournefortii Gouan (0)	Th.	11·4	—	—	1	4	—	—	—	—	—	—
Lolium rigidum Gaudin (+)	Th.	11·4	—	—	3	—	2	—	—	1	2	—
Portulaca oleracea L. (0)	Th.	11·4	—	—	—	—	—	—	—	—	1	1
Setaria verticillata (L.) P. Beauv. (0)	Th.	11·4	—	—	—	—	—	—	—	—	—	1
Silene setacea Viv. (+)	Th.	11·4	—	—	—	1	—	—	—	—	—	1
Spergularia marina (L.) Griseb. (0)	Th.	11·4	—	—	—	—	—	—	4	—	—	—
Beta vulgaris L. (0)	Th.	7·6	—	—	—	—	—	—	—	2	1	—
Coronopus didymus (L.) Sm. (+)	Th.	7·6	—	—	—	1	—	—	—	—	—	—
Emex spinosus (L.) Campd. (0)	Th.	7·6	—	—	—	—	—	—	—	2	—	—
Juncus bufonius L. (0)	Th.	7·6	—	—	—	—	2	—	—	—	—	—
Kochia indica Wight (+)	Th.	7·6	—	—	—	—	—	—	—	—	4	2
Lophochloa cristata (L.) Hyl. (+)	Th.	7·6	—	—	3	—	—	—	—	—	3	—
Lotus halophilus Boiss. et Sprun. (+)	Th.	7·6	—	—	—	—	—	2	—	—	—	—
Polypogon monspeliensis (L.) Desf. (0)	Th.	7·6	—	—	—	—	3	—	—	3	3	4
Schismus barbatus Thell. (0)	Th.	7·6	—	—	—	1	—	—	—	—	—	—
Aegilops kotschyi Boiss. (0)	Th.	3·8	—	—	—	3	—	—	—	—	—	—
Amberboa lippii (L.) DC. (0)	Th.	3·8	—	—	—	—	—	—	—	—	3	—
Anagallis arvensis L. (0)	Th.	3·8	—	—	—	—	2	—	—	—	—	—
Anchusa milleri Willd. (0)	Th.	3·8	—	—	—	2	—	—	—	—	—	—
Chenopdium album L. (+ +)	Th.	3·8	—	—	—	—	—	—	—	—	2	—
Halopeplis amplexicaulis (Vahl) Ung. Sternb. (+)	Th.	3·8	—	—	—	—	—	—	4	—	—	—
Hordeum marinum Huds. (+)	Th.	3·8	—	—	—	4	—	—	—	—	—	—
Malva parviflora L. (0)	Th.	3·8	—	—	—	—	—	—	—	—	4	—
Polygonum aviculare L. (+)	Th.	3·8	—	—	—	—	1	—	—	—	—	—
Spergularia diandra (Guss.) Boiss. (0)	Th.	3·8	—	—	—	—	4	—	—	3	—	—
Sphenopus divaricatus (Gouan) Rchb. (+ +)	Th.	3·8	—	—	—	—	—	—	2	—	—	—
Urtica urens L. (+)	Th.	3·8	—	—	—	—	—	—	—	2	—	—

* Nomenclature follows Täckholm (1974). Dr. T. A. Cope (Kew) verified the determination of grasses.

** Hydrophyte

*** Biennial

dactylon. The common annuals are *Schanginia aegyptiaca*, *Spergularia diandra*, *Chenopodium ambrosioides* and *Amaranthus ascendens*.

Close to the water level in the canal banks, *Phragmites australis*, *Typha domingensis* and *Conyza dioscoridis* dominate. In the stream, *Ceratophyllum demersum* forms nearly a pure community.

The main human activity in the study area is agriculture. Sand depressions between dunes and borders of salt marshes are densely cultivated. There are two major types of cultivation: orchards of fruit trees (mainly pear, apple, guava and date palm), and vegetables such as water melon, tomato, and egg plant. Agricultural practices including irrigation from the Nile and drainage water, ploughing, application of insecticides, fertilizers and clearing of weeds, create distinct types of habitat.

In orchards, the most common perennials are *Echinops spinosissimus*, *Stipagrostis lanata* and *Lolium perenne*. The most common annuals are *Polypogon monspeliensis*, *Rumex pictus* and *Conyza linifolia*.

