PART IV

RESULTS

In the present study the results are divided into two main groups:

I- Graminaceous species II- Non- Graminaceous species

I- Graminaceous Species

These include: 1) *Ammophila arenaria*, 2) *Elymus farctus* and 3) *Halopyrum mucronatum*

Gramineae (Poaceae) comprises about 670 genera and 10,000 species, cosmopolitan, mostly annual or perennial herbs with rhizomes or stolons. Gramineae characterized by stems (culms) are cylindrical usually hollow in the internodes and solid in the node. Leaves mostly solitary at the nodes, alternate with sheath encircling the culm. Inflorescence composed of spiklets arranged in a panicle or racemes. Flowers usually bisexual, perianth represented by 2 (-3) minute or fleshy scales called lodicules; stamens hypogenous 1-6 rarely more with anthers opening by a longitudinal slit or a terminal pore; ovary one locular with one ovule; styles usually two rarely one or three with plumose stigma. Fruit a caryopsis with thin pericarp adnate to the seed. Seeds with starchy endosperm. In Egypt Gramineae is classified into 18 tribes and 20 subtribe including 109 genera. The studied species belong to three tribe namely: Aveneae, Eragrostideae and Triticeae (Cope & Hosni 1991 and Bolous 2005).

1-*Ammophila arenaria* (L.) Link.

1.1. Taxonomical features

Ammophila (Tribe Aveneae) comprises two species, *Ammophila arenaria* (European beach grass) and *Ammophila breviligulata* (American beach grass). The Egyptian flora includes *Ammophila arenaria.* Some recent floras, divided *Ammophila arenaria* into two subspecies namely: *arenaria* and *arundinacea.* Subspecies *arundinacea* H. Lindb., differs from subspecies *arenaria* by their long callus-hairs and glumes only slightly (not distinctly) exceeding the floret. Subspecies *arenaria* is distributed and confined to the Atlantic coast of Europaea while the other has narrower distribution, confined to the Mediterranean region. In Egypt, *Ammophila arenaria* grows only in the Mediterranean coastal sand dunes from Rafah in the northeast of Sinai westward to Sallum in northwest never recorded in any other parts of the Egyptian deserts (Täckholm 1974, Huiskes 1979a, Cope & Hosni 1991 and Bolous 2005). This species can be classified taxonomically according to (Engler and Prantel system 1924-1942, Täckholm 1974; Cope & Hosni 1993 and Bolous 2005) as follow:

Family	: Gramineae (Poaceae)
Tribe	: Aveneae
Sub-tribe	: Alopecurinae
Genus	: *Ammophila*
Species	: *arenaria*
Subspecies	: *arenaria*

Ammophila arenaria (L.) Link., Hort. Berol. 1: 105 (1827)
Arundo arenaria L., Sp. Pl. ed. 1, 82 (1753).
Ammophila arundinacea Host, Gram. Austr. 4: 24, t 41 ff. 1, 2 (1809). Nom. Illeg.
Ammophila littoralis (Beauv.) Rothm., Feddes Repert. 52: 269 (1943).

Psamma littoralis Beauv., Agrost. 143, t. 6 f. 1 (1812)
Psamma arenaria (L.) Roem. & Schult., Syst. Veg. 2: 843 (1817).

Syn. according to Feinbrun-Dothan (1986) and Bolous (2005)

Arabic names: Gazzouf, (جزوف)

English names: Marram grass, European beach grass

1.1.2. Macro- morphological characters:

Ammophila arenaria is a tall seashores perennial grass with a deep and extensive woody creeping rhizomes. Culms glabrous, cylindrical, erect, with yellow or greenish color, up to 120 cm tall (up to 145 cm in Egypt "figure 2"), many-nodded (4-9 nodes/culm); internodes cylindrical, usually hollow 3-48 cm long. Leaf blades, rigid, long, narrow, velvety-pubescent on the upper surface soon becoming involute, up to 60 cm long and 6 mm wide(13-69 cm long and 3-6 mm width) when opened out with pungent apex; Leaf-sheath, ribbed, round, not hairy, split with overlapping edges; ligule, 2-fid, membranous 1-3 cm long. Inflorescence a contracted, elongated, spike-like panicle up to 30 cm long (table 9, figure 3), oblong to cylindrical, straw-coloured; spiklet yellowish, large, 1-flowered, 10-12 mm long, with rhachilla-extension, strongly laterally compressed; rhachilla disarticulating above the persistent glumes; glumes persistent, narrowly lanceolate, usually acute to acuminate, equal or sub equals, the lower 10-12 mm with 1-nerved , the upper 10-13 mm with 3 to 5-nerved and enclosing the floret; lemma thinly coriaceous, lanceolate, sharply keeled, 2-denticulate at the tip, usually as long as glumes and with a tuft of fine white hairs at its base; callus-hairs 4-6 mm long; stamens 3; ovary glabrous; fruit, a caryopsis, free, oblong-obovoid, grooved on venteral face, hilum linear. Flowering period of *Ammophila arenaria* started in the winter season till spring (from early March to late

April) followed by fruiting, seed dispersal directly in May and June. Plant is vegetative in winter and spring season (See figure 4, 5 and 6).

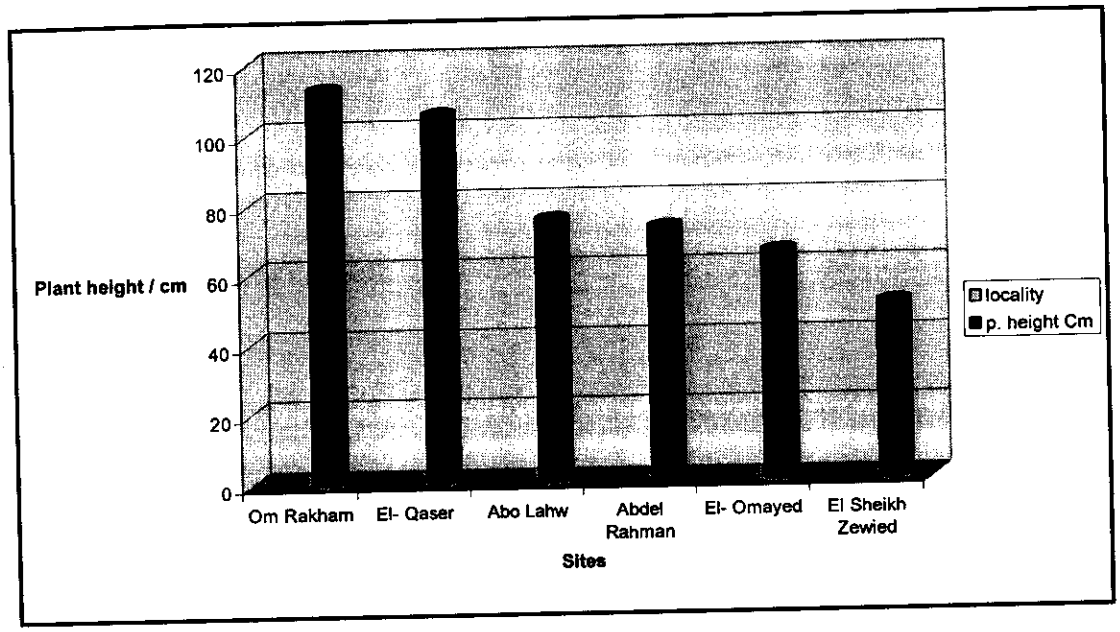


Figure (2): Histogram showing height of *A. arenaria* in different sites.

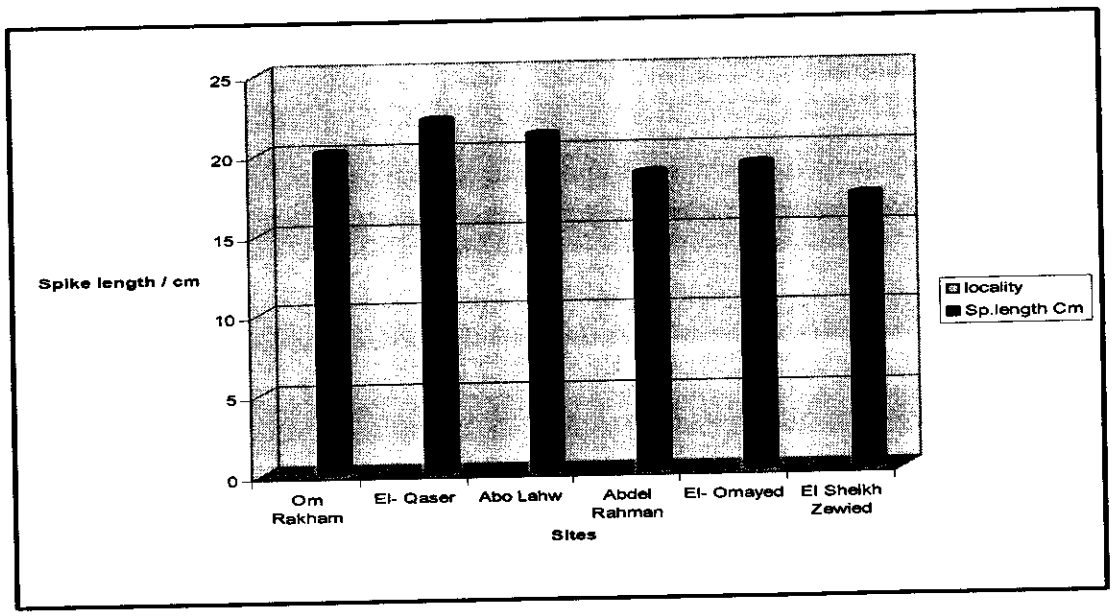
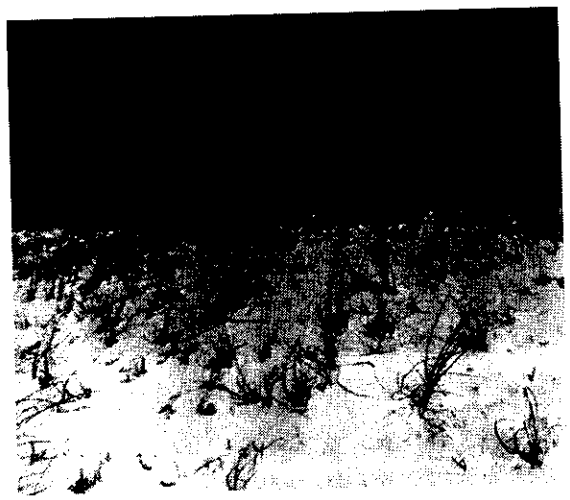


Figure (3): Histogram showing spike length of A. *arenaria* in different sites.

(4)



(5)

Figure (4): Close up views of the inflorescences of *Ammophilla arenaria* growing on calcareous coastal sand dunes of Sidi Sidi Abdel Rahman site, western Med. Coast (20 / 5 / 2004).

Figure (5): General view of the community of *Ammophilla arenaria* growing on the calcareous coastal sand dunes of El Omayed site, western Med. Coast (20 / 5 / 2004) .

Figure (6): Community dominated by *Ammophilla arenaria* associated with *Otanthus maritima* on the calcareous coastal sand dunes of El Omayed site, western Med. Coast (20 / 5 / 2004).

1.1.2. Micro- morphological characters:

1.1.2.1. Culm anatomy

Culms of *Ammophilla arenaria* are circular in outline in cross section (Figure 7 a). Epidermis of the plant grown at Om Rakham site shows small compact lignified epidermal cells followed by 2-4 ring of thin cellulosic compact cells containing chlorophyll (chlorenchyma), followed by complete ring of fibers enclosing immature vascular bundles, while the ground tissue shows normal monocot-form (Y-shaped) xylem. The bundle enclosed in lignified bundle sheath, the ground tissues mainly thin cellulosic wall except the transitional cells located between the ring (Figure 7 a& b) of fiber and ground tissues. In case of Sidi Abdel Rahman specimens, the epidermis shows thick cuticle and more lignified cells, the parenchymatous cells contain chlorophyll are changed and become compact, small in size, highly lignified and devoid of chlorophyll, vascular bundles sheath enclosed by more than one layer of lignified cells (Figure 8 c& d).

1.1.2.2. Leaf anatomy

The leaf appear in cross section as typical monocot leaf characterized by absence of mid- rib and presence of mesophyll enclosing the vascular bundles. In the samples collected from Om Rakham site (Figure 9 a &b) showing that the abaxial epidermal system showing normal cuticle followed by thick walled epidermal cells; epidermis followed by thin walled paranchymatous cells extending from the abaxial surface to the adaxial surface of the leaf. From the adaxial surface the epidermis becomes more or less lignified containing unicellular hairs, the stomata are scattered all over this surface with clear substomtal chambers. The epidermal cells followed by large amount of thin cellulosic photosynthetic tissues enclosing the V.B. Each V.B surrounded by one

row of thick walled fiber, while immature V. B is not enveloped by this sheath. In the samples collected from Sidi Abdel Rahman, cuticle is very thick and epidermal cell wall is also thick-lignified. Paranchymatous cells extend from the abaxial surface to the adaxial surface of the leaf is also lignified with narrow stomatal chambers (Figure 10 c & d).

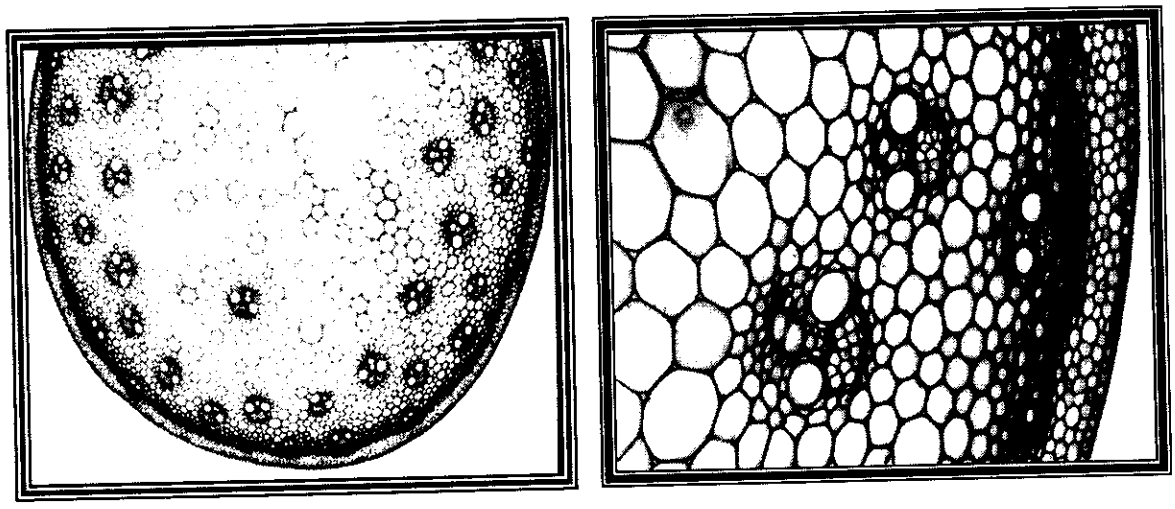
1.2. Geographical distribution

World distribution: *Ammophila arenaria* grows in coasts of the North Africa, Atlantic coast of Europae, east coast of North America and the Mediterranean region to latitude 62° (Huiskes 1979 and Pickart 1997). In Egypt: *Ammophila arenaria* grows only in Mediterranean coastal sand dunes from Rafha in the east to El Sallum in west (Täckholm 1974, Cope & Hosni 1992 and Bolous 2005).

1.3. Ecological features

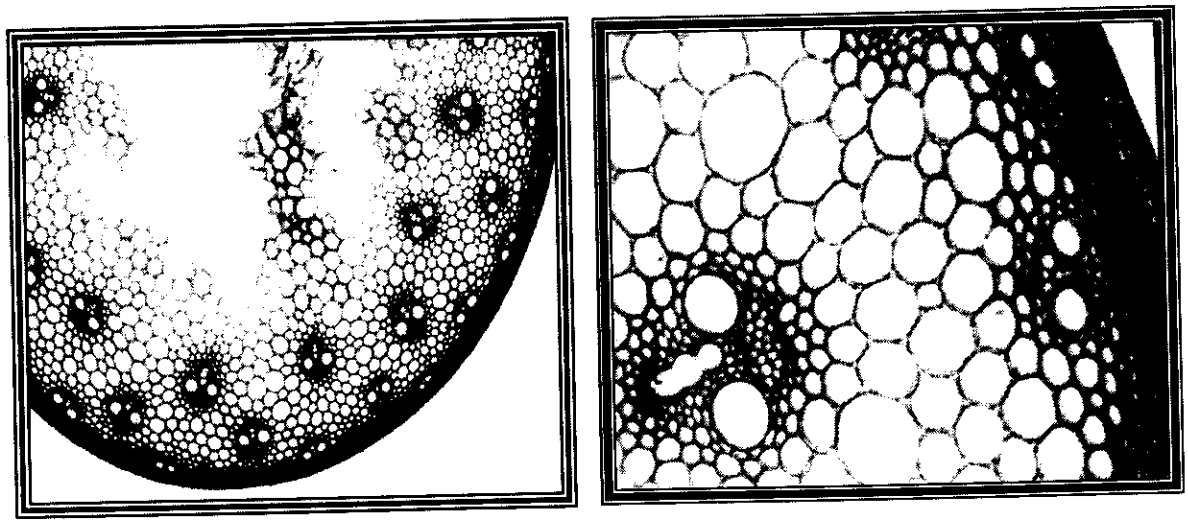
1.3.1. Floristic composition

The floristic composition of the communities dominated by *Ammophila arenaria* include, nineteen species belonging to 11 families. The most characteristic families were Gramineae (21.05%) which represented by four species, *Stipagrostis scoparia, Sporobolus pungens, Lygeum spartum* and *Elymus farctus*. Compositae (21.05%) represented also by four species, *Artemisia monosperma, Hyoseris radiata, Otanthus maritimus* and *Xanthium spinosum.* Each of Chenopodiaceae and Leguminosae (10.52%) were represented by two species each: *Salsola Kali, Atriplex halimus* and *Lotus polyphyllos* and *Ononis vaginalis,* respectively. Tamaricaceae, Zygophyllaceae, Boraginaceae, Amaryllidaceae, Cistaceae Euphorbiaceae and Thymelaceae are represented by one species (5.26%) (table 10).



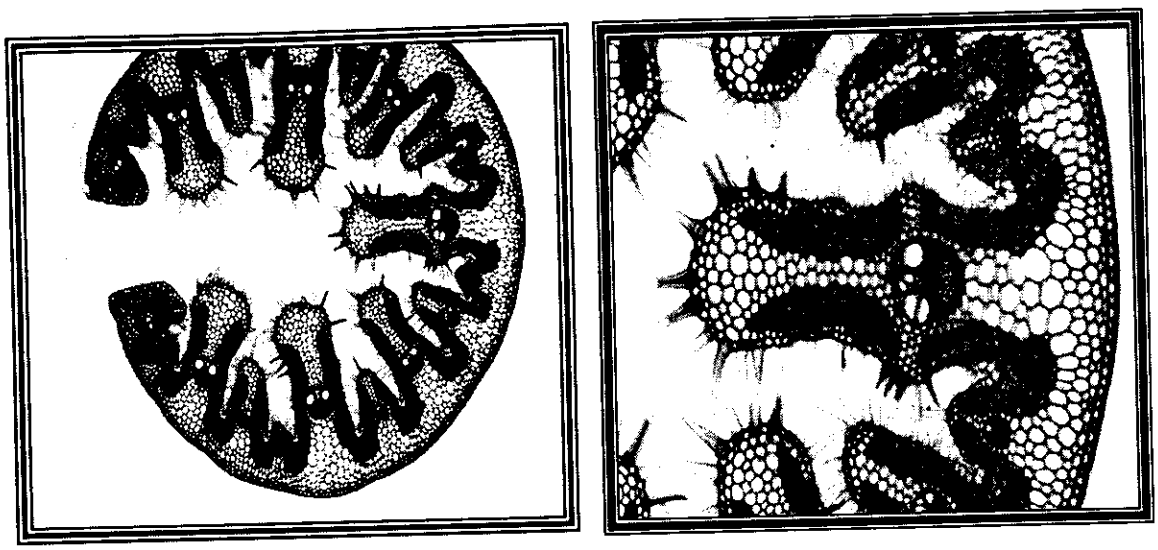
(a) (b)

Figure (7): T.S. in stem of *Ammophila arenaria* collected from the Med. Coastal sand dune at Om Rakham site. (a) Magnification 40 X and (b) Magnification 160 X



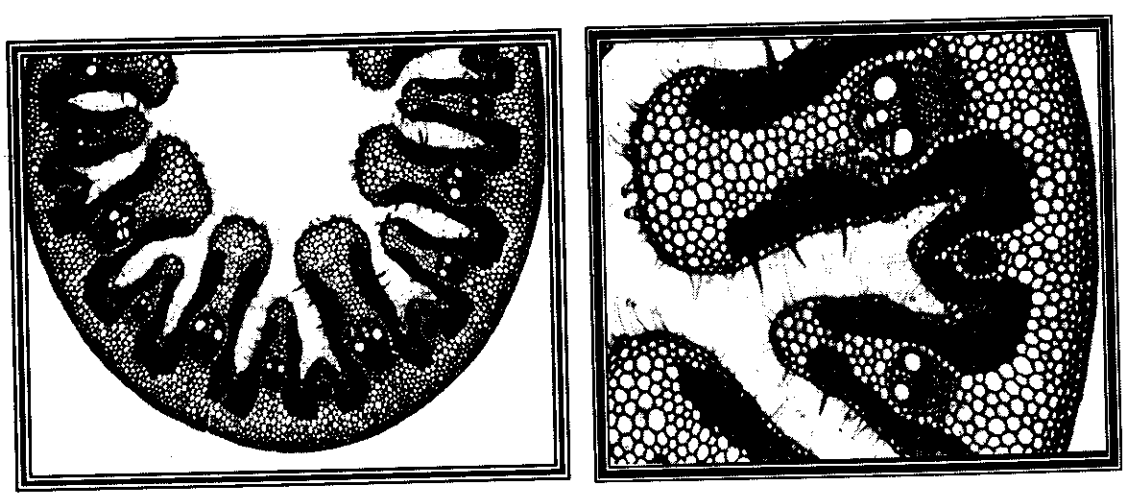
(c) (d)

Figure (8): T.S. in stem of *Ammophila arenaria* collected from the Med. Coastal sand dune at Sidi Sidi Abdel Rahman site. © Magnification 40 X and (d) Magnification 160 X



(a) (b)

Figure (9): T.S. in leaf of *Ammophila arenaria* collected from the Med. Coastal sand dune at Om Rakham site. (a) Magnification 40 X and (b) Magnification 100 X



(c) (d)

Figure (10): T.S. in leaf of *Ammophila arenaria* collected from the Med. Coastal sand dune at Sidi Sidi Abdel Rahman site. (c) Magnification 40 X and (d) Magnification 100 X

1.3.2. Life form

The recorded species associated with *Ammophila arenaria* were belonging to five different life forms. Chamaephyte was the dominant life form recorded (42.10%). It was represented by eight species namely: *Zygophyllum album, Artemisia monosperma, Otanthus maritimus, Euphorbia paralias, Helianthemum lippii, Lotus polyphyllos, Ononis vaginalis* and *Echium angustifolium.* Hemicryptophyte (21.05%) included four species namely: *Stipagrostis scoparia, Sporobolus pungens, Lygeum spartum* and *Elymus farctus.* Phanerophyte (15.78%), includes three species namely: *Tamarix aphylla, Thymelaea hirsuta* and *Atriplex halimus.* Geophytes (10.52%) two species, *Pancratium maritimum* and *Hyoseris radiata. Xanthium spinosum* and *Salsola kali* were the only two Therophytes (10.52%) recorded in the stands dominated by *A. arenarea* (table 10, figure 11).