In the fields cultivated for vegetables, *Lotus corniculatus*, *L. creticus*, *Conyza dioscoridis* and *Lolium perenne* are the only perennials recorded. The most common annuals are *Cakile maritima* and *Rumex pictus*.

In terms of species number, the richest habitats are those of stabilised sand dunes (harbouring 42 species), canal banks (33 species) and cultivated fields (31 species).

The exposure of dune slopes is of great influence on species composition and abundance. While 33 species are recorded on the summit of the stabilised dunes, 12 species are recorded on the windward slopes and 23 on the leeward slopes. Species which are present only on the leeward slopes are *Ephedra alata*, *Astragalus tomentosus*, *Aegialophila pumila*, *Lolium perenne*, *Cyperus capitatus*, *Mesembryanthemum crystallinum*, *Brassica tournefortii*, *Plantago squarrosa*, *Centaurea glomerata*, *Senecio desfontainei*, *Aegilops bicornis*, *Bromus scoparius*, *Lolium rigidum*, and *Lophochloa cristata*. Those which are recorded only on the summit are *Atriplex halimus*, *Silene setacea*, *Coronopus didymus*, *Lotus corniculatus*, *Erodium gruinum*, *Anchusa milleri*,

Table 2. Life form spectrum of the vegetation of the study area as a whole and in various habitat types.

Habitat	Phanerophytes	Chamaephytes	Hemicryptophytes	Cryptophytes	Therophytes
Unstabilised dunes	0·0	14·3	3·3	25·4	57·1
Summit of stabilised dunes	3·5	15·0	3·2	19·0	59·3
Leeward slope of stabilised dunes	7·2	20·0	3·2	15·0	54·6
Windward slope of stabilised dunes	0·0	25·0	3·2	21·8	50·0
Abandoned fields	0·0	10·0	5·0	45·0	40·0
Sand sheets over salt marsh	5·0	10·0	5·0	30·0	50·0
Coastal salt marshes	5·3	21·6	0·0	26·2	42·1
Canal banks	0·0	11·6	5·3	35·9	47·1
Cultivated fields	0·0	6·5	0·0	12·9	80·6
Cultivated orchards	0·0	11·1	3·2	4·2	81·5
Percentage of the total flora	2·16	11·68	3·19	27·65	55·32

Heliotropium curassavicum, *Picris radicata*, *Aegilops kotschyi* and *Hordeum marinum*. The abundance of most species (e.g. *Rumex pictus*) is higher on the leeward side than on the windward side of the stabilised dunes.

The life form spectrum (Table 2) indicates that therophytes form the highest percentage (55%) of the flora in the study area, followed by cryptophytes (28%) and chamaephytes (12%). Phanerophytes attain the lowest percentage (2%). However, these percentages vary from one habitat to the other. Therophytes attain maximum percentages in the cultivated orchards (82%) and the habitat of cultivated fields (81%), and a minimum percentage (40%) in the abandoned fields. On the other hand, the cryptophytes attain maximum percentages in the abandoned fields (45%) and canal banks (36%), and a minimum percentage (4%) in the cultivated orchards.

DISCUSSION

The western Mediterranean coastal land of Egypt may be differentiated into two zones (Hilmy 1951). The first includes the zone east of Alexandria (which includes the site of the present study) in which the sands are poor in carbonate and consist mainly of quartz grains, shell fragments, and an abundance of heavy metals. The percentage of calcium carbonate is markedly lower than in the zone west of Alexandria, and the percentage of fine sand and clay is higher (Tadros & Rezk 1969). These sands are water-borne sediments derived mainly from the Abyssinian plateau and subsequently mixed with shell fragments on the beach. On the other hand, the sands in the zone west of Alexandria are mainly carbonate oolites with a few shell fragments and almost no heavy minerals.