1.3.3. Chorology

Mono-regional elements were represented by 13 species (68.42%). Nine species were Mediterranean, three species were Saharo–Arabian and one species for Sudanian. **Bioregional** elements were represented by four species (21.05%): two Mediterranean, Saharo-Arabian species and one species for each of Saharo-Arabian, Sudanian and East Mediterranean, West Sahro-Arabian. **Pluriregional** representing 10.52%, two species for pluriregional; boreal-tropical (table 10, figure 12).

also the highest presence value (P = 100%). The abundant species were *Lotus polyphyllos*, *Elymus farctus*, *Tamarix aphylla*, *Euphorbia paralias* and *Sporobolus pungens* with IV value 20.13, 19.71, 13.58, 11.82 and 11.03 and presence value P= 50, 66.66, 16.66, 33.33 and 33.33 % respectively. Five of the remaining fourteen species associated to *Ammophila arenaria* were: *Otanthus maritimus* (IV = 8.65 and P = 16.66 %), *Artemisia monosperma* (IV = 8.49 and P = 16.66%) *Pancratium maritimum* (IV = 7.79 and P = 33.33 %), *Ononis vaginalis*, (IV= 7.09 and P =33.33 %) and *Thymelaea hirsuta*, (IV= 6.53 and P =33.33 %). Seven of remaining nine species were *Atriplex halimus*, *Stipagrostis scoparia*, *Zygophyllum album*, *Hyoseris radiata*, *Helianthemum lippii*, *Echium angustifolium* and *Lygeum spartum* with IV values not exceeding 5.93 (table 11). *Xanthium spinosum* and *Salsola Kali* is the only two annual species recorded.

1.3.5. Soil analysis

1.3.5.1. Physical properties of soil

1.3.5.1.1. Soil texture

Results of the soil mechanical analysis (table 12) showed that the soil supporting growth of *Ammophila arenaria* is sandy. The percentages of coarse fraction (including medium, fine and very fine sand) ranges between 99.3% in Abu Lahw stands and 93.5% in El Sheikh Zuwayid stands. The maximum value of medium sand (9.4%) was recorded in El Omayed site, while its minimum value (0.4%) was in Sidi Sidi Abdel Rahman site. The maximum percentage of fine sand (71.6%) was recorded in Abu Lahw, and its minimum value (30.07%) was in El Sheikh Zuwayid stands. Silt and clay reached its maximum value (6.5%) at subsurface layer (20-40 cm) in El Sheikh Zuwayid stands, and its

minimum value (0.7%) at surface layer (0-20 cm) in Abu Lahw region. From the above results, the soil is coarse in texture, with very little amount of silt and clay (table 12).

1.3.5.1.2. Moisture Content (MC)

Soil moisture content outlined in (table 12) showed that there was gradual increase in value with soil depth. Soil moisture attains its maximum value (3.46 %) at lower layer (20-40cm) in El Omayed stands, while its minimum value (0.63%) at surface layer (0-20cm) in Sidi Abdel Rahman site.

1.3.5.2. Chemical properties

1.3.5.2.1. Soil reaction (pH)

The soil reaction is neutral or slightly alkaline where it ranged between (7.5- 7.92). Soil reaction reached its maximum value (7.92) at surface layer (0-20cm) in El Omayed stands, while their minimum value was (7.5) at the surface layer (0-20 cm) in Om Rakham stands (table 12).

1.3.5.2.2. Electric conductivity (EC)

Table (12) showed that the electric conductivity of the soil supporting the growth of *Ammophila arenaria* is slightly saline where it reached its maximum values 2.8 mmhos/cm at the surface layer (0-20 cm) in El Sheikh Zuwayid stands, while its minimum value was (0.27 mmhos/cm) at the surface layer (0-20 cm) in Om Rakham stands.

1.3.5.2.3. Water soluble anions (Cl^- and SO_4^{--})

The data of soluble anions outlined in (table 12) showed that, the maximum concentration of soluble chloride ions in the studied habitats was (22.4 Meq/L) at the surface layer (0-20 cm) in El Sheikh Zuwayid

stands, while its minimum value was (2.0 Meq/L) at the surface layer (0-20 cm) in Om Rakham stands. This showed the same variation trend of the electrical conductivity. Also soluble sulphates show the same variation trend as soluble chloride ions, where it reached (1.27 Meq/L) as a maximum value at the surface layer (0-20 cm) in El Sheikh Zuwayid site, while its minimum value was (0.23 Meq/L) at the surface layer (0-20 cm) in Om Rakham stands.

1.3.5.2.4. Water soluble cations (Ca^{++}, Mg^{++}, Na^{+} and K^{+})

The soluble calcium ions in the studied habitats reached its maximum value (6.0 Meq/L) at the surface layer (0-20 cm) in El Sheikh Zuwayid site, while its minimum value was (1.93 Meq/L) at the surface layer (0-20 cm) in Om Rakham stands. While magnesium ions reached its maximum value (3.4 Meq/L) at the surface layer (0-20 cm) in El Sheikh Zuwayid site, while its minimum value was (0.65 Meq/L) at the surface layer (0-20 cm) in Om Rakham stands. Sodium ion was the major soluble cation in the soil supporting the growth of *Ammophila arenaria* it reached (30.0 Meq/L) at the surface layer (0-20 cm) in El Sheikh Zuwayid site as a maximum value, its minimum value was (1.02 Meq/L) at the surface layer (0-20 cm) in Om Rakham. Table (12), indicated that the soil salinity induced by sodium chloride in El Sheikh Zuwayid site. Potassium ion concentration was also show the same variation trend as other soluble cations, where, it reached its maximum value (0.66 Meq/L) at the surface layer (0-20 cm) in Sidi Abdel Rahman site, while its minimum value was (0.20 Meq/L) at the surface layer (0-20 cm) in Om Rakham stands.

1.3.5.2.5. Calcium Carbonate ($CaCO_3$)

Ammophila arenaria grows in soil with high percentages of calcium carbonate $CaCO_3$ and can be used as indicator for it. The

maximum value (96%) of $CaCO_3$ was recorded at the surface layer (0-20 cm) in Om Rakham stands, while its minimum value was (32%) at the subsurface layer in El Sheikh Zuwayid site (table 12).

1.3.5.2.6. Organic Carbon (OC)

Soils supporting the growth of *Ammophila arenaria* plant are very poor in organic carbon content. Percentages of organic carbon reached (0.07%) as a maximum value at surface layer of El Sheikh Zuwayid stands respectively while its minimum value (0.01%) at surface of El Qasser site (table 12).

1.4. Uses

Ammophila arenaria is a sea- shores perennial grass widely used as an efficient sand-binder plant and planted for that purpose. Younger shoots of *A. arenaria* were eaten by rabbits but their influence is very local where less than 1 % of the *A. arenaria* standing crop was lost by rabbit predation in Grampian region (Britain). Sheep and cattle are grazing on *A. arenaria* standing but the species is avoided if there are alternatives. Also small mammals eat its seeds. Some insects feed on the plant leaves and used them as a host for reproduction (Huiskes 1979 and Pickart 1997).

Table (9): Morphologicai characteristics measured as mean value: culms, leaf and spike of *Ammophila arenaria* at different localities.

Locality	Culm (aerial stem = ahaulm)					Leaf				Spike		
	plant Height (cm)	Width of Patch (cm)	Number of culm / Patch	Number of Lateral / culm	Length of Internodes (cm)	Length of Leaf blade (cm)	Width of Leaf blade (mm)	Length of Leaf Sheath (cm)	Number of Leaf / culm	Length of Spike (cm)	Number of Flower / Spikelet	Length (Spike :Culm Ratio (cm)
El Omayed	65.0	40.0	30.0	4.0	10.0	36.0	5.0	13.0	6.0	19.0	1.0	0.3
Abdel Rahman	72.5	43.0	19.0	2.0	21.0	38.0	4.0	19.0	6.0	18.5	1.0	0.25
El Qaser	105.0	50.0	43.0	3.0	25.0	35.0	5.0	18.0	7.0	22.0	1.0	0.21
Om Rakham	112.5	65.0	68.0	7.0	20.0	50.0	4.0	20.0	7.0	20.0	1.0	0.177
Abu Lahw	75.0	30.0	24.0	4.5	20.0	34.0	5.0	11.0	6.5	21.0	1.0	0.28
El Sheikh Zuwyid	50.0	45	52	2.0	9.5	31.0	4.5	12	5.0	17.0	1.0	0.34
Range	40-145	15-95	7-90	1-10	3-48	13-69	3-6	4-30	5-8	17-25	1.0	0.17-0.34

Table (10): Floristic composition of *Ammophila arenaria* community, for each species: chorology, family and life form were mentioned.

Species	Chorology	Family	Life form
Ammophila arenaria	Mediterranean	Gramineae (Poaceae)	Hemicryptophyte
Artemisia monosperma	Saharo-Arabian	Compositae(Asteraceae)	Chamaephyte (semi-shrub)
Atriplex halimus	Mediterranean , Saharo-Arabian	Chenopodiaceae	Phanerophyte (shrub)
Echium angastifolium	Mediterranean	Boraginaceae	Chamaephyte (semi-shrub)
Elymus farctus	Mediterranean extending to south Europe	Gramineae (Poaceae)	Hemicryptophyte
Euphorbia paralias	Mediterranean extending to west Europe	Euphorbiaceae	Chamaephyte (semi-shrub)
Helianthemum lippii	Saharo-Arabian , Sudanian	Cistaceae	Chamaephyte (semi-shrub)
Hyoseris radiata	Mediterranean	Compositae(Asteraceae)	Geophyte
Lotus polyphyllos	West Sahro- Arabian	Leguminosae (Papilionoideae)	Chamaephyte (semi-shrub)
Lygeum spartum	Mediterranean	Gramineae (Poaceae)	Hemicryptophyte
Ononis vaginalis	East Mediterranean, West Sahro- Arabian	Leguminosae (Papilionoideae)	Chamaephyte (semi-shrub)
Otanthus maritimus	Mediterranean	Compositae(Asteraceae)	Chamaephyte (semi-shrub)
Pancratium maritimum	Mediterranean	Amaryllidaceae	Geophyte
Salsola Khali	Pluriregional, boreal-tropical	Chenopodiaceae	Therophyte, (annual)
Sporobolus pungens	Mediterranean	Gramineae (Poaceae)	Hemicryptophyte
Stipagrostis scoparia	Saharo-Arabian	Gramineae (Poaceae)	Hemicryptophyte
Tamarix aphylla	Sudanian	Tamaricaceae	Phanerophyte (tree)
Thymelaea hirsute	Mediterranean , Saharo-Arabian	Thymelaceae	Phanerophyte (shrub)
Xanthium spinosum	Pluriregional, boreal-tropical	Compositae(Asteraceae)	Therophyte, (annual)
Zygophyllum album	Saharo-Arabian	Zygophyllaceae	Chamaephyte (semi-shrub)

Table (11): Importance and Presence values (P %) of the perennial species associated with *Ammophila arenaria* in different localites .(A= EL Omayed, B= Abdel Rahman, C = EL Qasser, D = Om El Rakham, F= Abu Lahw and S= El sheikh Zuwayid)

Species	Site No.						Mean IV	P%
	A	B	C	D	F	S		
A-Dominant species								
Ammophila arenaria	143.5	181.34	180.0	172.4	130.44	190.58	166.37	100
B- Associated species								
a- perennials:								
Artemisia monosperma	-	-	-	-	-	50.98	8.49	16.66
Atriplex halimus	-	-	-	-	35.59	-	5.93	16.66
Echium angustifolium	-	-	-	15.1	-	-	2.51	16.66
Elymus farctus	-	44.12	33.8	13.83	26.51	-	19.71	66.66
Euphorbia paralias	34.9	-	-	-	36.05	-	11.82	33.33
Helianthemum lippii	-	-	-	20.89	-	-	3.48	16.66
Hyoseris radiata	-	-	11.11	20	-	-	5.18	33.33
Lotus polyphyllos	51.5	-	51.8	17.52	-	-	20.13	50
Lygeum spartum	-	-	-	10.88	-	-	1.81	16.66
Ononis vaginalis	-	-	22.85	19.7	-	-	7.09	33.33
Otanthus maritimus	51.9	-	-	-	-	-	8.65	16.66
Pancratium maritimum	-	-	-	-	39.57	7.2	7.79	33.33
Sporobolus pungens	-	49.4	-	-	16.81	-	11.035	33.33
Stipagrostis scoparia	-	-	-	-	-	35.42	5.9	16.66
Tamarix nilotica	-	-	-	-	-	81.5	13.58	16.66
Thymelaea hirsuta	-	24.9	-	-	14.91	-	6.53	33.33
Zygophyllum album	17.9	-	-	9.56	-	4.65	5.35	50
b- Annuals								
Salsola Kali	-	-	-	-	-	++	-	-
Xanthium spinosum	-	-	-	-	-	+	-	-

Presence of annual species (+ = rare, ++ = common).

Table (12): Results of physical and chemical analyses of soil supporting *Ammophila arenaria* in different localities (M.C = moisture content, F = fine, s = sand, m = medium, V = very, S +C = Silt +Clay, Fra. = Fraction and O.C = Organic carbon)

Locality	profile depth cm	Physical characters						Chemical characters									
		M.C %	Soil particles %				Sandy fra.%	pH	Ec mmohs / cm	Cations and anions (Meq/L)						O.C %	$CaCO_3$ %
			m.s	F.s	V.F.s	S +C				Ca^{++}	Mg^{++}	Na^{+}	K^{+}	Cl^{-}	SO^{-}_{4}		
El Omayed	0- 20	2.6	9.4	69.2	20.3	1.1	98.9	7.92	0.39	2.12	1.1	1.89	0.31	3.0	0.52	0.02	94.0
	20-40	3.46	9.0	70.0	20.0	1.0	99.0	7.66	0.47	1.4	1.0	2.34	0.36	4.3	0.68	0.01	93.0
Adel Rahman	0- 20	0.63	0.4	56.5	41.2	1.9	98.1	7.61	2.3	3.5	2.57	16.95	0.66	19.5	1.07	0.03	94.0
	20-40	1.85	2.8	58.0	37.1	2.1	97.9	7.57	0.71	2.59	1.32	2.93	0.36	4.9	0.75	0.02	92.0
El Qasser	0- 20	1.95	2.0	43.3	53.2	1.5	98.5	7.80	0.3	2.0	1.1	1.02	0.27	2.8	0.33	0.01	97.0
	20-40	2.52	1.1	38.7	57.9	2.3	97.7	7.56	0.42	2.25	1.83	1.87	0.27	3.8	0.27	0.01	92.5
Om Rakham	0- 20	1.94	6.2	46.5	44.6	2.7	97.3	7.50	0.27	1.93	0.65	1.22	0.20	2.0	0.23	0.02	94.0
	20-40	2.48	2.7	47.5	46.5	3.3	96.7	7.61	0.31	1.54	1.2	1.37	0.23	2.7	0.38	0.01	88.0
Abu Lahw	0- 20	1.26	1.6	71.6	26.1	0.7	99.3	7.62	1.1	2.1	1.4	10.86	0.46	8.9	0.47	0.04	94.0
	20-40	2.44	1.2	63.7	34.2	0.9	99.1	7.76	0.44	1.35	0.7	2.34	0.27	4.4	0.33	0.02	91.0
El Sheikh Zuwyid	0- 20	1.66	2.6	34.0	57.3	6.1	93.9	7.63	2.8	6.0	3.4	30.0	0.65	22.4	1.27	0.07	34.0
	20-40	2.2	1.4	30.0	62.1	6.5	93.5	7.77	0.39	2.5	2.1	3.07	0.51	4.7	0.66	0.04	32.0

2- *Elymus farctus* (Viv.) Runem. ex Melderis

2.1.Taxonomical features

Genus *Elymus* (tribe Triticeae) comprises about 150 species, mostly perennials, distributed in Asia but extending through temperate latitudes of both hemispheres. In Egypt it is represented by three species: *Elymus farctus, Elymus elongates* and *Elymus repens*. The former is distinguished from other two species by fragile rhachis disarticulating at maturity between the spikelets at the base of the internodes. Rhachis of other two species are tough and not disarticulating at maturity. *Elymus farctus* includes four subspecies (*boreali-atlanticus, farctus, rechingeri* and *bessarabicus*), and four varieties, two for subsp. *farctus* (*farctus* and *sartorii*) and the other two for subsp. *bessarabicus* (*bessarabicus* and *striatulus*). According to Boulos (2005), the species is represented in Egypt by subsp. *farctus* (var. *sartorii*) and subsp. *rechingeri*. This species can be classified taxonomically according to (Engler & Prantel system 1924-1942, Täckholm 1979, Cope & Hosni 1991 and Bolous 2005) as follow:

Family	: Gramineae (Poaceae)
Tribe	: Triticeae
Sub-tribe	: Alopecurinae
Genus	: *Elymus*
Species	: *farctus*
Subspecies	: *farctus* var. *sartorii*

Elymus farctus (Viv.) Runem. ex Melderis, Bot. J. Linn. Soc. 76: 382 (1978)
Triticum junceum L., Cent. Pl. I: 6 (1755), non *Elymus junceus* Fischer (1806).
Triticum farctum Viv., Ann. Bot. (Genoa) 1(2): 159 (1804)
Agropyron junceum (L.) P. Beauv., Ess. Agrostogr. 102, 146 (1812).
Elytrigia juncea (L.) Nevski, Trudy Bot. Ins. Akad. Nauk SSSR, ser. 1, Fl. Sist. Vyss. Rast. 2: 83 (1936).

Syn. according to Davis (1985), Feinbrun-Dothan (1986) and Boulos (2005).

English names: Sand couch, Russian Wheatgrass .

2.1.1. Macro- morphological characters

Elymus farctus is a rhizomatous perennial grass with a long creeping rhizome. Culms erect rigid, glabrous, cylindrical, fairly thick, yellow or greenish color. Culm up to 80 cm tall (30-150 cm in Egypt, Figure 13), many-nodded (4-10 node/culm); internodes cylindrical, usually hollow up to 49 cm long. Leaf-blades, rigid, glaucous-green, convolute or flat with inrolled margins, up to 38 cm long and 3-6 mm wide, with elevated veins, densely and minutely pubescent on ribs of the upper surface, glabrous beneath; Leaf-sheaths, round, densely and minutely pubescent 2-21 cm long; ligule, a narrow membranous rim; auricles, absent. Inflorescence, a terminal erect raceme, usually longer than leaves, 10-35 cm long (Figure 14) with 8-12 spikelet (4-13 spikelet in Egypt); rhachis, fragile, disarticulating at the base of each internode, glabrous on the main angles; spikelets, glabrous, awnless, solitary, alternate, sessile, at each node of rhachis, appressed and oriented their laterally compressed broad side towards rhachis, 5-9 flowered (4-8 flower/spikelet in Egypt), 10-25 mm long (19-30 mm long and 5-10 mm

wide in Egypt table 13), falling entire with the rhachis internode; glumes, subequal or unequal, narrowly lanceolate or oblong, indurate- coriaceous 10-18 mm long, with 5-12-veined, asymmetrically keeled, glabrous, obtuse; lemmas 10-18 mm, glabrous, obtuse, keeled toward apex; palea, spinulose-ciliate along keels; stamens 3; anthers 4-10 mm; ovary hairy at apex. Fruit, a fusiform caryopsis with a hairy apical appendage; hilum linear, as long as caryopsis. Flowering period of *Elymus farctus* occurs in spring season (from April to June) followed by fruiting, seed dispersal directly. Plant is vegetative in winter and spring season (see Figure 15, 16 and 17).

2.1.2. Micro- morphological characters

2.1.2.1. Culm anatomy

Culm is circular in outline cross section. Normal epidermis is one layer of horizontally arranged cells covered by thin cuticle layer (Figure 18 a, 19 c), and more or less lignified wall (in case of Sidi Abdel Rahman specimens the epidermis has thick cuticle and more lignified cells (Figure 19 c& d). Epidermis is free from hairs in all specimens collected however, number of stomata are scattered in shallow depressions. Under the stomata there are stomatal chambers, characterized by the presence of parenchyma cells containing chlorophyll (in case of Sidi Abdel Rahman specimens these parenchyma cells are changed and become small in size, lignified and devoid of chlorophyll (Figure 19 c& d). In El Bossaly specimens thin layer (ring) of fiber is interpreted by thin parenchymatous patches containing chlorophyll under substomatal chambers (Figure 18 a&b). Ground tissue of El Bossaly specimens show large thin cellulosic cell wall, while in these of Sidi Abdel Rahman the ground tissues were composed of thin cellulosic small compact cells. Vascular bundles are typical Y- shaped monocot type, scattered in the ground tissue. Bundle

sheath of El Bossaly specimens is formed of 1-2 thin lignified cells while in case of Sidi Abdel Rahman ring of fiber (1-3) small thick lignified cells were enclosed the bundle (Figure 19 c& d).

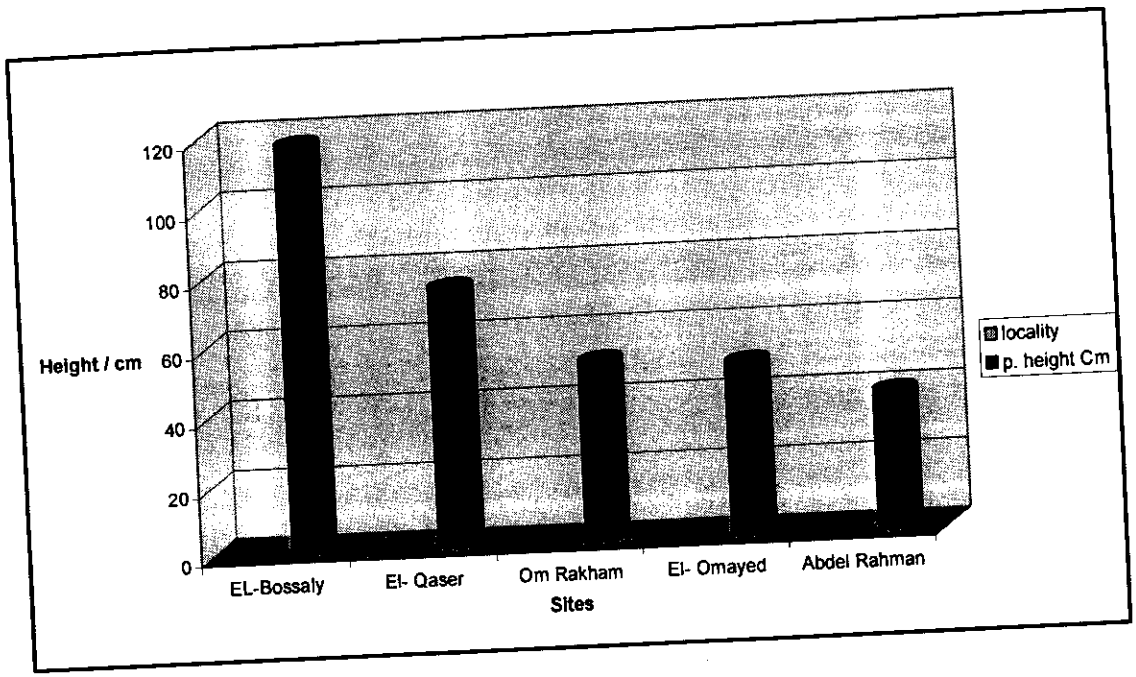


Figure (13): Histogram showing height of *E. farctus* in different sites.

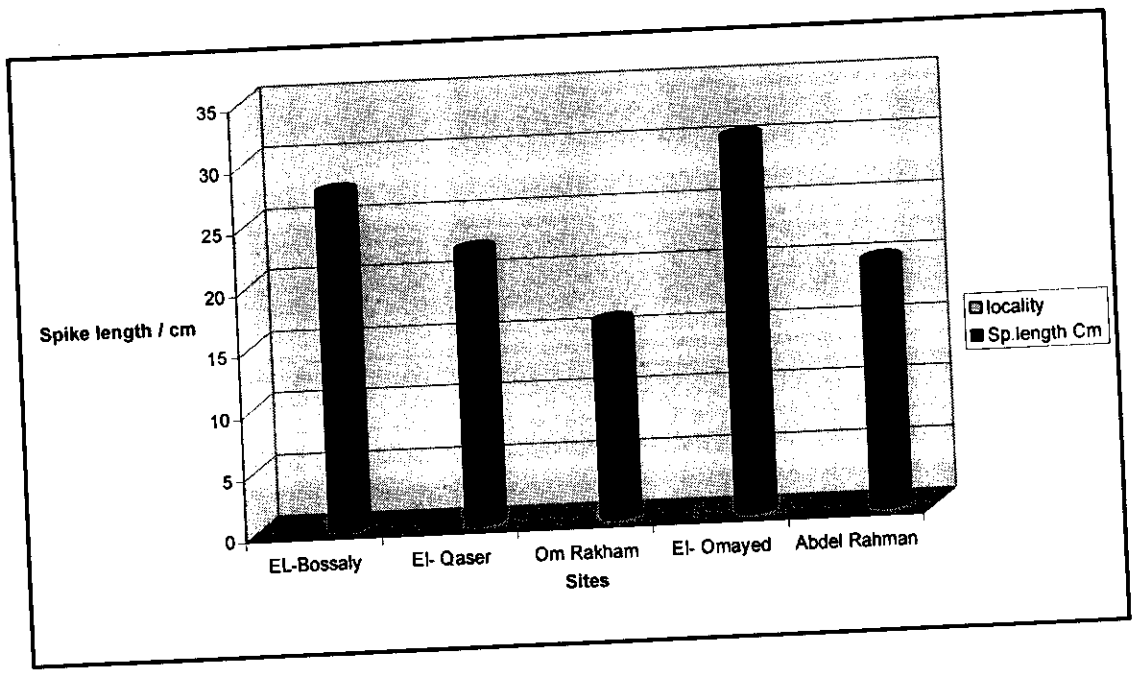


Figure (14): Histogram showing spike length of *E. farctus* in different sites.

(15)

(16)

Figure (15): Close up view of a single flowering patch of *Elymus farctus* growing in coastal sand dunes of El Bossaly site, Med. coast, Egypt (21 / 5 / 2004).

Figure (16): Feeble growth of *Elymus farctus* grown on coastal sand dunes of Sidi Abdel Rahman site, Med. Coast, Egypt (21 / 5 / 2004)..

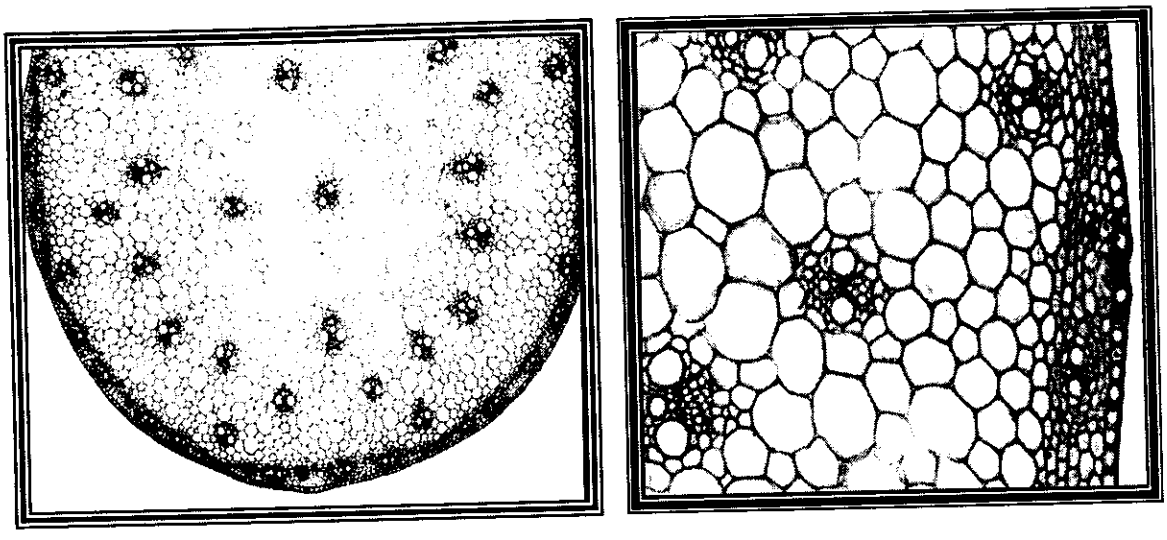
Figure (17): General view of the community of *Elymus farctus* with some associated species as *Phragmites australis, Tamarix nilotica*, coastal sand dunes of El Bossaly site Med. coast, Egypt (21 / 5 / 2004).

2.1.2.2. Leaf anatomy

The leaf appears in cross section as typical monocot leaf characterized by the absence of midrib and presence of mesophyll enclosing the vascular bundles (Figure 20 a &21 c). In the transfer section of *Elymus farctus* leaf in El Bossaly (Figure 20 a &b), the abaxial epidermal system show normal cuticle followed by thick walled epidermal cells; epidermis followed by thin walled paranchymatous cells extends from the abaxial surface to the adaxial surface of the leaf. From the adaxial surface the epidermis become more or less lignified containing unicellular hairs, the stomata are scattered all over this surface with clear substomtal chambers. The epidermal cells followed by large amount of thin cellulosic photosynthetic tissues enclosing the V.B. Each V.B surrounded by one row of thick walled fiber, while immature V. B not enveloped by this sheath (In case of Sidi Abdel Rahman cuticle is very thick and epidermal cell wall is also thick-lignified. Paranchymatous cells extend from the abaxial surface to the adaxial surface of the leaf is also lignified with narrow stomatal chambers (Figure 21 c &d).

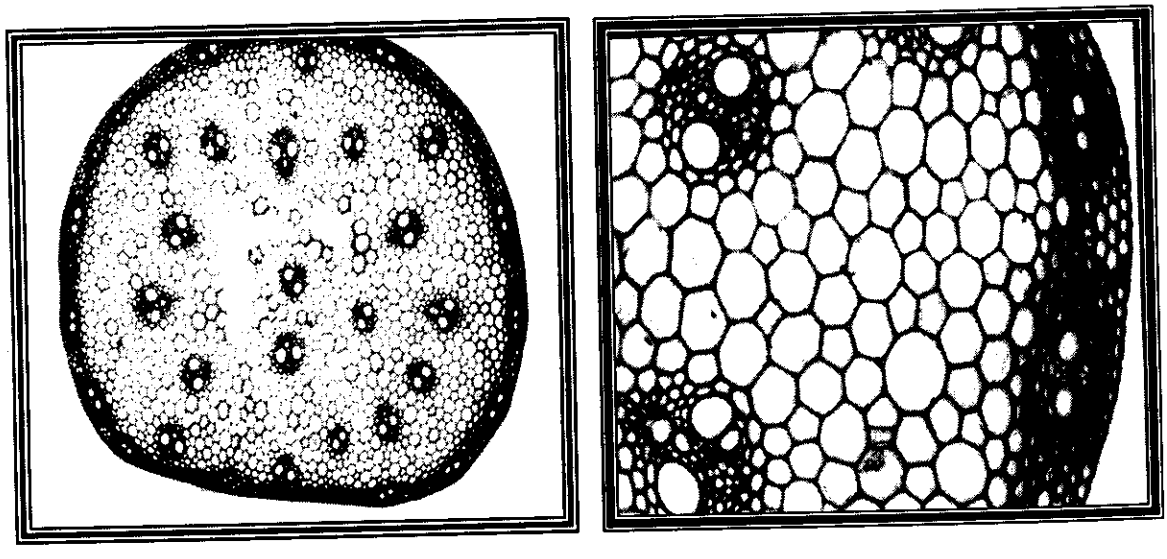
2.2. Geographical distribution

World distribution: *Elymus farctus* grows along the coasts of Europe and the Mediterranean Sea eastwards to the Black Sea. In Egypt, *Elymus farctus* grows only on the Mediterranean coastal sand dunes (Davis 1985, Feinbrun-Dothan 1986 and Boulos 2005).



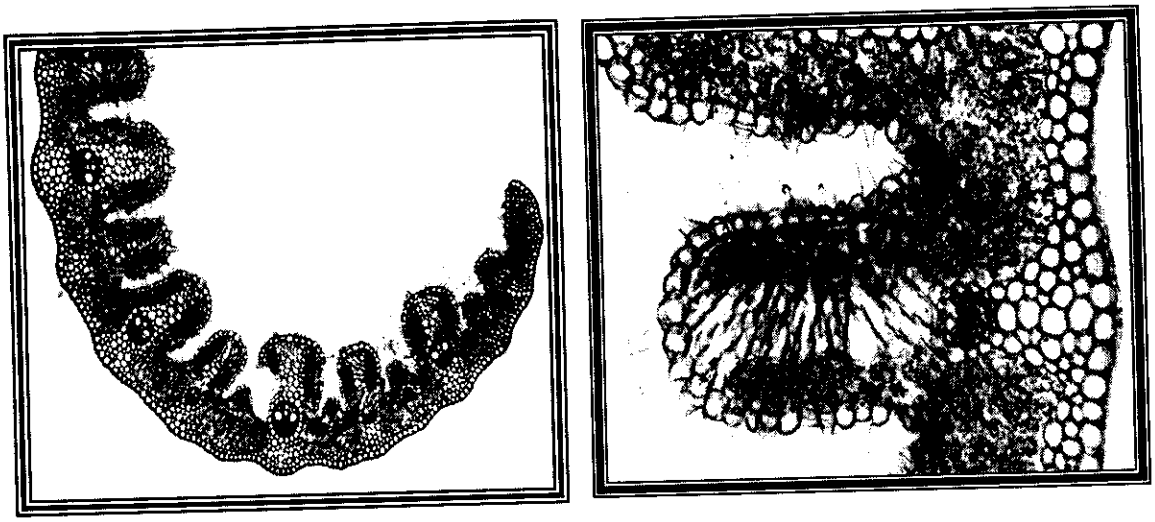
(a) (b)

Figure (18): T.S. in stem of *Elymus farctus* collected from Med. coastal sand dune at El Bossaly site (a) Magnification 40 X and (b) Magnification 160 X



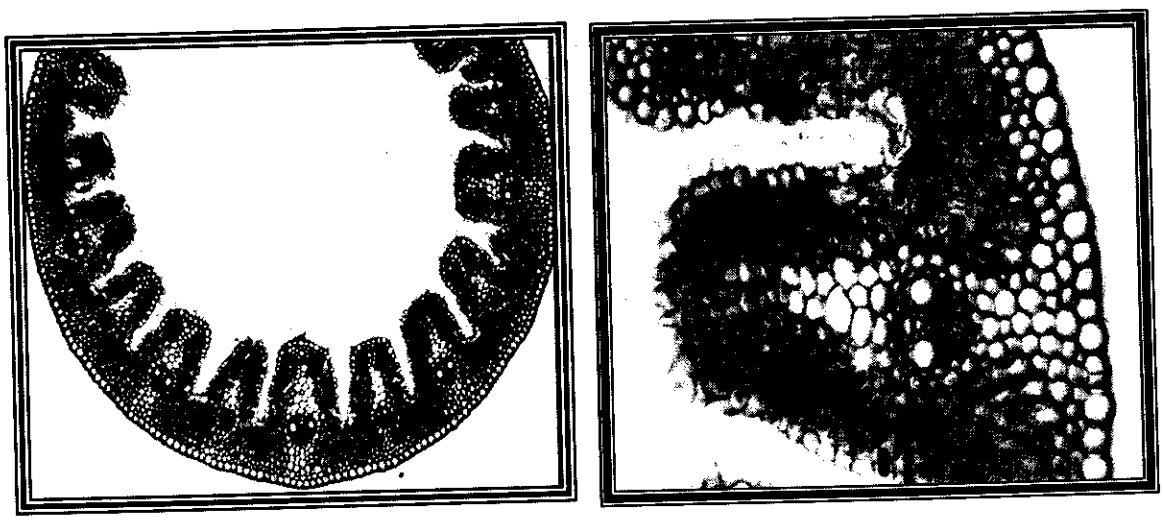
(c) (d)

Figure (19): T.S. in stem of *Elymus farctus* collected from Med. coastal sand dune at Sidi Abdel Rahman site (a) Magnification 40 X and (b) Magnification 160 X



(a) (b)

Figure (20): T.S. in leaf of *Elymus farctus* collected from Med. coastal sand dune at El Bossaly site (a) Magnification 40 X and (b) Magnification 160 X.



(c) (d)

Figure (21): T.S. in leaf of *Elymus farctus* collected from Med. coastal sand dune at Sidi Abdel Rahman site (c) Magnification 40 X and (d) Magnification 160 X.

2.3. Ecological features

2.3.1. Floristic composition

The floristic composition of the communities was dominated by *Elymus farctus* compromises, twenty three species (18 perennials and five annual) belonging to 14 families. Some of these families were represented by four species such as Gramineae (*Phragmites australis, Ammophila arenaria, Sporobolus pungens* and *Stipagrostis lanata*) while others were represented by three species such as Compositae, Leguminosae (*Echinops spinosissimus, Hyoseris radiata, Senecio glaucus* and *Lotus palustris, Lotus polyphyllos, Ononis vaginalis*), respectively. Other families such as Boraginaceae and Caryophyllaceae were represented by two species each: (*Echium angustifolium, Arnebia decumbens* and *Gymnocarpos decander, Silene succulenta*), respectively. Each of the rest families Tamaricaceae, Zygophyllaceae, Rubiaceae, Cyperaceae, Moraceae, Thymelaceae, Cruciferae, Polygonaceae and Umblliferae were represented by one species each (table 14).

2.3.2. Life form

The species associated with *Elymus farctus* is belonging to five different life forms: Chamaephyte (30.43 %) was the dominant life form comprises seven species namely: *Zygophyllum album, Crucianella maritima, Lotus polyphyllos, Ononis vaginalis, Echium angustifolium, Gymnocarpos decander* and *Silene succulenta*. Hemicryptophyte (30.43 %) includes also seven species: *Phragmites australis, Ammophila arenaria, Sporobolus pungens, Stipagrostis lanata, Cyperus capitatus, Lotus palustris* and *Echinops spinosissimus*. Phanerophyte (13.04 %) containing three species (table 14, Figure 22). *Hyoseris radiata* is the only Geophyte (4.34 %) recorded in studied sites. Therophyte (21.73 %) are frequent, especially in El Bossaly stands, it represented by five

species namely: *Cakile maritima, Rumex vesicarius, Daucus guttatus, Senecio glaucus* and *Arnebia decumbens.*

2.3.3. Chorology

Mono-regional elements (73.91 %) are the common chorotype. It represented by 17 species, ten of them were Mediterranean, six species are Saharo–Arabian and one species for Sudanian. **Bioregional** elements (21.73 %) represented as five species (table 14, Figure 23). **Pluriregional** elements (4.34 %) represented as one pluriregional; boreal-tropical species.

2.3.4 Vegetation analysis

Vegetation analysis of the community dominated by *Elymus farctus* (table 15) based on the mean importance value showed, the dominance of *Elymus farctus* with a highest IV value (97.39out of 300) and also the highest presence value (P =100%). The abundant species are *Ammophila arenaria, Lotus polyphyllos, Sporobolus pungens, Hyoseris radiata, Thymelaea hirsuta* and *Echinops spinosissimus* with IV value (51.75, 20.31, 14.66, 12.93, 11.76 and 10.73) and presence value (P= 80, 40, 20, 40, 40 and 60%) respectively. Five of the rest twelve species associated to *Elymus farctus* are: *Ononis vaginalis*, (IV= 9.51 and P =40 %), *Zygophyllum album* (IV = 8.61 and P = 40 %), *Ficus palmata* (IV = 8.55 and P = 40%), Echium *angastifolium* (IV = 7.6 and P = 40 %) and *Gymnocarpos decander* (IV= 6.97 and P =20 %). The reset seven remaining species are: *Stipagrostis lanata, Crucianella maritima, Lotus palustris, Cyperus capitatus, Silene succulenta, Tamarix nilotica* and *Phragmites australis* with IV value (4.73, 4.48, 3.82, 3.39, 2.6, 1.25 and 1.24) and presence value (P= 20%) for each respectively. Five annual species were recorded associated to *Elymus farctus*; *Cakile maritima,*

Rumex vesicarius, Daucus guttatus, Senecio glaucus and *Arnebia decumbens* which frequent in El Bossaly stands.