These differences in the physical and chemical characters of sands of the two zones seem to be reflected in their vegetation composition. In the western zone, the vegetation on all dune formations is dominated by *Ammophila arenaria* but with distinctly lower abundance on stable than on active dunes (Ayyad 1973). On the other hand, the vegetation of the active dunes in the eastern zone as recorded in the present study is characterized by the dominance of *Elymus farctus* and the absence of *Ammophila arenaria*. The vegetation of the highly stabilised dunes and the sand shadows, in the western zone, is codominated by two or more of the following species: *Euphorbia paralias*, *Crucianella maritima*, *Echinops spinosissimus*, *Ononis vaginalis*, *Pancratium maritimum* and *Thymelaea hirsuta* (Ayyad 1973; Ayyad & El-Bayyoumy 1980; Kamal 1982). In the eastern zone, the vegetation on similar sand formations is codominated by *Echinops spinosissimus*, *Echium sericeum*, *Artemisia monosperma*, *Stipagrostis lanata*, and *Ephedra alata*. Most of these species as well as *Plantago squarrosa*, *Rumex pictus* and *Ifloga spicata*, which are common annuals in the study area, were not recorded in the western coastal dunes, but in other less calcareous habitats (Kamal 1982; Abdel Razik *et al.* 1984). Some of the dominant species on the deltaic coastal dunes to the east of the study area (Zahran *et al.* 1985; Serag 1986), are rated as common in the area of the present study, e.g. *Echinops spinosissimus*, *Cyperus capitatus*, *Stipagrostis lanata*, *Cutandia memphitica*, *Cakile maritima* and *Reichardia tingitana*. This indicates that the vegetation of the study area may be more related to the deltaic coastal vegetation than to the vegetation of the region west of Alexandria. This may be attributed to similarities in soil characteristics of the study area with those of the deltaic coastal dunes. In both regions, the percentage of calcium carbonate is less than 2%, the percentage of fine sand is more than 85%, and the water holding capacity ranges from 26–30% (Tadros & Rezk 1969; Serag 1986). Other soil characteristics may also be involved.

Some species which are common weeds in the fertile fields of the Nile delta are also recorded in the cultivated habitats of the present study (e.g. *Portulaca oleracea, Beta vulgaris, Emex spinosus, Urtica urens, Lippia nodiflora, Amaranthus ascendens, Anagallis arvensis, Conyza linifolia, Sonchus oleraceus, Cynodon dactylon, Imperata cylindrica* and *Polypogon monspeliensis*). The propagules of these species may have reached the study area by the irrigation canal of Rashidiah, or the Bousseli drainage canal. These species are not recorded in the coastal dunes of the western zone but some were recorded in Wadi Habis, 300 km west of Alexandria (El-Hadidi & Ayyad 1975).

Various workers have found differences in plant response to calcium supply (e.g. Jefferies & Willis 1964; Clarkson 1965; Ramakrishnan 1968). The strong relationship between the amount of calcium in the soil and its pH has led to a confusion between the separate effects of calcium and pH and a tendency to term all plants from soils with a high pH as calcicolous (i.e. lime-dwelling) and those from soils with low pH as calcifugous (i.e. lime-fleeing). Some ecologists have attempted to avoid this confusion by using the terms basiphilous (base-loving) for plants which occur on soils characterised by high pH but low calcium levels (e.g. serpentinic soils). The opposite of this term would be acidophilous, i.e. acid-loving (Bannister 1980).

If the effects of calcium alone are considered, then calcicoles would be expected to be tolerant to high levels of calcium and possibly to have a high requirement for the element. Calcifuges would be expected to have low tolerance and be able to subsist on soils low in calcium. Accordingly, the species of the western Mediterranean coastal dunes of Egypt (extending from Rosetta to Sallum) could be classified into three categories according to the percentage of $CaCO_3$ in their habitats:

(1) $CaCO_3$-dwelling: species restricted to the western zone only (from Alexandria to Sallum), e.g. *Ammophila arenaria, Euphorbia paralias, Crucianella maritima, Ononis vaginalis, Jasonia candicans, Hyoseris lucida, Pancratium maritimum, Allium erdelii* and *Lygaeum spartum.*

(2) $CaCO_3$-fleeing: species restricted to the region east of Alexandria (i.e. absent west of Alexandria), e.g. *Stipagrostis lanata, Ephedra alata, Cyperus capitatus, Carex extensa, Plantago squarrosa* and *Astragalus tomentosus.*

(3) $CaCO_3$-indifferent: species common to both regions, i.e. east and west of Alexandria, e.g. *Elymus farctus, Echium sericeum, Echinops spinosissimus, Lycium europaeum* and *Cakile maritima.* Most of these species have a greater phenotypic plasticity, and may include ecological races (ecotypes) with overlapping amplitudes.