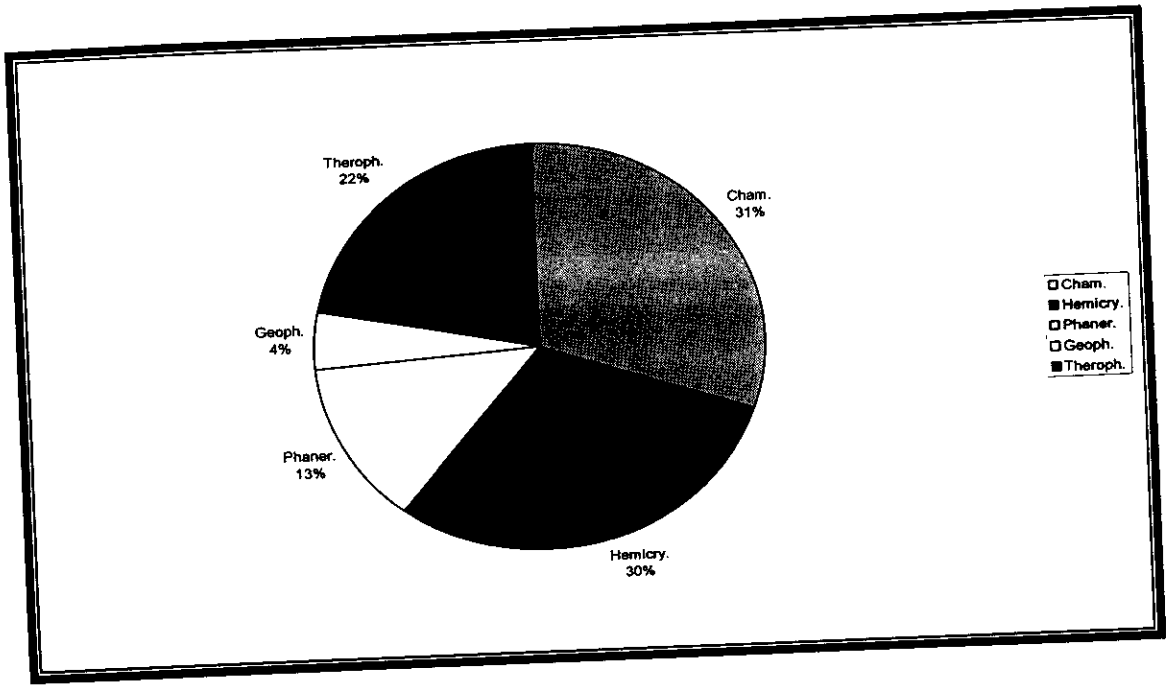


Figure (22): Histogram showing the life forms of plants associated with *E. farctus.*

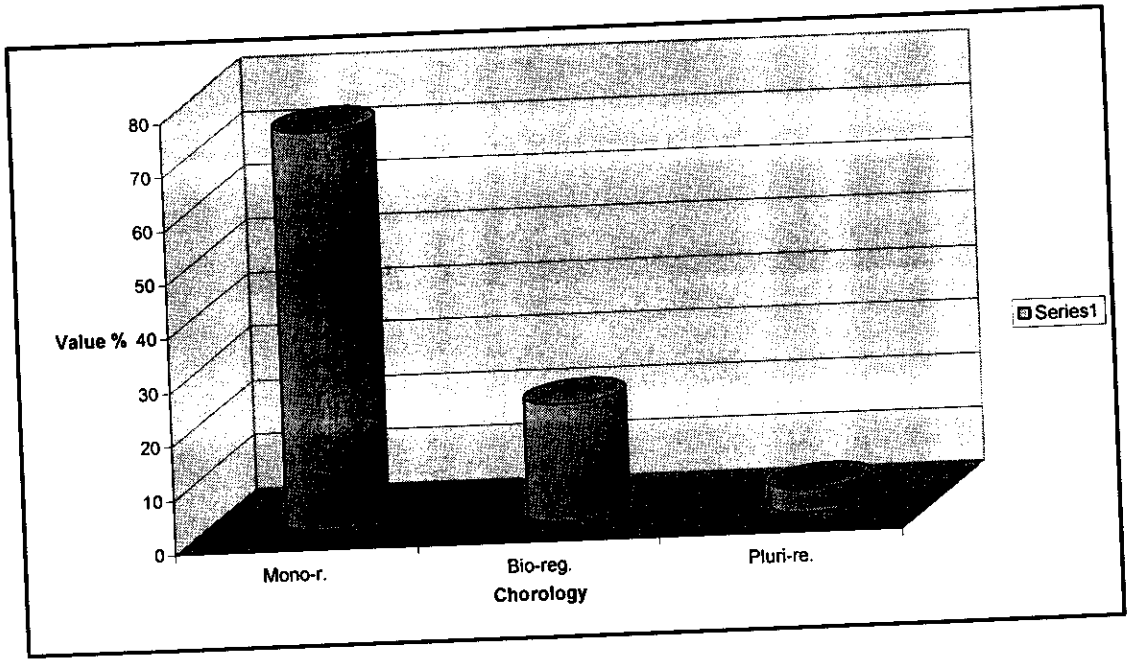


Figure (23): Histogram showing chorology of plants associated with *E. farctus.*

2.3.5. Soil analysis

2.3.5.1. Physical properties of soil

2.3.5.1.1. Soil texture

The mechanical analysis of the soil supporting *Elymus farctus* in different localities are shown in (table 16). The retrieved data indicates that the suitable soil is sandy: its sand fraction (including medium, fine and very fine sand) ranges from (86.10%) in El Bossaly site to (98.60%) in Sidi Abdel Rahman site. The maximum value of medium sand (17.4%) was recorded in El Omayed region, while its minimum value was zero in El Bossaly site. The maximum percentage of fine sand (64%) was recorded in Sidi Abdel Rahman, and its minimum value (2.6%) in El Bossaly stands. Silt and clay fraction ranges from (1.4%) at Sidi Abdel Rahman site to (13.9%) at El Bosaly site.

2.3.5.1.2. Moisture Content (MC)

Soil moisture content outlined in (table 16) showed that there are gradual increases in soil moisture content with the soil depth. Soil moisture attains its maximum value (3.14 %) at lower layer (20-40cm) in El Omayed stands, while its minimum value was (0.88%) at subsurface layer (20-40cm) in El Bossaly site.

2.3.5.2. Chemical properties

2.3.5.2.1. Soil reaction (pH)

The soil reaction was neutral or slightly alkaline where it range between (7.31- 7.8). Soil reaction reached its maximum value (7.73) and (7.8) at two layers respectively in El Qasser stands, while its minimum values were (7.38) and (7.31) at two layers respectively in El Bossaly stands.

2.3.5.2.2. Electric conductivity (Ec)

Table (16) show that the electric conductivity of the soil supporting the growth of *Elymus farctus* is slightly saline soil with maximum values (0.76 and 1.6 mmhos/cm) at the surface and subsurface layers respectively in Sidi Abdel Rahman site and minimum value was (0.23 mmhos/cm) at the surface layer (0-20 cm) in El Bossaly stands.

2.3.5.2.3. Water soluble anions (Cl^- and SO_4^{--})

The data of soluble anions outlined in table (16) showed that, the maximum concentration of soluble chloride ions in the studied habitats is (8.5 Meq/L) at the subsurface layer in Sidi Abdel Rahman site, while its minimum value was (2.0 Meq/L) at the surface layer (0-20 cm) in El Bossaly, which show the same variation trend of the electrical conductivity. Also soluble sulphates show the same variation trend as soluble chloride ions, where it reached (1.03 Meq/L) as a maximum value at the subsurface layer in Sidi Abdel Rahman site, while its minimum value was (0.23 Meq/L) at the surface layer (0-20 cm) in Om Rakham stands.

2.3.5.2.4. **Water soluble cations:** (Ca^{++}, Mg^{++}, Na^+ and K^+)

The soluble calcium ions in the studied habitats reached its maximum value (2.5 Meq/L) at the surface layer (0-20 cm) in Sidi Abdel Rahman site, while its minimum value was (0.89 Meq/L) at the subsurface layer in El Bossaly stands. While magnesium ions reached its maximum value (2.51 Meq/L) at the surface layer (0-20 cm) in Sidi Abdel Rahman site, while its minimum value was (0.55 Meq/L) at the subsurface layer (20-40 cm) in El Bossaly stands. Sodium ions reached (2.87 Meq/L) at the surface layer (0-20 cm) in Abdel-Rahman site as a maximum value, while its minimum value was (1.02 Meq/L) at the

subsurface layer (20-40 cm) in El Qasser site. Potassium ion concentration was also show the same variation trend as other soluble cations, where, it reached its maximum value (0.79 Meq/L) at the subsurface layer (20-40 cm) in Sidi Abdel Rahman site, while its minimum value was (0.22 Meq/L) at the surface layer (0-20 cm) in Om Rakham stands.

2.3.5.2.5. Calcium Carbonate ($CaCO_3$)

The data outlined in table (16) indicates that *Elymus farctus* tends to grow in soil with wide range of $CaCO_3$ which range from (16%) at El Bossaly site to (94%) in other sites.

2.3.5.2.6. Organic carbon (O.C)

Soils supporting the growth of ***Elymus farctus*** plant are very poor in organic carbon content. Percentage of organic carbon is (0.19%) as a maximum value at surface layers of El Bossaly stands, while its minimum value was (0.01%) at El Omayed and Sidi Abdel Rahman site.

2.4. Uses

According to their extensive spreading root system and their tolerance to salty conditions, *Elymus farctus* are widely used to stabilize inland and coastal sand dunes (Hilton and Harvey 2002).

Table (13): Morphological characteristics measured as mean value: culms, leaf and spike of *Elymus farctus* at different localities

Locality	Culm (aerial stem = culm)				Leaf				Spike					
	Height (cm)	Width of Patch (cm)	Number of culm / Patch	Length of internodes (cm)	Length of Leaf blade (cm)	Width of Leaf blade (mm)	Length of Leaf Sheath (cm)	Number of Leaf / culm	Length of Spike (cm)	Number of Spikelet / Spike	Number of Flower / Spikelet	Length of Spiklet (cm)	Width of Spikelet (cm)	Length (Spike :Culm) Ratio (cm)
EL-Bossaly	117.5	65.0	80.0	18.5	25.5	5.0	17.0	8.5	27.5	11.5	7.5	2.8	1.0	0.23
El- Omayed	50.0	27.5	18.0	12.0	12.5	3.5	8.0	6.0	30.5	12.0	5.0	2.15	0.7	0.61
Abdel Rahman	40.0	12.5	8.5	3.5	16.5	3.5	6.25	5.5	20.0	5.5	6.0	2.5	0.7	0.5
El Qasser	75.0	22.5	25.0	26.0	23.0	4.0	12.5	5.5	22.25	9.0	6.5	2.75	0.8	029
Om Rakham	52.5	22.5	12.5	19.5	10.5	3.5	7.0	5.5	16.0	7.0	5.0	2.1	0.7	0.30
Range	30-150	5-80	2-130	1-49	6-38	3-6	2-21	4-10	10-35	4-13	4-8	1.9-3	0.5-1.0	0.2-0.61

Table (14): Floristic composition of *Elymus farctus* community, for each species: chorology, family and life form were mentioned.

Species	Chorology	Family	Life form
Elymus farctus	Mediterranean extending to south Europe	Gramineae (Poaceae)	Hemicryptophyte
Ammophila arenaria	Mediterranean	Gramineae (Poaceae)	Hemicryptophyte
Arnebia decumbens	Irano-Turanian , Saharo-Arabian	Boraginaceae	Therophyte (annual)
Cakile maritima	Mediterranean, Euro-Siberian	Cruciferae	Therophyte (annual)
Crucianella maritima	Mediterranean	Rubiaceae	Chamaephyte (semi-shrub)
Cyperus capitatus	Mediterranean	Cyperaceae	Hemicryptophyte
Daucus guttatus	Mediterranean	Umbliliferae	Therophyte (annual)
Echinops spinosissimus	Mediterranean	Compositae(Asteraceae)	Hemicryptophyte
Echium angastifolium	Mediterranean	Boraginaceae	Chamaephyte (semi-shrub)
Ficus palmata	Sudanian	Moraceae	Phanerophyte (tree)
Gymnocarpos decander	Saharo-Arabian	Caryophyllaceae	Chamaephyte (semi-shrub)
Hyoseris radiata	Mediterranean	Compositae(Asteraceae)	Geophytes
Lotus palustris	Mediterranean	Leguminosae (Papilionoidae)	Hemicryptophyte
Lotus polyphyllos	West Sahro-Arabian	Leguminosae (Papilionoidae)	Chamaephyte (semi-shrub)
Ononis vaginalis	East Mediterranean, West Sahro-Arabian	Leguminosae (Papilionoidae)	Chamaephyte (semi-shrub)
Phragmitis australis	Pluriregional	Gramineae (Poaceae)	Hemicryptophyte
Rumex vesicarius	Saharo-Arabian	Polygonaceae	Therophyte (annual)
Senecio glaucus	Irano-Turanian , Saharo-Arabian	Compositae(Asteraceae)	Therophyte (annual)
Silene succulenta	Mediterranean	Caryophyllaceae	Chamaephyte (semi-shrub)
Sporobolus pungens	Mediterranean	Gramineae (Poaceae)	Hemicryptophyte
Stipagrostis lanata	Saharo-Arabian	Gramineae (Poaceae)	Hemicryptophyte
Tamarix nilotica	Saharo-Arabian	Tamaricaceae	Phanerophyte (tree)
Thymelaea hirsuta	Mediterranean, Saharo-Arabian	Thymelaceae	Phanerophyte (shrub)
Zygoph yllum album	Saharo-Arabian	Zygophyllaceae	Chamaephyte (semi-shrub)

Table (15): Importance) and Presence values (P %) of the perennial species associated with *Elymus farctus* in different localities. (A= EL-Omayed, B= Sidi Abdel Rahman, C =EL Qasser, D = Om El Rakham and F= El Bossaly)

Species	Site No.					Mean IV	P%
	A	B	C	D	F		
A- Dominant species *Elymus farctus*	92.1	95.7	84.69	95.87	118.59	97.39	100
B- Associated species a- perennials: *Ammophila arenaria*	42.5	69.7	41.81	104.89	-	51.75	80
Crucianella maritima	22.41	-	-	-	-	4.48	20
Cyperus capitatus	-	-	-	-	16.95	3.39	20
Echinops spinosissimus	30.27	-	5.69	-	17.72	10.73	60
Echium angustifolium	27.64	-	-	-	10.36	7.6	40
Ficus palmata	25.77	-	16.99	-	-	8.55	40
Gymnocarpos decander	34.86	-	-	-	-	6.97	20
Hyoseris radiata	-	-	24.61	40.07	-	12.93	40
Lotus palustris	-	-	-	-	19.11	3.82	20
Lotus polyphyllos	-	-	59.4	41.26	-	20.13	40
Ononis vaginalis	19.4	-	28.19	-	-	9.51	40
Phragmites australis	-	-	-	-	6.24	1.24	20
Silene succulenta	-	-	-	-	13	2.6	20
Sporobolus pungens	-	73.33	-	-	-	14.66	20
Stipagrostis lanata	-	-	-	-	23.68	4.73	20
Tamarix nilotica	-	-	-	-	6.28	1.25	20
Thymelaea hirsuta	23.55	35.25	-	-	-	11.76	40
Zygophyllum album	-	25.25	-	17.81	-	8.61	40
b- Annuals *Arnebia decumbens*	-	-	-	-	+	-	-
Rumex vesicarius	-	-	-	-	++	-	-
Senecio glaucus	-	-	-	-	++	-	-
Daucus guttatus	-	-	-	-	+	-	-
Cakile maritima	-	-	+	-	++	-	-

Presence of annual species (+ = rare, ++ = common).

Table (16): Results of physical and chemical analyses of soil supporting *Elymus farctus* in different localities (M.C = moisture content, F = fine, s = sand, m = medium, V = very, S +C = Silt +Clay, Fra. = Fraction and O.C = Organic carbon)

Locality	Profile depth cm	Physical characters						Chemical characters									
		M.C %	Soil particles %				Sandy Fra. %	pH	Ec mmohs / cm	Cations and anions (Meq/L)						O.C %	$CaCO_3$ %
			m.s	F.s	V.F.s	S +C				Ca^{++}	Mg^{++}	Na^{+}	K^{+}	Cl^{-}	SO^{-}_4		
El Bosaly	0- 20	0.99	0.0	2.6	83.5	13.9	86.10	7.38	0.23	1.12	1.10	2.06	0.56	2.0	0.45	0.19	19.0
	20-40	0.88	2.3	9.8	80.0	7.9	92.10	7.31	0.33	0.89	0.55	2.67	0.74	2.6	0.29	0.12	16.0
El Omayed	0- 20	2.30	17.4	58.0	18.6	6.0	94.0	7.63	0.34	1.53	0.95	1.30	0.38	3.0	0.33	0.02	94.6
	20-40	3.14	15.3	61.8	19.4	3.5	96.50	7.73	0.32	2.23	1.80	1.74	0.25	3.4	0.54	0.01	94.0
Abdel Rahman	0- 20	1.34	0.6	64.0	34.0	1.4	98.60	7.57	0.76	2.50	2.51	2.87	0.43	5.5	0.76	0.03	94.0
	20-40	2.81	0.5	52.5	45.5	1.5	98.50	7.45	1.60	2.50	2.50	1.11	0.79	8.5	1.03	0.01	94.0
El Qaser	0- 20	1.65	1.5	40.4	56.1	2.0	98.0	7.73	0.32	1.20	1.30	1.30	0.31	2.8	0.28	0.04	94.0
	20-40	2.42	0.8	40.3	56.5	2.4	97.60	7.8	0.30	1.46	1.12	1.02	0.27	2.7	0.3	0.03	91.0
Om Rakham	0- 20	1.94	6.2	47.0	44.1	2.7	97.3	7.5	0.28	1.95	0.80	1.2	0.22	2.2	0.23	0.03	94.0
	20-40	2.48	2.7	48.0	46.0	3.3	96.7	7.61	0.31	1.60	1.16	1.36	0.25	2.9	0.38	0.03	88.0

3- *Halopyrum mucronatum* (L.) Stapf

3.1. Taxonomical features

Genus *Halopyrum* (Tribe Eragrostideae) is represented by one species *Halopyrum mucronatum* growing on the Red Sea coastal sand bares at 7 km South of Abu Ramad (1150 km south of Suez) (Zahran 1976 & 1989 and Bolous 2005). This species can be classified taxonomically (Engler and Prantel system 1924-1942, Täckholm 1979, Cope and Hosni 1991 and Boulos 2005) as follows:

Family	: Gramineae (Poaceae)
Tribe	: Eragrostideae
Sub-tribe	: Eleusininae
Genus	: *Halopyrum*
Species	: *mucronatum*

Halopyrum mucronatum (L.) Stapf in Hook., Icon. Pl. 25: t. 2448 (1896).
Uniola mucronata L. Sp. Pl. ed. 2, 104 (1762).
Triticum repens Thw., Enum. Pl. Zeyl. 376. 1864, non L., Sp. Pl. ed. 1. 1: 86. 1753.
Eragrostis mucronata (L.) Deflers, Bull. Soc. Bot. France 34: 69 (1887), non Roem. & Schult. (1817).
Desmazeria unioloides Deflers, Voy. Yemen 220 (1889), nom. superfl., based on *Uniola mucronata* L.

Syn. according to Lazarides (1994) Bolous (2005)

3.1.1. Macro- morphological characters:

Halopyrum mucronatum is a vigorous stoloniferous perennial grass forming, huge dense tussocks (40-100 culm/patch). Culms rigid, woody, glabrous up to 1.5 m tall (In Egypt vertical culms 50-90 cm and

horizontal culms 50-135 cm table 17), many-nodded (5-9 node/culm), strongly branching to produce clusters of shoots at the nodes (2-5 lateral branches/culm); internode cylindrical, usually hollow 4-30 cm long. Leaf-blades, involute and narrowly linear to setaceous or flattened, usually glaucous, up to 45 cm long and 4 mm wide (4-30 cm long and 3-6 mm width in Egypt) with pungent or filiform apex; leaf Sheath, coriaceous with woolly-ciliate ligules. Inflorescence a contracted, elongated panicle up to 40 cm long (up to 42 cm in Egypt table 17), with a linear to narrowly lanceolate, loose branches (racemes) scattered along the axis. Spikelets awnless, lanceolate to ovate or oblong with straw colored, 8-26 mm long and 5-7 mm wide, strongly compressed laterally, shortly pedicellate on the rhachis of spiciform racemes, with 8 to 25 flowered, rhachilla disarticulating above the glumes and between the florets; glumes persistent, coriaceous, ovate-lanceolate, keeled, acute 6.0-9.5 mm long with 3-7 nerved; lemmas lanceolate to oblong-lanceolate, scaberulous or puberulous acute, notched, mucronulate, rounded on the back or keeled only above the middle, 7- 9 mm long, and with 3-nerved; paleas as long as their lemmas, subacute, scaberulous on the keeles; callus and tips of the rachilla internodes bearded with white hairs 3-5 mm long; stamens 3, with long slender anthers; styles short, distinct; stigmas plumose, laterally exserted. Caryopsis, oblong or ellipsoid, compressed, concavo-convex in profile, 2.5-3 mm long, free with a large embryo; summer seed, produced in May, black and 2.8 mg while winter seeds produced in November, brown, 2.1 mg . *Halopyrum mucronatum* flowers twice a year, from late April to May and late September through November. It produce two type of seeds, summer seed, produced in May, black and heavier 2.8 mg while winter seeds produced in November, brown, 2.1 mg. Seed dispersal followed fruiting months. Vegetative

growth period started in winter and summer seasons (See Figure 24, 25&26).

(24)

(25)

Figure (24): Single patch of *Halopyrum mucronatum*, on Red Sea coastal sand dunes (Abu Ramad) (13 / 4 / 2005).

Figure (25): Showing root of *Halopyrum mucronatum*, covered by sand sheath on Red Sea coastal sand dunes (Abu Ramad) (13 / 4 / 2005).

Figure (26): General view of pure community of *Halopyrum mucronatum*, Red Sea coastal sand dunes (Abu Ramad) (13 / 4 / 2005).

3.1.2. Micro- morphological characters:

3.1.2.1. Culm anatomy

Culm is circular in outline cross section (Figure 27 a). Epidermis is one layer of vertically arranged cells of lignified wall, covered by thick cuticle. Epidermis is free from hairs however, number of stomata are scattered in shallow depressions. Under the stomata there are stomatal chambers, which characterized by presence of parenchyma cells containing chlorophyll. Ground tissue is differentiated into lignified parenchyma to outword and non lignified parenchyma to inword (Figure 27 a &b). Vascular bundles are typical Y- shaped monocot type, scattered in the ground tissue in 3-4 rows. Ring of fiber enclosed the bundles in dense form, and thin layer of fibers enclosed the inward bundles.

3.1.2.2. Leaf anatomy

The leaf appear in cross section as typical monocot leaf characterized by absence of mid- rib and presence of mesophyll enclosing the vascular bundles. In general, the leaf has deeply furrows (Figure 28 a). The abaxial epidermal system is characterized by presence of thick cuticle and lignified epidermal cells (Figure 28 b). The shallow furrows covered by large thin walled epidermal cells acts as motor cells help the leaf movement and rolling. The adaxial epidermal system has thick cuticle and lignified epidermal cells as appeared in the abaxial surface. The deep furrows ends with small stomata covered by unicellular hairs. The ground mesophyll contains mature large vascular bundles however, large ribs containing the mature vascular bundle and vice versa. The epidermis followed by compact cellulosic layer followed by compact mesophyll layer of thin cellulosic cells, containing chlorophyll enclosing mature vascular bundles (Figure 28 a &b), or young vascular bundles in which phloem and xylem are immature. Xylem appears as xylem

trachieds. The bundles as whole appeared with thick bundle fiber. In adaxial surface the epidermis followed by strip of photosynthetic cells.

3.2. Geographical distribution:

World distribution: *H. mucronatum* grows on coastal dunes from Egypt to Mozambique, through Arabia to Pakistan, India and Sri Lanka. In Egypt: *Halopyrum mucronatum* grows only on Red Sea coastal sand dunes at 7 km South of Abu Ramad (1150 km south of Suez) (Jafri 1966, Zahran 1976, 1982 & 1989, Lazarides 1994, Khan & Ungar 2001 and Bolous 2005).

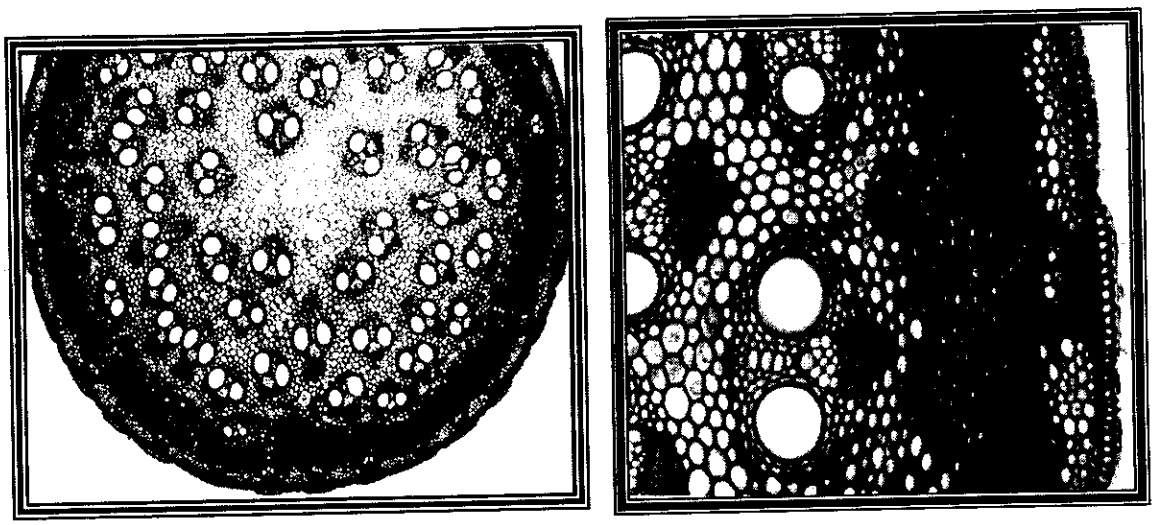
3.3. Ecological features

3.3.1. Floristic composition

The floristic composition of the communities dominated by *Halopyrum mucronatum* resulted, four perennial species belonging to 4 families (table 19). The most characteristic families are Chenopodiaceae represented by one species, *Suaeda vera*, Gramineae represented also by one species, *Sporobolus spicatus*. Zygophyllaceae and Asclepiadaceae represented by one species each: *Zygophyllum album* and *Pentatropis nivalis*, respectively.

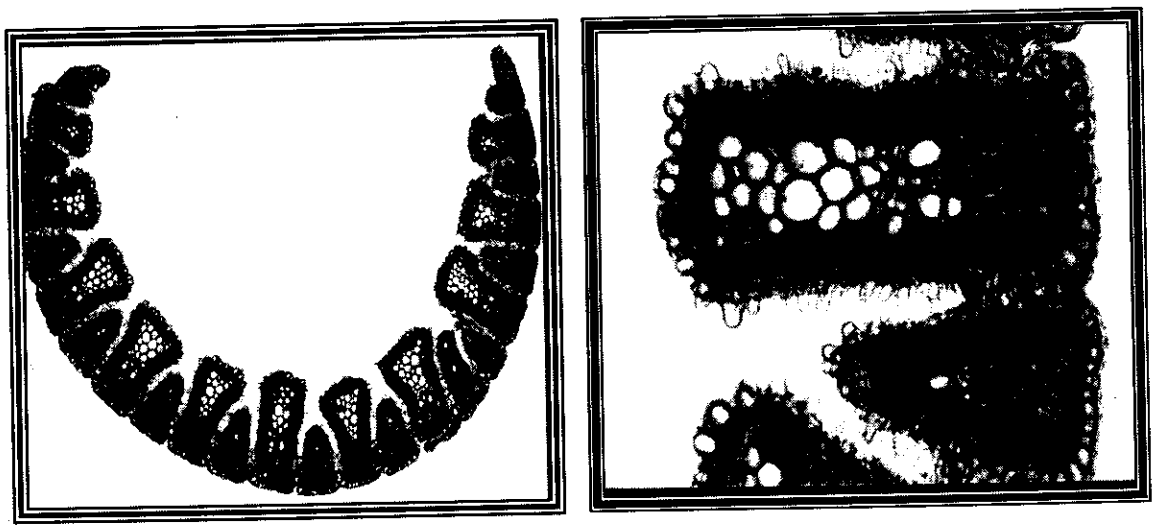
3.3.2. Life form

The recorded species around *Halopyrum mucronatum* are belong to three different life forms; Chamaephyte was the dominant life form (50%) and represented by two species namely; *Suaeda vera*, and *Zygophyllum album*. Hemicryptophyte and Phanerophyte represented by one species each, *Sporobolus spicatus* and *Pentatropis nivalis*, respectively (table 19).



(a) (b)

Figure (27): T.S. in culm of *Halopyrum mucronatum* collected from Red Sea coastal sand dune at Abu Ramad site (a) Magnification 40 X and (b) Magnification 160X.



(a) (b)

Figure (28): T.S. in leaf of *Halopyrum mucronatum* collected from Red Sea coastal sand dune at Abu Ramad site (a) Magnification 40 X and (b) Magnification 160 X .

3.3.3. Chorology

Mono-regional element represented by two species. One species is Saharo–Arabian and one species for Sudanian. **Bioregional** elements, represented by two Mediterranean and Saharo-Arabian species (table 19).

3.3.4. Vegetation analysis

Vegetation analysis of the communities dominated with *Halopyrum mucronatum* (table 20) based on the mean importance value showed, the dominance of *Halopyrum mucronatum* with a highest IV value (56.69 out of 300) and also the highest presence value (P = 100%). The abundant species is *Sporobolus spicatus* and *Zygophyllum album* with IV value (50.4 & 45.7) and presence value (P=100%) respectively. The other two species associated to *Halopyrum mucronatum* are: *Suaeda vera* (IV = 20.6 and P = 100 %) and *Pentatropis nivalis* (IV= 17.55 and P =50 %). All the associated species were perennials.

3.3.5. Soil analysis

3.3.5.1. Physical properties of soil

3.3.5.1.1. Soil texture

The soil mechanical analysis (table 18) indicated that the soil is sandy. The percentages of coarse fractions are (88.7%) (including medium, fine and very fine sand). Percentage of medium sand was (0.6 %). While the percentages of fine sand were (36.5 % and 35.3 %) for the 0-20 and 20-40 cm layers, respectively. On the other hand the values of very fine sand were (51.6 %) and (54.0 %) at the same layers. Silt and clay were (11.3 % and 10.3 %)) at the surface and subsurface layers respectively.

3.3.5.1.2. Moisture Content (MC)

Soil moisture content outlined in (table 18) show that, surface layer has high soil moisture content than that of lower layer. It was amounted (2.41 %) at surface layer (0-20cm), and (1.86 %) at lower layer (20-40cm).

3.3.5.2. Chemical properties

3.3.5.2.1. Soil reaction (pH)

The soil reaction is neutral or slightly alkaline where it ranges from 7.24 to 7.42 (table 18).

3.3.5.2.2. Electric conductivity (Ec)

Table (18) show that the electric conductivity of the soil supporting growth of *Halopyrum mucronatum* is saline with (6.2 mmhos/cm) at the surface layer (0-20cm) and (4.25 mmhos/cm) in the lower layer (20-40cm).

3.3.5.2.3. Water soluble anions (Cl^- and SO_4^{--}):

The data of soluble anions outlined in (table 18) showed that, the concentration of soluble chloride ions in the studied habitat is high. It is (55.5 Meq/L) at the surface layer (0-20cm) and (40.5 Meq/L) in the lower layer (20-40cm) which show the same variation trend of the electrical conductivity. The soluble sulphates is (2.75 Meq/L) at the surface layer (0-20cm) and (1.38 Meq/L) in the lower layer (20-40cm).

3.3.5.2.4. Water soluble cations (Ca^{++}, Mg^{++}, Na^+ and K^+)

The soluble calcium ions in the studied habitat is (8.7 Meq/L) at the surface layer (0-20 cm) and (5.4 Meq/L) in the subsurface layer (20-40 cm). While concentration of soluble magnesium ions is (7.9 Meq/L) at

(0-20 cm) and (7.7 Meq/L) in the subsurface layer (20-40cm). Sodium ions are the major soluble cation in the soil supporting the growth of *Halopyrum mucronatum,* it is (33.04 Meq/L) at the surface layer (0-20 cm) and (27.39 Meq/L) in the bottom layer (20-40cm). Table (18), indicates that the soil salinity induced by sodium chloride. Potassium ion concentration is (1.46 Meq/L) at the surface layer (0-20 cm) and (1.1 Meq/L) in the subsurface layer (20-40 cm).

3.3.5.2.5. Calcium Carbonate ($CaCO_3$)

The percent of calcium carbonate is (19.0 %) at the surface layer (0-20 cm) and (16.0 %) in the subsurface layer (20-40cm).

3.3.5.2.6. Organic carbon (O.C)

Percent of organic carbon is (0.15 and 0.09%) at surface and subsurface layers of Abu Ramad stands respectively.

3.4. Uses

Halopyrum mucronatum is a maritime species of little value as fodder but a potential seed crop and an excellent sand binder because of its vigorous, spreading habit and coarse, woolly roots and useful in preventing erosion (Lazarides 1994, Khan & Ungar 2001).

Table (17): Morphological characteristics measured as mean value: culms, leaf and spike of *Halopyrum mucronatum*

Locality	Culm (aerial stem = ahaulm)					Leaf				Spike					
	Plant Height (cm)	Width of Patch (cm)	Number of culm / Patch	Number of Lateral / culm	Length of internode (cm)	Length of Leaf blade (cm)	Width of Leaf blade (mm)	Length of Leaf Sheath (cm)	Number of Leaf / culm	Length of Spike (cm)	Number of Spiklet / Spike	Number of Flower / Spiklet	Length of Spiklet (cm)	Width of Spiklet (cm)	Length(Spike :Culum Ratio (cm)
Abu Ramad	50-90	50-80	40-100	2-5	4-30	4-30	3-6	4-20	5-9	18-42	12-43	7-12	1.5-2.5	0.4-0.6	0.42

Table (18): Results of physical and chemical analyses of soil supporting *Halopyrum mucronatum* (M.C = moisture content, F = fine, s = sand, m = medium, V = very and S +C = Silt +Clay, Fra. = Fraction and O.C = Organic carbon)

Locality	profile depth cm	Physical characters						Chemical characters									
		M.C %	Soil particles %				Sandy fra.%	pH	Ec mmohs / cm	Cations and anions (Meq/L)						O.C %	$CaCO_3$ %
			m.s	F.s	V.F.s	S +C				Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CL^{-}	SO_4^{--}		
Abu Ramad	0- 20	2.41	0.6	36.5	51.6	11.3	88.7	7.24	6.2	8.7	7.9	33.04	1.46	55.5	2.75	0.15	19.0
	20-40	1.86	0.4	35.3	54.0	10.3	89.7	7.42	4.25	5.4	7.7	27.39	1.1	40.5	1.38	0.09	16.0

Table (19): Floristic composition of *Halopyrum mucronatum* community, for each species: chorology, family and life form were mentioned

Species	Chorology	Family	Life form
Halopyrum mucronatum	Sudano-Zambezian	Gramineae (Poaceae)	Hemicryptophyte
Pentatropis nivalis	Sudanian	Asclepiadaceae	Phanerophyte (shrub)
Sporobolus spicatus	Med.,Saharo-Arabian	Gramineae (Poaceae)	Hemicryptophyte
Suaeda vera	Med.,Saharo-Arabian	Chenopodiaceae	Chamaephyte (semi-shrub)
Zygophyllum album	Saharo-Arabian	Zygophyllaceae	Chamaephyte (semi-shrub)

Table (20): Importance and Presence values (P %) of the perennial species associated with *Halopyrum mucronatum* in different localities (A and B – Abu Ramad)

Species	Stand No		Mean IV	P %
	A	B		
A- Dominant species *Halopyrum mucronatum*	90.1	23.28	56.69	100
Associated species a- perennials: *Pentatropis nivalis*	35.11	-	17.55	50
Sporobolus spicatus	62.32	38.34	50.4	100
Suaeda vera	28.01	13.2	20.60	100
Zygophyllum album	50.7	40.7	45.7	100

II- Non-Graminaceous Species

These include: 4) *Atriplex farinosa* (Chenopodiaceae), 5) *Euphorbia paralias* (Euphorbiaceae), 6) *Lotus polyphyllos* (Leguminosae) and 7) *Populus euphratica* (Salicaceae)

4- *Atriplex farinosa* Forssk.

4.1. Taxonomical features

Chenopodiaceae comprises 103 genera and 1300 species, cosmopolitan especially in the saline habitats of the arid region. Genus *Atriplex* including about 300 species mostly annual herbaceous or perennial shrubs. Leaves mostly alternate; flowers unisexual on monoecious or dioecious plant, in terminal or axillary clusters. In Egypt genus *Atriplex* represented by eighteen (18) species. The plant under investigation is *Atriplex farinosa* Forssk.,. (Bolous 1999)

Arabic names: Hawwa حوا Hindaal هندال Roghal الرعل (Täckholm 1974 and Bin-Jaber 1990)
English names: Salt bush

4.1.1. Macro- morphological characters

Atriplex farinosa is a tall robust shrub, 50-80 cm or more (50-195 cm in Egypt, figure 29). Root brownish color, much branched and spreading widely in the soil. Stem erect, strong, slender, richly branched from the base and above forming a bush; branches are slender, densely mealy-canescent all over whitish-grey covered densely by leaves. Leaf blade are whitish-grey covered by excreted salts from excretive glands,

ovate-elliptic, usually entire obtuse at the apex, cordate or auriculate at the base 1.5-4 cm x 1-2 cm (1.7-5.5 cm length and 1.2 - 2.5 cm width in Egypt, figure 30); petiole 2-6 mm long; auricles long obtuse, 1.0-16 mm long. Inflorescence in terminal large leafless panicle. Fruit bracteoles are glabrous obconical to broadly-elliptic, entire, and connate at the base, 4.0-7.0 x 3.0-6.0 mm. Long (table 21). Flowering period of *Atriplex farinosa* occurred in autumn season (from late September to November), while fruiting beginning in late October till December. Seed dispersal followed fruiting months directly. Vegetative growth period occurred during late winter till spring season (See figure 31, 32, 33 &34).

4.2. Geographical distribution

World distribution: *Atriplex farinosa* grows in tropical northeast Africa, Saudi Arabia, and along Red Sea coast in both sides. Migahid (1978) mentioned that it also present in mountainous regions. In Egypt: *Atriplex farinosa* is confined to sand bars of the Red Sea coast (Kassas & Zahran 1967, Zahran 1982a, Zahran 1989, Bolous 1999 and Fahmy 2004).

4.3. Ecological features

4.3.1. Floristic composition

The floristic composition of the community dominated by *Atriplex farinosa* indicated that, it comprises seven perennial species belonging to four families. The most characteristic families are Chenopodiaceae (42.85%) represented by three species namely: *Arthrochnemum macrostachyum, Halopeplis perfoliata* and *Suaeda monica.* Zygophyllaceae (28.57%) represented by two species (*Nitraria retusa* and *Zygophyllum album*). Plumbaginaceae and Verbenaceae (14.28) represented by one species each (table 22)

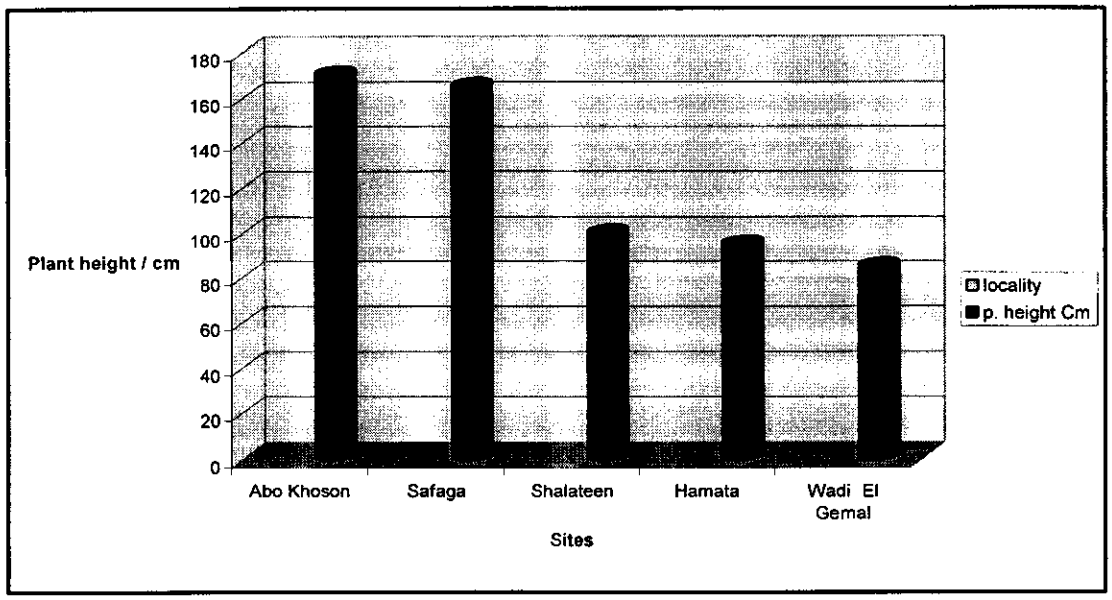


Figure (29): Histogram showing height of *A. farinosa* in different sites.

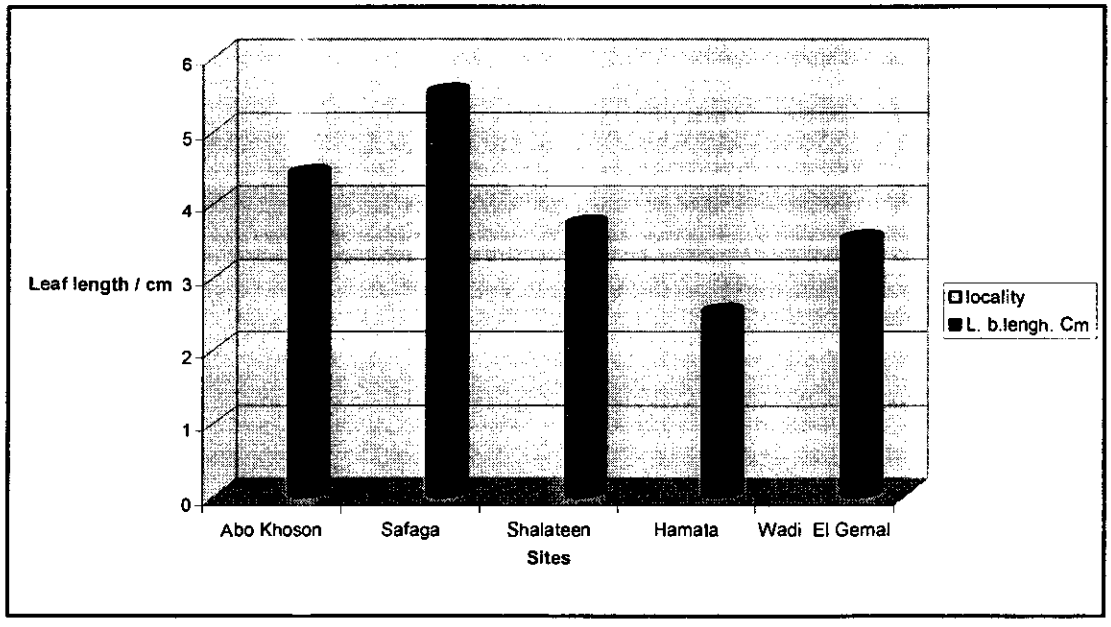


Figure (30): Histogram showing leaf blade lengthes of *A. farinosa* in different sites.

(31)

(32)

Figure (31): ***Atriplex farinosa*****, shrub with height reached 195 cm growing on the Red Sea coastal sand dunes at Abu Ghoson area (15 / 4 / 2005).**

Figure (32): Close up view of ***Atriplex farinosa*****, showing its leaves, Red Sea coast. (15 / 4 / 2005).**

(33)

(34)

Figure (33): Pure community of ***Atriplex farinosa*****, on the first line of Red Sea coastal sand dune (Shalateen area) (18 / 4 / 2005)..**

Figure (34): Damaged and grazed community of ***Atriplex farinosa*****, at Hamata coastal sand dunes, Red Sea coast (15 / 4 / 2005)..**

4.3.2. Life form

The species associated with *Atriplex farinosa* are belonging to two different life forms. Chamaephyte was the dominant life form recorded (57.14%); it represented by four species namely: *Arthrochnemum macrostachyum, Halopeplis perfoliata, Zygophyllum album* and *Limonium axillare*).

While Phanerophytes (42.85%), represented by three species: *Nitraria retusa, Suaeda monica* and *Avicennia marina* (table 22).

4.3.3. Chorology

Mono-regional elements represented by six species (85.71%). Four species are Saharo–Arabian and two species for Sudanian and Sudano-Zambezian, while **bioregional** elements (14.28%), represented by one Mediterranean, Saharo-Arabian species (table 22).

4.3.4. Vegetation analysis

The vegetation analysis of the community dominated by *Atriplex farinosa* (table 23) indicated that, all the species associated to *Atriplex farinosa* are perennials. Based on the mean importance value: *Atriplex farinosa* is dominant with the highest IV value (168.2 out of 300) and also the highest presence value (P=100%). The abundant species is *Zygophyllum album* and *Limonium axillare* with IV value (72.89&41.98) and presence value P=100 & 40% respectively. The remaining five species associated with *Atriplex farinosa* not exceeding the IV=10.87 (table 23).

4.3.5. Soil analysis

4.3.5.1. Physical properties of soil

4.3.5.1.1. Soil texture

The soil mechanical analysis (table 24) indicated that the soil is sandy. The percentages of coarse fraction (including medium, fine and very fine sand) was reached its maximum value 98.5% in Wadi El Gemal stands and its minimum value 86.2% in surface layer of Safaga site. The maximum value of medium sand 49.9% was recorded in subsurface layer of Hamata stands, while it's minimum value 11.8% in subsurface layer of Abu Ghoson stands. While the maximum percentages of fine sand 59.8% was recorded in Wadi El Gemal stands, and its minimum value 29.6% in subsurface layer of Safaga stands. Silt and clay reached its maximum value 17.5 at subsurface layer of Shalateen stands and its minimum value 1.5% at surface layer (0-20 cm) in Wadi El Gemal stands. From the above results, the soil is coarse in texture, with little amount of silt and clay.