Dunes contain a diverse and specialised flora adapted not only to each geographic area but also to each facet of the dune (Tinley 1985). One of these facets is dune exposure. The present study indicates that the leeward slopes are richer in vegetation composition and species abundance than the windward slopes, which may be attributed to the injurious effects of wind. Another important facet is the process of dune formation. In the early stages, coastal dunes are unstable, and their soils are loose, coarse, poor in nutrients and probably saline. Few species can tolerate these adverse conditions. In the present study, the embryo dunes are overwhelmingly dominated by *Elymus farctus* (syn. *Agropyron junceiforme*). This species dominates also many of the European foredunes (Chapman 1976) and may be considered as the pioneer species in the psammosere. It is endowed with the ability of dune fixation, and of furnishing a less hostile habitat for other species such as *Echinops spinosissimus*, *Echium sericeum*, *Artemisia monosperma* and *Ephedra alata* which become more and more common until they dominate the stable dunes.

In the present study, the number of species recorded on the stabilised dunes (42) is notably higher than on the active dunes (7). Similar records were made by Ayyad (1973), Ayyad & El-Bayyoumy (1980) on the coastal dunes west of Alexandria. Chapman (1976) refers to similar reports from the coastal dunes of Sweden and the Atlantic coastal dunes of France.

The life form spectrum of the study area reflects a typical desert flora (Table 2). The majority of species are either therophytes (55·32%) or cryptophytes (perennial ephemeroid herbs) (27·65%). Both are "drought evaders"; the greater parts of the photosynthetically-active and transpiring organs are shed during the unfavourable season. The majority of other perennials in the study area are evergreen shrubs or sub-shrubs (chamaephytes). These are "drought-enduring" plants. The relative percentage of life forms vary with habitat; chamaephytes acquire dominance in more saline, less sandy habitats, and therophytes in less saline, more sandy habitats. Similar results had been recorded in other regions in Egypt (Zahran 1977, 1982; Ayyad & El-Ghareeb 1982; El-Ghareeb & Adel-Razik 1985; Serag 1986). On a global scale, Chapman (1960) reports that the vegetation of coastal dunes and salt marshes is essentially hemicryptophytic, with a tendency towards greater abundance of chamaephytes and therophytes towards eastern Europe and Asia.

The vegetation composition in the study area is mainly a product of land-use practices and human activities that have dominated the coastal region east of Alexandria during the last few decades. Artificial fixation of dunes started around 1936 by erecting reed fences and propagating selected trees capable of dune fixation, e.g. species of *Acacia*, *Eucalyptus*, *Prosopis*, *Casuarina* and *Tamarix* (El-Kholy 1983). The inhabitants were then encouraged to grow vegetables and fruit trees among the dunes. The general practice in these cultivations is flood irrigation which, with inadequate drainage, results in increasing salinity of upper soil layers. Inhabitants are now moving enormous quantities of sand from adjacent dunes to their fields in order to build up less saline layers of soil. But the problem, in fact, can be solved only by applying proper irrigation and drainage methods. Another practice which threatens efforts of rehabilitation and restoration of agroecosystems in the study area is the removal of sand for use in brick industry. This of course results in soil degradation, eradication of vegetation cover, and restraining the ecosystem succession towards stability.

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دراسة تمهيدية عن الكساء الخضري للساحل الشمالي لمصر بمنطقة البوصيلي

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خلاصة

يتناول هذا البحث بالدراسة الوصفية توزيع الكساء الخضري على الأراضي الساحلية بمنطقة البوصيلي الواقعة على بعد حوالي ٣٥ كيلومترا شرق الاسكندرية (مصر) . وأجريت الدراسة باختيار ٤٢ موقعا تمثل في مجملها معظم الإختلافات البيئية الظاهرة بالمنطقة . وتقع هذه المواقع على امتداد قطاع شريطي طوله ٧ كيلومتر وعرضه ٥ كيلومتر .

وفي كل موقع من هذه المواقع سُجل تواجد وغزارة أفراد كل من الأنواع النباتية المعمرة والحولية . وقد أمكن تمييز ثماني بيئات بمنطقة الدراسة ، تتميز كل منها بخصائص طوبوغرافية معينة ، كما أمكن تحديد الأنواع النباتية السائدة بكل بيئة . وقد أظهرت الدراسة اختلاف تركيب الكساء الخضري بالمنطقة عنه في الأراضي الساحلية الواقعة غرب الاسكندرية ، وعزى ذلك إلى الزراعةالمكثفة بمنطقة الدراسة واختلاف صفات التربة بالمنطقتين .

*العنوان الحالي : قسم العلوم بكلية التربية الأساسية ، الشامية ٧١٥٠٩ ، الكويت .