4.3.5.1.2. Moisture Content (MC)

Soil moisture content outlined in (table 24) showed that there was gradual increase in soil moisture content with the soil depth. Soil moisture attains its maximum value 9.19% at subsurface layer of Safaga stands, while its minimum value was 1.99% at surface layer (0-20cm) of Shalateen stands.

4.3.5.2. Chemical properties

4.3.5.2.1. Soil reaction (pH)

The soil reaction is neutral or slightly alkaline where it range between (7.11- 7.64). Soil reaction reached its maximum value 7.64 at

surface layer (0-20cm) in Abu Ghoson stands, while its minimum value was 7.11 at the subsurface layer of Shalateen stands.

4.3.5.2.2. Electric conductivity (EC)

Table (24) shows that the electric conductivity of the soil supporting growth of *Atriplex farinosa* is saline soil with maximum value 21.5 mmhos/cm at the surface layer (0-20 cm) in Shalateen stands, while its minimum value was 3.4 mmhos/cm at the surface layer (0-20 cm) in Wadi El Gemal stands.

4.3.5.2.3. Water soluble anions (Cl^- and SO_4^{--})

The data of soluble anions outlined in (table 24) showed that, the maximum concentration of soluble chloride ions in the studied habitats is reached 280.0 Meq/L at the surface layer (0-20 cm) in Shalateen stands, while its minimum value was 37.0 Meq/L at the surface layer (0-20 cm) in Wadi El Gemal stands, which show the same variation trend of the electrical conductivity. Also soluble sulphates show the same variation trend as soluble chloride ions, where it is 6.82 Meq/L as a maximum value at the surface layer (0-20 cm) in Shalateen stands, while its minimum value was 0.91 Meq/L at the surface layer (0-20 cm) in Wadi El Gemal stands.

4.3.5.2.4. Water soluble cations (Ca^{++}, Mg^{++}, Na^+ and K^+)

The soluble calcium ions in the studied habitats reached its maximum value 58.0 Meq/L at the surface layer (0-20 cm) in Shalateen stands, while its minimum values were 6.0 and 4.0 Meq/L at the surface and subsurface layers in Wadi El Gemal stands and Abu Ghoson stands respectively. While magnesium ions reached its maximum value 53.0 Meq/L at the surface layer (0-20 cm) in Shalateen site, while its minimum values were 6.5 and 7.0 Meq/L at the surface layers (0-20 cm) in Wadi El

Gemal and Abu Ghoson stands respectively. Sodium ions are the major soluble cation in the soil supporting the growth of *Atriplex farinosa* it reached 78.26 and 80.86 Meq/L at the surface and subsurface layers in Shalateen and Safaga stands respectively as a maximum values, while its minimum value was 28.69 Meq/L at the surface layer (0-20 cm) in Wadi El Gemal stands. Table (24), indicates that the soil supporting the growth of *Atriplex farinosa* induced by sodium chloride. Potassium ion concentration was also show the same variation trend as other soluble cations, where, it reached its maximum value 6.66 Meq/L at the surface layer (0-20 cm) in Shalateen site, while its minimum value was 0.98 Meq/L at the surface layer (0-20 cm) in Wadi El Gemal stands.

4.3.5.2.5. Calcium Carbonate ($CaCO_3$)

The maximum value 94% of $CaCO_3$ was recorded at the surface layer (0-20 cm) of Hamata and Wadi El Gemal stands, while its minimum value was 16% at the surface layer (0-20 cm) in Shalateen site (table 24).

4.3.5.2.6. Organic carbon (O.C)

Percent of organic carbon reached to 0.24 % as a maximum value at surface layer of Safaga stands, while its minimum value 0.05% at subsurface layers of Wadi El Gemal sites (table 24).

4.4. Uses:

Atriplex farinosa is useful fodder plant with relatively high nutritive value for ruminants and as a feed supplement. The plant contains many medicinal organic compounds used in medicine such as flavonoids, alkaloids, steroids, glycosides, tannins, coumarins and traces of terpenoids. The Plant may be also suitable for revegetating very saline soils (Hopkins & Nicholson 1999, Bin-Jaber 1990 and Aganga *et al.*, 2003).

Table (21): Morphological characters (Stem and leaf) of *Atriplex farinosa* measured as mean value at different localities.

Locality	Stem					Leaf				
	plant Height (cm)	Number of Main Branch / Plant	Number of Lateral / Main Branch	Crown Cover (m2)	Crown Volume (m3)	Number of Leaf / Lateral Branch	Length of Leaf blade (cm)	Width of Leaf blade (cm)	Length of Leaf Petiole (mm)	Length of Leaf auricles (mm)
Safaga	165.0	6.0	22.0	2.82	3.10	48.0	5.5	2.3	5.0	8.0
Wadi El Gemal	85.0	21.0	13.0	1.29	0.73	40.0	3.5	1.8	3.0	5.0
Abo Khoson	170.0	8.0	18.0	4.27	4.83	41.0	4.4	2.1	4.0	4.0
Hamata	95.0	3.0	11.0	0.80	0.507	31.0	2.5	1.5	3.0	3.0
Shalateen	100.0	17.0	17.0	1.97	1.58	52.0	3.7	1.8	3.0	4.0
Range	50-195	1-35	6-27	0.5-4.75	.45-5.2	20-70	1.7-5.5	1.2-2.5	2-6	1 – 1.6

Table (22): Floristic composition of *Atriplex farinosa* community, for each species: chorology, family and life form were mentioned.

Species	Chorology	Family	Life form
Atriplex farinosa	Saharo - Arabian	Chenopodiaceae	Phanerophyte (shrub)
Arthrochnemun macrostachyum	Mediterranean, Saharo-Arabian	Chenopodiaceae	Chamaephyte (semi-shrub)
Avicennia marina	Saharo - Arabian	Verbenaceae	Phanerophyte (Tree)
Halopeplis perfoliata	Saharo - Arabian	Chenopodiaceae	Chamaephyte (semi-shrub)
Limonium axillare	Sudano-Zambezian	Plumbaginaceae	Chamaephyte (semi-shrub)
Nitraria retusa	Saharo-Arabian	Zygophyllaceae	Phanerophyte (shrub)
Suaeda monica	sudanian	Chenopodiaceae	Phanerophyte (shrub)
Zygophyllum album	Saharo-Arabian	Zygophyllaceae	Chamaephyte (semi-shrub)

Table (23): Importance (and Presence values (P %) of the perennial species associated with *Atriplex farinosa* in different localities. (A=Safaga, B= Wadi El Gemal, C = Abu Ghoson, D = Hamata and F= Shalateen).

Species	Site No.					Mean IV	P%
	A	B	C	D	F		
A- Dominant species							
Atriplex farinosa	202.3	183.15	162.44	141.09	152.02	168.2	100
B- Associated species							
a- perennials:							
Arthrochnemum macrostachyum	-	-	-	-	34.51	6.90	20
Avicennia marina	-	50.48	-	-	-	10.09	20
Halopeplis perfoliata	-	-	-	-	54.38	10.87	20
Limonium axillare	-	-	52.53	157.41	-	41.98	40
Nitraria retusa	22.49	-	-	-		4.49	20
Suaeda monica	-	-	-	-	22.77	4.54	20
Zygophyllum album	75.25	66.32	85.2	101.47	36.24	72.89	100

Table (24): Results of physical and chemical analyses of soil supporting *Atriplex farinose* in different localities. (M.C = moisture content, F = fine, s = sand, m = medium, V = very, S +C = Silt +Clay, Fra. = Fraction and O.C = Organic carbon)

Locality	Profile depth cm	Physical characters						Chemical characters									
		M.C %	Soil particles %				Sandy fra.%	pH	Ec mmohs / cm	Cations and anions (Meq/L)						O.C %	$CaCO_3$ %
			m.s	F.s	V.F.s	S +C				Ca^{++}	Mg^{++}	Na^{+}	K^{+}	Cl^{-}	SO^{-}_{4}		
Hamata	0- 20	4.47	25.6	37.8	34.3	2.3	97.7	7.39	9.0	6.6	14.5	60.86	1.23	82.5	1.32	0.2	94.0
	20-40	5.72	49.9	32.5	16.1	1.5	98.5	7.63	6.0	5.1	11.12	51.3	1.07	62.0	1.93	0.12	91.0
Wadi El Gemal	0- 20	2.37	17.1	59.8	21.6	1.5	98.5	7.35	3.4	6.0	6.5	28.69	0.98	37.0	0.91	0.09	94.0
	20-40	4.41	13.8	54.0	26.8	5.4	94.6	7.44	4.3	5.0	12.0	40.86	1.12	45.0	1.01	0.15	94.0
Sha lateen	0- 20	1.99	22.3	48.0	19.1	10.6	89.4	7.22	21.5	58.0	53.0	78.26	6.66	280.	6.82	0.22	16.0
	20-40	5.47	16.4	42.7	23.3	17.5	82.5	7.11	7.0	31.0	27.0	66.52	1.33	62.0	2.73	0.18	16.0
Abu Khoson	0- 20	3.34	24.6	37.7	30.4	7.3	92.7	7.64	5.0	9.0	7.0	65.2	1.82	51.0	2.62	0.11	88.0
	20-40	4.54	11.8	43.3	36.8	8.1	91.9	7.57	4.5	4.0	13.0	56.08	1.03	45.0	2.3	0.08	94.0
Safaga	0- 20	4.81	16.9	32.5	36.8	13.8	86.2	7.25	9.0	27.0	39.0	71.73	1.44	66.0	3.1	0.24	31.0
	20-40	9.19	29.0	29.6	25.5	15.9	84.1	7.33	8.5	26	22.0	80.86	1.61	80.0	2.95	0.21	37.0

5- *Euphorbia paralias* L.

5.1. Taxonomical features

Family Euphorbiaceae comprises about 340 genera and 8100 species mostly herbs or shrubs, trees or lianes with terminal and axillary racemose rarely cymose inflorescence or reduced to flower-like cyathia; leaves are alternate or opposite. Genus *Euphorbia* including about 2000 species cosmopolitan, mostly monoecious herbs, shrubs, trees or succulent, always with milky latex. In Egypt genus *Euphorbia* represented by 42 species. The plant under investigation is *Euphorbia paralias* L., Sp. Pl., ed. (Bolous 2000).

Arabic names: Shagaret El-Hanash شجرة الحنش (Täckholm 1974).

English names: Sea spurge.

5.1.1. Macro- morphological characters

Euphorbia paralias is a glabrous glaucous shrub, up to 50 cm (figure 35). Stem erect leafy many from the base (figure 36). Cauline leaves 1-2 x 0.2-0.5 cm elliptic to oblong sessile with rounded broad base, densely imbricate. Umbellar and floral leaves 0.6-1.2 cm broadly ovate with cordate base mucronate, all leaves fleshy. Umbel rays 3-5 short simple or branched, Cyathia c.3 mm, pedunculate, involucres campanulate, the lobes oblong, ciliate glands lunate, dentate, with 2 short horns. Capsule 4.0 x 5.5 mm, depressed-globes, 3- lobed, finely, wrinkled, glabrous. Seeds 3.0 x 2.5 mm, broadly ovoid, gray with blackish rounded spots, smooth, caruncle small, reniform. Flowering period of *Euphorbia paralias* started in spring season from April to June followed by fruiting, seed dispersal directly in June and August. Plant is vegetative in late winter and spring season (see figure 37, 38, 39 &40).

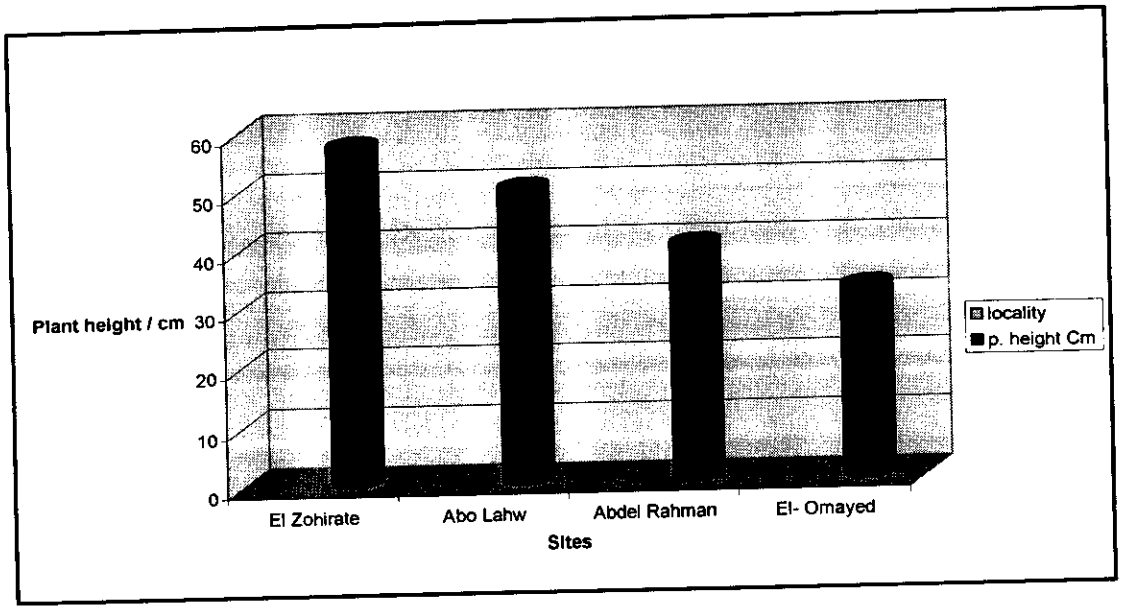


Figure (35): Histogram showing height of *E. paralias*, grows in different sites, Med. coast

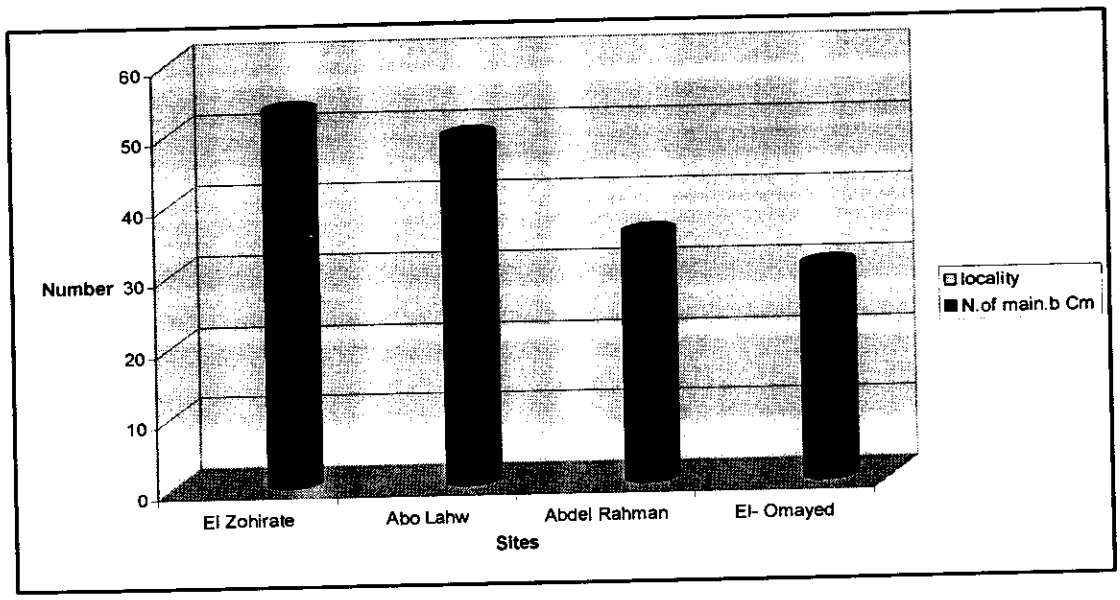
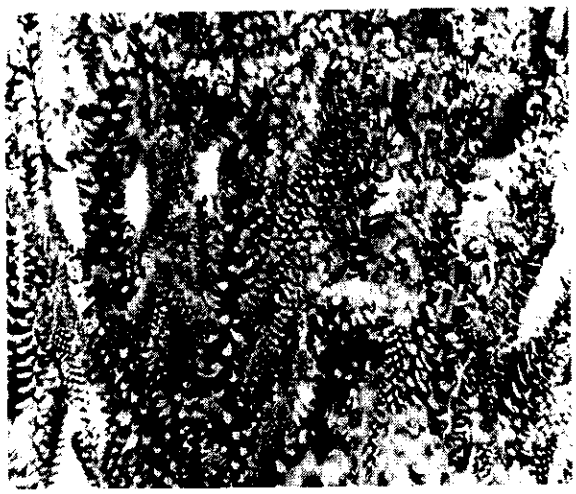
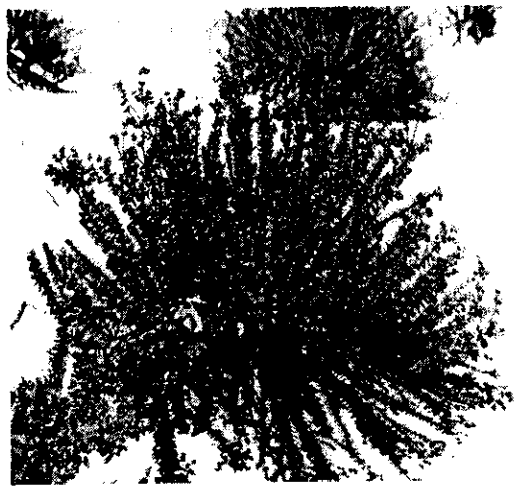


Figure (36): Histogram showing number of main branch of *E. paralias*, grows in different sites, Med. coast



(37)



(38)

Figure (37): Photo showing leafy stem and cythicia inflorescences of *Euphorbia paralias* grown on the Mediterranean calcareous coastal sand dunes (25 / 4/ 2004).

Figure (38): Photo showing a single plant of *Euphorbia paralias*, with much number of branches from the base (Mediterranean calcareous coastal sand dunes of Al Zohirate site) (27 / 4/ 2004).

(39)

(40)

Figure (39): Photo showing plants of *Euphorbia paralias*, associated with *Nitraria retusa* and *Lycium shwaii* in transitional area in Sidi Abdel Rahman site (25 / 4/ 2004).

Figure (40): Photo showing pure community of *Euphorbia paralias*, grown on Mediterranean calcareous coastal sand dunes of Al Zohirate site (27 / 4/ 2004)..

5.2. Geographical distribution

World distribution: *Euphorbia paralias* grows in Atlantic Islands, west Europe, Black Sea coast and Mediterranean region. In Egypt: *Euphorbia paralias* is growing only on the Mediterranean coastal sand dunes area including north Sinai coast (Zohary 1962, Oppermann 1999 Bolous 2000).

5.3. Ecological features

5.3.1. Floristic composition

The floristic composition of the community dominated by *Euphorbia paralias* includes, seventeen (17) species belonging to 11 families. The most characteristic families were Gramineae (17.64%) represented by three species, *Sporobolus pungens, Ammophila arenaria* and *Elymus farctus*. Compositae (11.76%) represented by two species, *Echinops spinosissimus* and *Otanthus maritimus*. Chenopodiaceae, Leguminosae, Zygophyllaceae (11.76%) represented also by two species each: *Arthrochnemum macrostachyum, Atriplex halimus* and *Lotus polyphyllos, Ononis vaginalis* and *Nitraria retusa, Zygophyllum album* respectively. Plumbaginaceae, Boraginaceae, Amaryllidaceae, Convolvulaceae, Solanaceae and Thymelaceae (5.88%) each was represented by one species (table 25)

5.3.2. Life form

The species associated with *Euphorbia paralias* are belonging to four different life forms. Chamaephyte was the dominant life form recorded (41.17%). It represented by seven species namely: *Zygophyllum album, Arthrochnemum macrostachyum, Otanthus maritimus, Limoniastrum monopetalum, Lotus polyphyllos, Ononis vaginalis* and

Echium angustifolium. Hemicryptophyte (29.41%) include five species, *Sporobolus pungens, Ammophila arenaria, Cressa cretica, Echinops spinosissimus* and *Elymus farctus*. While phanerophyte (23.52%), containing four species: *Lycium shawii, Thymelaea hirsuta, Nitraria retusa* and *Atriplex halimus*. *Pancratium maritimum* is the only geophyte (5.88 %) recorded in the field (table 25, figure 41).

5.3.3. Chorology

Mono-regional elements (64.70%) represented by eleven (11) species. Eight species are Mediterranean; three species are Saharo–Arabian. **Bioregional** elements (35.29%), represented as four (Mediterranean, Saharo-Arabian) species and one species for each of (Saharo-Arabian, Sudanian) and (Mediterranean, Irano-Turanian) (table 25).

5.3.4. Vegetation analysis

The vegetation analysis of the community dominated by *Euphorbia paralias* (table 26) based on the mean importance value showed, the dominance of *Euphorbia paralias* with a highest IV value (123.71 out of 300) and also the highest presence value (P = 100%), (figure 42). The abundant species were *Lotus polyphyllos*, *Zygophyllum album*, *Otanthus maritimus, Ammophila arenaria, Atriplex halimus,* and *Thymelaea hirsute* with IV value (14.07, 10.63, 9.38, 8.9, 8.33 and 8.24) and presence value P= 25.0, 50.0, 25.0, 25.0, 50 and 50% respectively. Five of the remaining eleven species associated with *Euphorbia paralias* are: *Pancratium maritimum* (IV = 7.71 and P = 25%), *Echinops spinosissimus* (IV = 6.59 and P = 50%), *Nitraria retusa* (IV = 6.41 and P = 25%), *Sporobolus pungens* (IV= 5.10 and P =25%) and *Limoniastrum*

monopetalum (IV= 5.09 and P =25%). The remaining six species are not exceeding 5.0 IV (table 26).

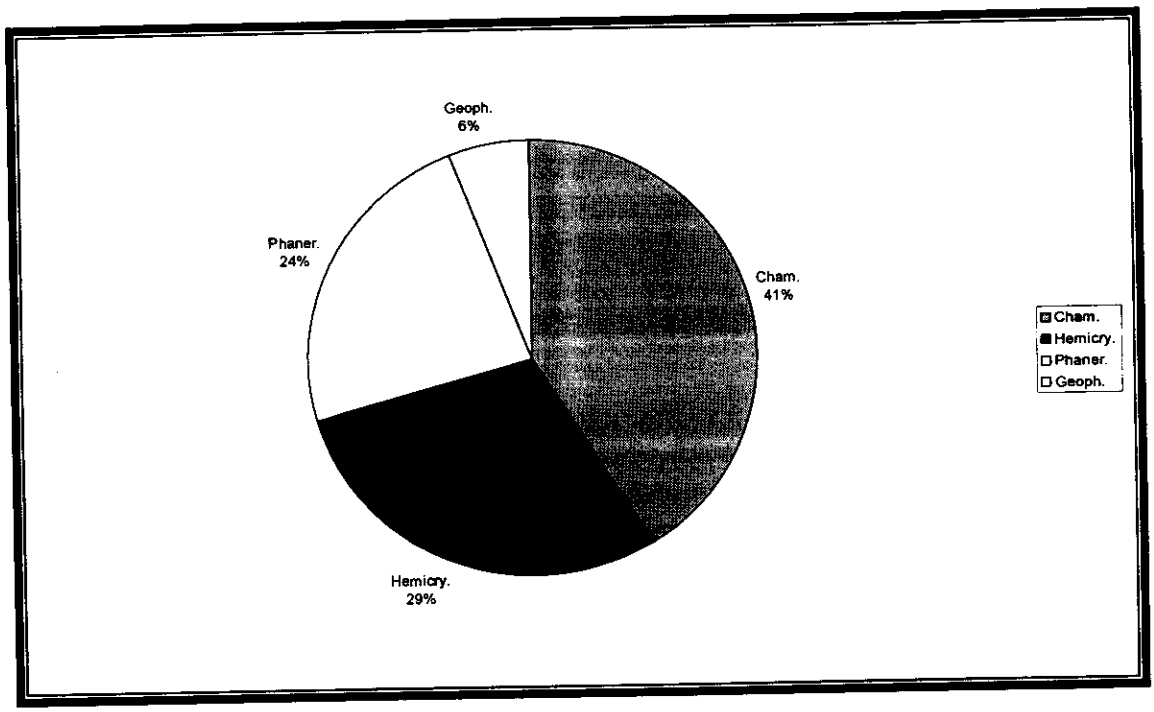


Figure (41): Histogram showing life form of plants associated with *E.paralias,* grows in different sites, Med. Coast.

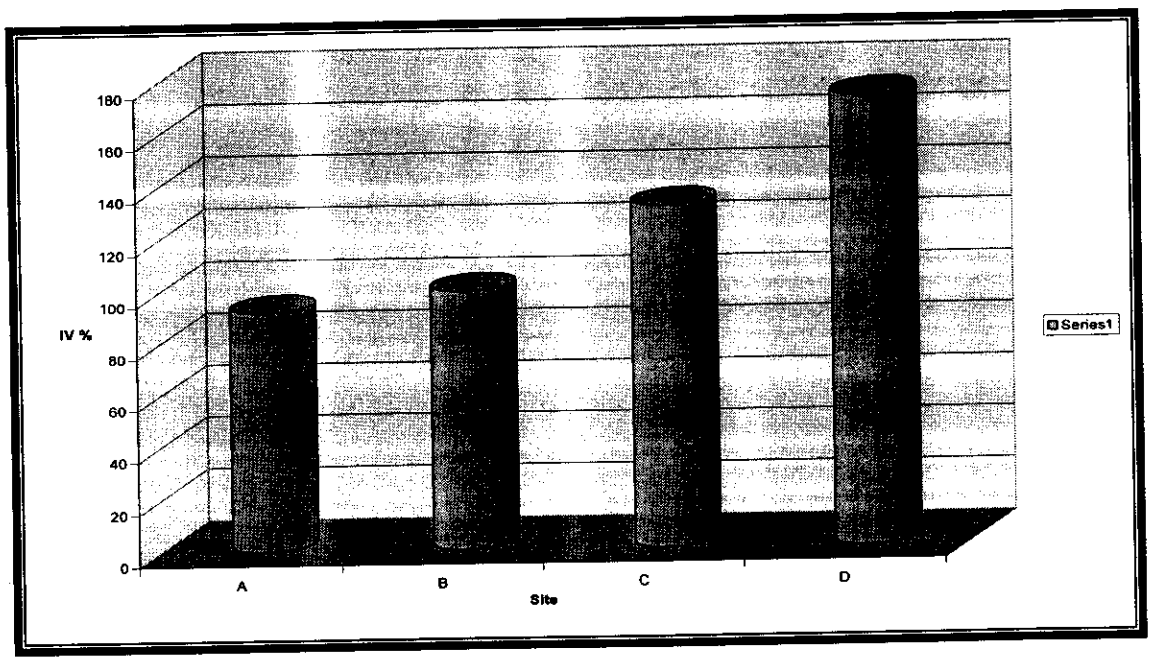


Figure (42): Histogram showing importance values of *E.paralias,* grows in different sites, Med. Coast. (A= EL-Omayed, B= Abdel Rahman, C =Abu Lahw and D= El Zohirate).

5.3.5. Soil analysis:-

5.3.5.1. Physical properties of soil

5.3.5.1.1 Soil Texture

The soil mechanical analysis outlined in (table 27) indicated that the soil is sandy. The percentages of coarse fraction (including medium, fine and very fine sand) ranges between (99.6%) at surface layer in El-Omayed stands and (95.8%) at surface layer in Sidi Abdel Rahman site. The maximum value of medium sand (23.0%) was recorded at subsurface layer in El Omayed site, while it's minimum value (0.6%) at subsurface layer in Sidi Abdel Rahman site. Silt and clay reached its maximum value (4.2% at surface layer in Abdel-Rahman stands, and its minimum value 0.4%) at surface layer (0-20 cm) in El Omayed site. From the above results, the soil is coarse in texture, with very little amount of silt and clay.

5.3.5.1.2. Moisture Content (MC)

Soil moisture content outlined in (table 27) showed that there was gradual increase in soil moisture content with the soil depth. Soil moisture attains its maximum value (3.82 %) at subsurface layer in El Omayed stands, while its minimum value was (0.88%) at surface layer (0-20cm) in Abdel Rahman.

5.3.5.2. Chemical properties

5.3.5.2.1. Soil reaction (pH)

The soil reaction is neutral or slightly alkaline where it ranges between (7.5- 7.76). Soil reaction reach its maximum value 7.76 at surface layer (0-20cm) in El Omayed stands, while its minimum value is 7.5 at the subsurface layer (20-40 cm) in Sidi Abdel Rahman stands (table 27).

5.3.5.2.2. Electric conductivity (Ec)

Table (27) show that the electric conductivity of the soil supporting growth of *Euphorbia paralias* is slightly saline soil where it reach its maximum value is (1.3 mmhos/cm) at the surface layer (0-20 cm) in El Zohirate site, while its minimum value is (0.315 mmhos/cm) at the subsurface layer (20-40 cm) in El Omayed stands.

5.3.5.2.3. Water soluble anions (Cl^- and SO_4^{--})

The data of soluble anions outlined in (table 27), showed that *Euphorbia paralias* can grow in chloride (Cl^-) concentrations ranges from (11.0 to 3.0 Meq/L). Chloride (Cl^-) ions reached 11.0 Meq/L at the surface layer (0-20 cm) in El Zohirate site as maximum value, while its minimum value was (3.0 Meq/L) at the subsurface layer (20-40 cm) in Abdel-Rahman stands which show the same variation trend of the electrical conductivity. Also soluble sulphates show the same variation trend as soluble chloride ions, where it reached (3.5 Meq/L) as a maximum value at the surface layer (0-20 cm) in Sidi Abdel Rahman site, while its minimum value was (0.5 Meq/L) at the subsurface layer in El Omayed stands.

5.3.5.2.4. Water soluble cations (Ca^{++}, Mg^{++}, Na^+ and K^+)

The soluble calcium ions in the studied habitats reached its maximum value (8.1 Meq/L) at the surface layer (0-20 cm) in Sidi Abdel Rahman site. While its minimum value was (1.2 Meq/L) at the subsurface layer (20-40 cm) in El Zohirate site. Magnesium ions reached its maximum value (4.25 Meq/L) at the surface layer (0-20 cm) in Sidi Abdel Rahman site, while its minimum value was (1.0 Meq/L) at the subsurface layer (20-40 cm) in Abu Lahw stands. Sodium ions reached (2.95 Meq/L) at the subsurface layer (20-40 cm) in El Zohirate site as a

maximum value, while its minimum value was (1.08 Meq/L) at the subsurface layer (20-40 cm) in Abdel Rahman. Potassium ion concentration was also showed the same variation trend as other soluble cations (table 27).

5.3.5.2.5. Calcium Carbonate ($CaCO_3$)

Calcium carbonate is an important indicator for growth of *Euphorbia paralias* plant in its habitat. The maximum value (94%) of ($CaCO_3$) was recorded at the surface layer (0-20 cm) in El Omayed stands, while its minimum value was (89.9%) at the subsurface layer in El Zohirate site. From the table, it can be noted that *Euphorbia paralias* grows in soil with highly calcium carbonate content (table 27).

5.3.5.2.6. Organic carbon (O.C)

Soils supporting the growth of *Euphorbia paralias* plant are very poor in organic carbon content. Percent of organic carbon reached to (0.18%) as a maximum value at surface layer of Sidi Abdel Rahman stands. While it's minimum value was (0.01%) at subsurface layer of El Omayed site.

5.4. Uses:

Euphorbia paralias is an important pharmaceutical species on the coastal dunes in the north-west of Egypt, it contain many of organic compound used in many drug. *Euphorbia paralias* sap is toxic and care should be taken to avoid getting it into your eyes or on your skin as it can cause irritation (Elhaak *et al.*, 1997, Abdelgaleil *et al.*, 2002 and Parks & Wildlife Service 2006).

Table (25): Floristic composition of *Euphorbia paralias* community, for each species: chorology, family and life form were mentioned.

Species	Chorology	Family	Life form
Euphorbia paralias	Mediterranean extending to west Europe	Euphorbiaceae	Chamaephyte (semi-shrub)
Ammophila arenaria	Mediterranean	Gramineae (Poaceae)	Hemicryptophyte
Arthrochnemon macrostachyum	Mediterranean, Saharo-Arabian	Chenopodiaceae	Chamaephyte (semi-shrub)
Atriplex halimus	Mediterranean, Saharo-Arabian	Chenopodiaceae	Phanerophyte (shrub)
Cressa cretica	Mediterranean, Irano-Turanian	Convolvulaceae	Hemicryptophyte
Echinops spinosissimus	Mediterranean	Compositae(Asteraceae)	Hemicryptophyte
Echium angastifolium	Mediterranean	Boraginaceae	Chamaephyte (semi-shrub)
Elymus farctus	Mediterranean extending to south Europe	Gramineae (Poaceae)	Hemicryptophyte
Limoniastrum monopetalum	West Mediterranean	Plumbaginaceae	Chamaephyte (semi-shrub)
Lotus polyphylios	West Sahro- Arabian	Leguminosae (Papilionoidae)	Chamaephyte (semi-shrub)
Lycium shawii	Saharo-Arabian , Sudanian	Solanaceae	Phanerophyte (shrub)
Nitraria retusa	Saharo-Arabian	Nitrariaceae	Phanerophyte (shrub)
Ononis vaginalis	East Mediterranean, West Sahro- Arabian	Leguminosae (Papilionoidae)	Chamaephyte (semi-shrub
Otanthus maritimus	Mediterranean	Compositae(Asteraceae)	Chamaephyte (semi-shrub)
Pancratium maritimum	Mediterranean	Amaryllidaceae	Geophyte
Sporobolus pungens	Mediterranean	Gramineae (Poaceae)	Hemicryptophyte
Thymelaea hirsute	Mediterranean , Saharo-Arabian	Thymelaceae	Phanerophyte (shrub)
Zygophyllum album	Saharo-Arabian	Zygophyllaceae	Chamaephyte (semi-shrub)

Table (26): Importance and Presence values (P %) of the perennial species associated with *Euphorbia paralias* in different localities. (A= EL-Omayed, B= Abdel Rahman, C =Abu Lahw and D= El Zohirate).

Species	Site No.				Mean IV	P %
	A	B	C	D		
A- **Dominant species**						
Euphorbia paralias	91.92	99.42	131.14	172.36	123.71	100
B- **Associated species**						
a- **perennials**:						
Ammophila arenaria	35.63	-	-	-	8.9	25
Arthrochnemum macrostachyum	-	11.14	-	-	2.78	25
Pancratium maritimum	-	-	30.84	-	7.71	25
Atriplex halimus	-	-	11.49	21.84	8.33	50
Cressa cretica	-	15.43	-	-	3.85	25
Echinops spinosissimus	-	9.78	-	16.61	6.59	50
Elymus farctus	-	-	18.99	-	4.74	25
Limoniastrum monopetalum	-	20.37	-	-	5.09	25
Lotus polyphyllos	56.3	-	-	-	14.07	25
Lycium shawii	-	18.89	-	-	4.72	25
Nitraria retusa	-	25.66	-	-	6.41	25
Ononis vaginalis .	18.74	-	-	-	4.68	25
Otanthus maritimus	37.52	-	-	-	9.38	25
Sporobolus pungens	-	-	20.43	-	5.10	25
Thymelaea hirsuta	-	-	17.35	15.63	8.24	50
Zygophyllum album	-	24.07	-	18.48	10.63	50
Echium angustifolium	-	-	10.0	-	2.0	25

Table (27): Results of physical and chemical analyses of soil supporting *Euphorbia paralias* in different localities. (M.C = moisture content, F = fine, s = sand, m = medium, V = very and S +C = Silt +Clay, Fra. = Fraction and O.C = Organic carbon)

Locality	Profile depth cm	Physical characters						Chemical characters									
		M.C %	Soil particles %				Sandy fra.%	pH	Ec mmohs / cm	Cations and anions (Meq/L)						O.C %	$CaCO_3$ %
			m.s	F.s	V.F.s	S +C				Ca^{++}	Mg^{++}	Na^{+}	K^{+}	Cl^{-}	SO^{--}_4		
El Omayed	0- 20	3.48	2.0	67.0	30.6	0.4	99.6	7.76	0.415	2.12	1.3	1.95	0.33	3.4	0.77	0.02	94.0
	20-40	3.82	23.0	60.6	15.0	1.4	98.6	7.75	0.315	2.0	1.1	1.56	0.28	3.5	0.50	0.01	93.0
Abdel Rahman	0- 20	0.88	2.8	56.7	36.3	4.2	95.8	7.45	1.15	8.1	4.25	1.82	0.3	5.0	3.50	0.18	92.5
	20-40	1.38	0.6	54.5	41.2	3.7	96.3	7.5	0.77	5.15	2.5	1.08	0.35	3.0	0.83	0.11	91.0
Abu Lahw	0- 20	1.3	2.1	56.7	38.2	3.0	97.0	7.63	0.6	1.9	1.25	2.26	0.35	3.9	0.96	0.04	93.0
	20-40	1.75	5.4	49.3	43.2	2.1	97.9	7.72	0.455	1.5	1.0	2.21	0.28	3.7	0.51	0.03	91.0
El Zohirate	0- 20	1.17	2.1	61.2	34.0	2.7	97.3	7.62	1.3	2.56	1.55	1.17	0.53	11.0	0.76	0.05	91.0
	20-40	2.28	1.3	51.0	45.2	2.5	97.5	7.62	0.67	1.2	1.8	2.95	0.35	5.5	0.90	0.04	89.9

6- *Lotus polyphyllos* E. D. Clarke

6.1. Taxonomical features

Family Leguminosae comprises about 642 genera and 18.000 species mostly herbs or shrubs trees or lianes with zygomorphic flower and legume (pod) fruit. Family Leguminosae including three subfamilies namely: Papilionoideae, Caesalpinioideae and Mimosoideae. Subfamily papilionoideae including about 12 genera and 150 species. Genus *Lotus* including about 100 species distributed around the world, mostly annuals, herbs, perennials or subshrubs with 3-5 foliolate leaves. Some of these species are used as a source of lectins, in folk medicine they are used as contraceptive, prophylactic agents and for treating sexually transmitted disorders and for peptic ulcer. In Egypt genus *Lotus* is represented by eighteen (18) species. *Lotus polyphyllos* E. D. Clarke, Travels 2 (2): 41 (1814) (syn. *Lotus argenteus* Webb & Berthel., Phyt. Canar. 3 (2, 2): 87 (1842), non Salisb., Prodr. 333 (1796), nom. Illeg.) was subjected to investigation (Bolous 1999).

6.1.1. Macro- morphological characters

Lotus polyphyllos is a subshrub 30-60 cm tall (figure 43). Root brownish color, much branched and spreading widely in the soil. Stems erect, weak, densely silvery-white pubescent, many, richly branched from the base and covered densely by leaves. Leaf blade 0.5-1.2 cm, crowded and usually covering the stem, mostly 3-foliate, sessile. Leaflets 2-5 (-8) x 1-2.5 (-4) mm, ovate-lanceolate, acute. Inflorescence, axillary, pedunculate 0.5-1.5 cm, 1-4 flowered; flowers yellow, turning brownish when dry, 7-9 mm, calyx 5.5-7mm, the teeth unequal, corolla slightly

longer than the calyx. Pod, sub cylindrical with a persistent deflexed style, 5-7 x 2.5 x 3 mm, 2-seeded; seeds ovoid 1.5 mm. All plant parts "except corolla and pod" with densely silvery-white pubescent. Flowering period of *Lotus polyphyllos* started in spring season from April to June followed by fruiting, seed dispersal directly in June and August. Plant is vegetative in winter and spring season (see figure 44, 45 &46).

6.2. Geographical distribution

World distribution: *Lotus polyphyllos* grows along the Mediterranean strip of Africa. In Egypt: *Lotus polyphyllos* is restricted to west Mediterranean coastal sand dunes area (Täckholm 1974, Zahran 1989 and Bolous 1999).

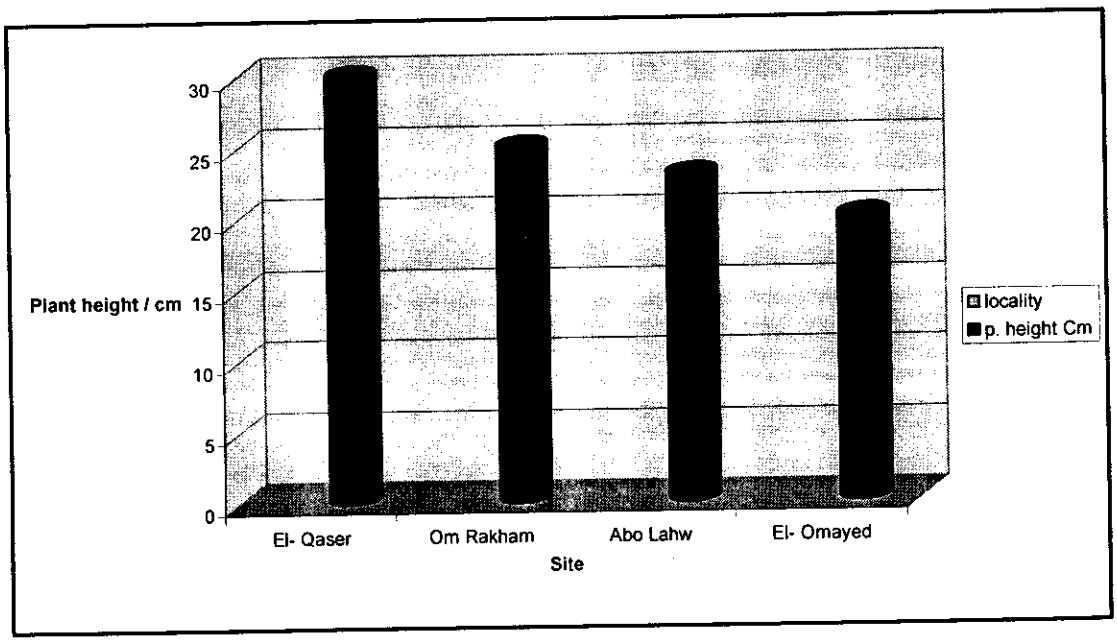


Figure (43): Histogram showing height of *L. polyphyllos* grows in different sites, Med. coast.

(44)

(45)

Figure (44): A hummock covered with *Lotus polyphyllos* growing on the Mediterranean calcareous coastal sand dunes (Om Rakham site) (25 / 4/ 2004).

Figure (45): Flowering individuals of *Lotus polyphyllos* growning on the Mediterranean calcareous coastal sand dunes (El Qasser site) (25 / 4/ 2004).

Figure (46): Community of *Lotus polyphyllos* associated with *Ammophilla arenaria*, Mediterranean calcareous coastal sand dunes (Om Rakham site) (25 / 4/ 2004).

6.3. Ecological features

6.3.1. Floristic composition

The floristic composition of the community dominated by *Lotus polyphyllos* (table 28) indicates that, ten species belonging to seven families. The most characteristic families are Gramineae 20.0% represented by two species, *Ammophila arenaria* and *Elymus farctus*. Compositae 20.0% represented also by two species, *Hyoseris radiata* and *Otanthus maritimus*. Cruciferae (20.0%) represented also by two species, *Diplotaxis acris* and *Cakile maritima*. Leguminosae, Zygophyllaceae, Boraginaceae and Euphorbiaceae (10.0%) represented by one species each: *Ononis vaginalis, Zygophyllum album, Echium angustifolium* and *Euphorbia paralias*, respectively.

6.3. 2. Life form

The recorded species associated with *Lotus polyphyllos* belonging to four different life forms. Chamaephyte was the dominant life form recorded (50.0%), it is represented by five species namely: *Zygophyllum album, Otanthus maritimus, Euphorbia paralias, Ononis vaginalis* and *Echium angastifolium*. Hemicryptophyte (20.0%) includes two species, *Ammophila arenaria* and *Elymus farctus*. Therophyte (20.0%) also contain two species, *Diplotaxis acris* and *Cakile maritima*. *Hyoseris radiata* is the only geophyte (10.0 %) recorded in the site (table 28 &figure 47).

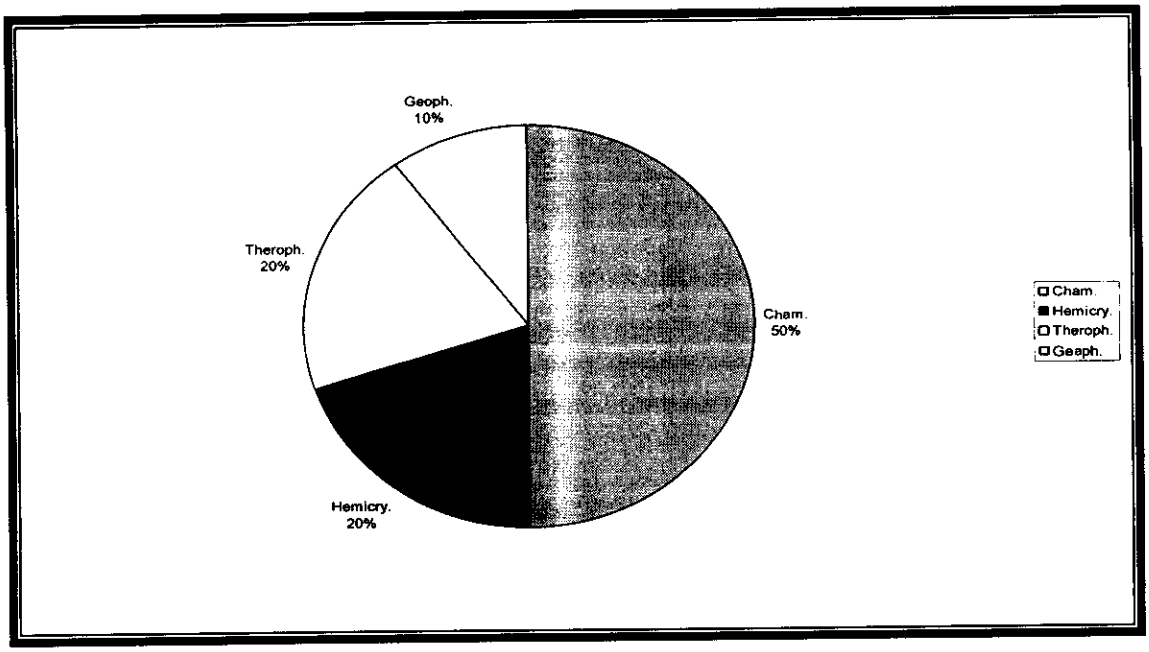


Figure (47): Histogram showing life form of plants associated with *L. polyphyllos*.

6.3. 3. Chorology

Most of the species associated with *Lotus polyphyllos* belonging to Mediterranean element. **Mono-regional** elements (80.0 %) represented by eight species. Six species are Mediterranean and two species are Saharo–Arabian. **Bioregional** elements (20.0 %) represented as one Mediterranean, Euro-Siberian species and one East Mediterranean, West Sahro- Arabian species.

6.3.4. Vegetation analysis:

The vegetation analysis of the community dominated by *Lotus polyphyllos* (table 29) based on the mean importance value showed, the dominance of *Lotus polyphyllos* with a highest IV value (123.15) as well as the highest presence value (P = 100%). The abundant perennial species are *Ammophila arenaria*, *Otanthus maritimus* and *Euphorbia paralias* with IV values (56.38, 32.40 and 23.19) and presence value (P= 100, 50.0 and 50.0 %), respectively. The remaining five perennial species associated with *Lotus polyphyllos* are: *Zygophyllum album* (IV = 13.91

and P = 75 %), *Hyoseris radiata* (IV = 13.35 and P = 50%), *Elymus farctus* (IV = 13.29 and P = 50 %), *Ononis vaginalis*, (IV= 11.57 and P =50 %) and *Echium angastifolium* (IV= 5.67 and P =25 %). The two annual species associated; *Diplotaxis acris* and *Cakile maritima* were recorded in El Qasser stands (figure 48).

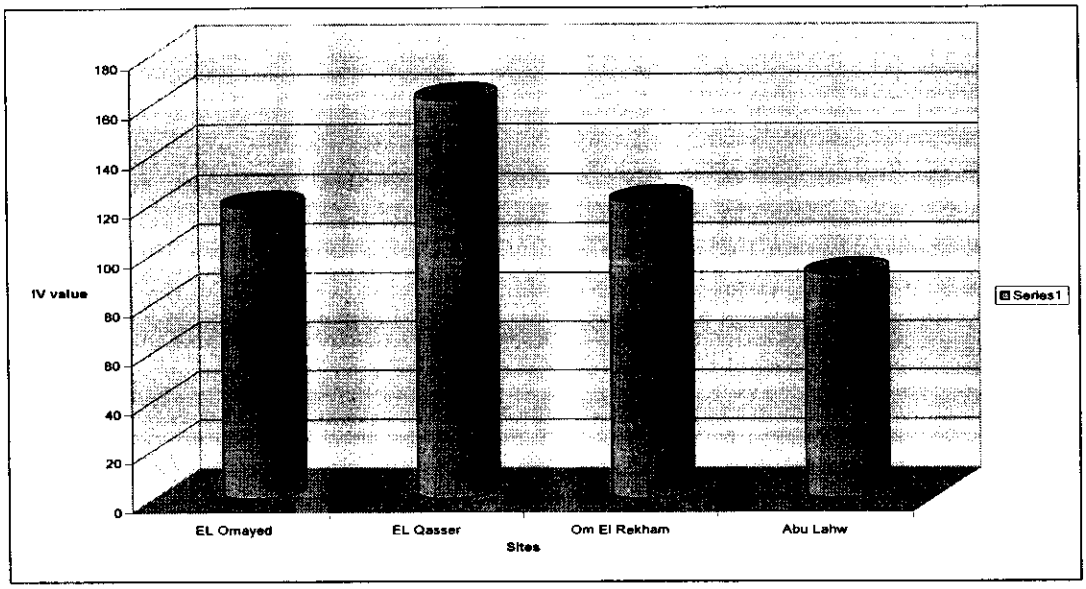


Figure (48): Histogram showing importance values of *L. polyphyllos* in different sites.

6.3.5. Soil analysis

6.3.5.1. Physical properties

6.3.5.1.1. Soil texture

The mechanical analysis of the soil supporting *Lotus polyphyllos* in different localities are shown in (table 30). The retrieved data indicates that the suitable soil is sandy: its sand fraction (including medium, fine and very fine sand) ranges from (95.50%) in El Omayed site to (99.3) in Abu Lahw site. Silt and clay fraction ranges from (0.7) at Abu Lahw site to (4.5%) at El Omayed site.

6.3.5.1.2. Moisture content (MC)

Soil moisture content outlined in (table 30) showed that there was gradual increase in soil moisture content with the increase in soil depth. Soil moisture attains its maximum value (3.91%) at subsurface (20-40 cm) layer in Abu Lahw stands, while its minimum value was (1.94%) at surface layer (0-20cm) layer in Om Rakham site.

6.3.5.2. Chemical properties

6.3.5.2.1. Soil reaction (pH)

The soil reaction is neutral or slightly alkaline where it range between (7.33- 7.68). Soil reaction reached its maximum values 7.68 at subsurface layer (20-40cm) in El Qasser stands, while its minimum values were 7.33 at the surface layer (0-20 cm) at El Omayed stands (table 30).

6.3.5.2.2. Electric conductivity (EC)

Table (30) show that the electric conductivity of the soil supporting the growth of *Lotus polyphyllos* is slightly saline soil where it reached its maximum values (1.77 mmhos/cm) at the surface layer (0-20 cm) in El-Omayed stands, while its minimum value was (0.27 mmhos/cm) at the surface layer (0-20 cm) in Om Rakham stands.

6.3.5.2.3. Water-soluble anions (Cl^- and SO_4^{--})

The data of soluble anions (Cl- and SO4--) outlined in (table 30) showed that, the maximum concentration of soluble anions in the studied habitats is (15.13 Meq/L) at the surface layer (0-20 cm) in El Omayed site, while its minimum value was (2.23 Meq/L) at the surface layer (0-20 cm) in Om Rakham stands, which show the same variation trend of the electrical conductivity. Chloride ions concentration showed higher concentrations than sulphates in all the studied sites.

6.3.5.2.4. Water soluble cations (Ca^{++}, Mg^{++}, Na^{+} and K^{+})

The soluble cations (Ca^{++}, Mg^{++}, Na^{+} and K^{+}) data outlined in (table 30) indicates that the soil supporting the growth of *Lotus polyphyllos* species dominated by Sodium ions. Its concentration ranges from (16.08 Meq/L) at El Omayed site to (1.11 Meq/L) at El Qasser stands. While concentration of calcium and magnesium ions not exceeding (4.0 Meq/L) in the studied sites and decreased to (0.72 Meq/L) as in Om Rakham site. Potassium ions showed the minimum concentration in all the studied cations its maximum concentration (0.72 Meq/L) was detected in El Omayed site, while its minimum value was (0.20 Meq/L) at El Qasser stands.

6.3.5.2.5. Calcium Carbonate ($CaCO_3$)

The data outlined in (table 30) indicates that *Lotus polyphyllos* tends to grow in $CaCO_3$ rich soil, and it is apparently its growth limiting factors, this is indicated from the calcium carbonate fraction which not decreased than (88%).

6.3.5.2.6. Organic carbon (O.C)

Soils supporting the growth of *Lotus polyphyllos* plant are very poor in organic carbon content. Percent of organic carbon reached to (0.12%) as a maximum value at surface layers of El Omayed stands, while its minimum value was (0.01%) at surface layers of El Qasser site.

6.4. Uses

The phytochemical screening of *Lotus polyphyllus* plant revealed that it contain flavonoids, volatile oils, tannins, sterols saponins, chlorides, sulphates, resins, reducing sugars, carbohydrates or glycosides and traces of alkaloids which useful in many medicinal drugs (Rizk 1986 and El Mousallami *et al.*, 2002).

Table (28): Floristic composition of *Lotus polyphyllos* community, for each species: chorology, family and life form were mentioned.

Species	Chorology	Family	Life form
Lotus polyphyllos	West Sahro-Arabian	Leguminosae (Papilionoldae)	Chamaephyte (semi-shrub)
Ammophila arenaria	Mediterranean	Gramineae (Poaceae)	Hemicryptophyte
Cakile maritima	Mediterranean, Euro-Siberian	Cruclferae	Therophyte (annual)
Diplotaxis acris	Saharo-Arabian	Cruciferae	Therophyte (annual)
Echium angastifolium	Mediterranean	Boraginaceae	Chamaephyte (semi-shrub)
Elymus farctus	Mediterranean extending to south Europe	Gramineae (Poaceae)	Hemicryptophyte
Euphorbia paralias	Mediterranean extending to west Europe	Euphorbiaceae	Chamaephyte (semi-shrub)
Hyoseris radiata	Mediterranean	Compositae (Asteraceae)	Geophyte
Ononis vaginalis	East Mediterranean, West Sahro-Arabian	Leguminosae (Papillonoidae)	Chamaephyte (semi-shrub)
Otanthus maritimus	Mediterranean	Compositae(Asteraceae)	Chamaephyte (semi-shrub)
Zygophyllum album	Saharo-Arabian	Zygophyliaceae	Chamaephyte (semi-shrub)

Table (29): Importance and Presence values (P %) of the perennial species associated with *Lotus polyphyllos* in different localities. (A= EL Omayed, B= EL Qasser, C =Om El Rakham and D= Abu Lahw)

Species	Site No.				Mean IV	P %
	A	B	C	D		
A- **Dominant species**						
Lotus polyphyllos	118.62	161.9	120.57	91.52	123.15	100
B- Associated species						
a- **perennials**:						
Ammophila arenaria	57.38	46.66	82.46	39.04	56.38	100
Echium angustifolium	-	-	22.17	-	5.67	25
Elymus farctus	-	25.67	-	27.5	13.29	50
Euphorbia paralias	41.43	-	-	51.35	23.19	50
Hyoseris radiata	-	18.56	34.87	-	13.35	50
Ononis vaginalis	-	19.35	26.95	-	11.57	50
Otanthus maritimus	59.31	-	-	70.3	32.4	50
Zygophyllum album	22.89	-	12.75	20.03	13.91	75
b- Annuals						
Diplotaxis acris	-	+	-	-	-	-
Cakile maritime	-	+	-	-	-	-

Presence of annual species (+ = rare).

Table (30): Results of physical and chemical analyses of soil supporting *Lotus polyphyllos* in different localities. (M.C = moisture content, F = fine, s = sand, m = medium, V = very and S +C = Silt +Clay, Fra. = Fraction and O.C = Organic carbon)

Locality	Profile depth cm	Physical characters						Chemical characters									
		M.C %	Soil particles %				Sandy Fra. %	pH	Ec mmohs / cm	Cations and anions (Meq/L)						O.C %	$CaCO_3$ %
			m.s	F.s	V.F.s	S +C				Ca^{++}	Mg^{++}	Na^{+}	K^{+}	Cl^{-}	SO^{-}_{4}		
El Omayed	0- 20	3.0	15.4	72.3	7.8	4.5	95.5	7.33	1.77	2.9	1.15	16.08	0.72	13.8	1.33	0.12	94.0
	20-40	3.83	11.0	80.0	8.2	0.8	99.2	7.56	1.55	2.7	1.12	13.91	0.72	12.1	1.29	0.11	92.0
El Qaser	0- 20	2.1	1.4	45.5	51.3	1.8	98.2	7.61	0.28	1.94	1.0	1.11	0.20	3.0	0.28	0.01	95.0
	20-40	3.7	2.0	46.4	49.6	2.0	98.0	7.68	0.34	1.62	1.0	1.34	0.28	3.3	0.26	0.01	91.0
Om Rakham	0- 20	1.94	6.2	46.5	44.7	2.6	97.4	7.5	0.27	1.9	0.72	1.22	0.22	2.0	0.23	0.03	90.0
	20-40	2.48	2.7	47.5	46.5	3.2	96.8	7.61	0.31	1.52	1.1	1.36	0.23	2.8	0.39	0.01	88.0
Abo Lahw	0- 20	3. 21	2.0	70.2	27.1	0.7	99.3	7.54	0.7	4.0	4.0	3.17	0.38	8.5	0.37	0.05	93.6
	20-40	3.91	2.3	60.7	36.1	0.9	99.1	7.66	0.73	3.5	2.5	3.30	0.35	9.0	0.43	0.03	91.0

7-*Populus euphratica* Oliv.

7.1. Taxonomical features

Family Salicaceae comprises two genera (*Salix* and *Populus*) and 435 species mostly dioeciously deciduous trees or shrubs. Genus *Populus* comprises 35 species distributed around the world. In Egypt *Populus* represented by one naturalized species *Populus euphratica* Oliv, Voy. Emp. Othoman, ed. Min., 6: 319, t. 45, 46 (1807) (syn. *Populus ariana* Dode, *Populus diversifolia* Schrenk (Rüger *et al.*, 2005) growing on the slopes of the high sand dunes in Siwa oasis (Bolous 1999). This species was introduced to Siwa Oasis during the Roman time about 331 B.C.(Belgrave 1923 and Zahran 1972).

Arabic names: Reqeiqaab ،رقيقاب Merseesh, Hour الحور (Täckholm 1974)
English names: Indian poplar, Euphrates poplar

7.1.1. Macro- morphological characters

Populus euphratica is a medium-size to large deciduous tree with rarely straight stem, often bushy, up to 15 m (not exceeding ten meters in Egypt). Bark on old stems is olive green (grayish) with irregular vertical fissures. Stem is often bent and always forked, branches slender. Root shallow, spreading widely. Leaves are highly polymorphic, juvenile leaves linear-lanceolate, usually entire 7-15 cm x 6-12 cm (2.3 - 13 cm length and 2.0 - 2.9 cm width in Egypt. table 31). Petiole 7-15 cm long (1.0 - 2.2 cm in Egypt). Leaves on mature shoots, rhombic or broadly ovate to triangular, sharply lanceolate in the upper half, 5-7.5 cm long (3.7 - 15.5 cm long and 5.4 - 11.3 cm width in Egypt), base 3-5 nerved with long petiole 1-5 cm long (2.5 – 5 cm in Egypt).Catkins lax, male

2.5-5 cm long. Stamens 12-24. Female catkins 5-7 cm long, ovary sessile, stigmas 3 biforked. Fruit capsule, ovoid-lanceolate 7-12 mm long (1-1.2 cm ovoid, 2-3 valved in Egypt) with pedicel 4-5 mm. Seed numerous, with tuft of long silky hairs. Flowering period of *Populus euphratica* occurred before leaf production, it started in winter season till spring (from January to April). Fruiting beginning in late March till May. Seed dispersal followed fruiting months directly. Vegetative growth period started in late winter till autumn season for about seven months (see figure 49, 50 &51).

7.2. Geographical distribution:

World distribution: *Populus euphratica* grows in North Africa, Libya, Egypt, SW and central Asia, Israel, Syria, Iraq, Iran, Turkey, Turkmenistan, Pakistan, India, Algeria and China (Michael *et al.*, 1999, Rüger *et al.*, 2005 and World Agroforsty Center 2006). In Egypt it is naturalized plant on sand dunes surrounding some lakes of Siwa Oasis Belgrave (1923) and Zahran (1972 & 1989).

(49)

(50)

Figure (49): Trees of *Populus euphratica* associated with *Tamarix aphylla* (25 / 5/ 2004).

Figure (50): Pure community of *Populus euphratica*, sand dunes of Siwa Oasis (25 / 5/ 2004)..

Figure (51): Close up view of the leaves and inflorescence of *Populus euphratica*, sand dunes of Siwa Oasis (25 / 5/ 2004)..

7.3. Ecological features

7.3.1. Floristic composition

The floristic composition of the community dominated by *Populus euphratica* indicates, nine perennial species belonging to 7 families. The most characteristic families are Chenopodiaceae and Gramineae (22.22%) represented by two species each, *Atriplex leucoclada, Cornulaca monacantha, Imperata cylindrica* and *Phragmites australis* respectively. Tamaricaceae, Zygophyllaceae, Palmae, Typhaceae and Leguminosae which represented by one species each (table 33)

7.3.2. Life form

The recorded species associated with *Populus euphratica* are belonging to four different life forms. Phanerophyte was the dominant life form recorded 33.33%, it represented by three species namely: *Tamarix aphylla, Phoenix dactylifera* and *Acacia saligna.* Chamaephyte 33.33%, also represented by three species: *Atriplex leucoclada, Cornulaca monacantha* and *Zygophyllum album.* Hemicryptophyte (22.22%) include two species, *Imperata cylindricall,* and *Phragmites australis. Typha domingensis* is the only helophyte (11.11) recorded in the site (table 33, figure 52).

7.3.3. Chorology

Mono-regional elements are represented by five species (55.55%): three species are Saharo–Arabian and one species for each of Australian and Sudanian. **Bioregional** species (11.11%), are represented by one Irano-Turanian and Saharo-Arabian species. **Pluriregional** (33.33%),

represented by two species for Mediterranean, Irano-Turanian, Saharo-Arabia and one species pluriregional; boreal-tropical (figure 53).

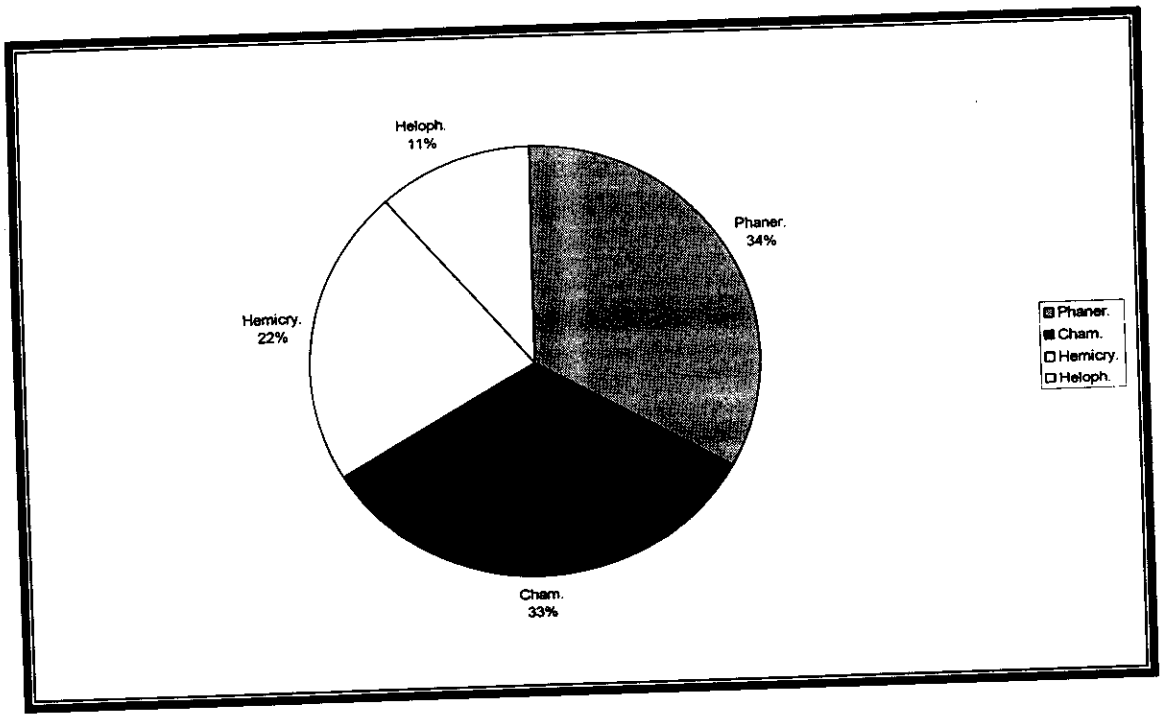


Figure (52): Histogram showing life form of plants associated with *P.euphratica.*

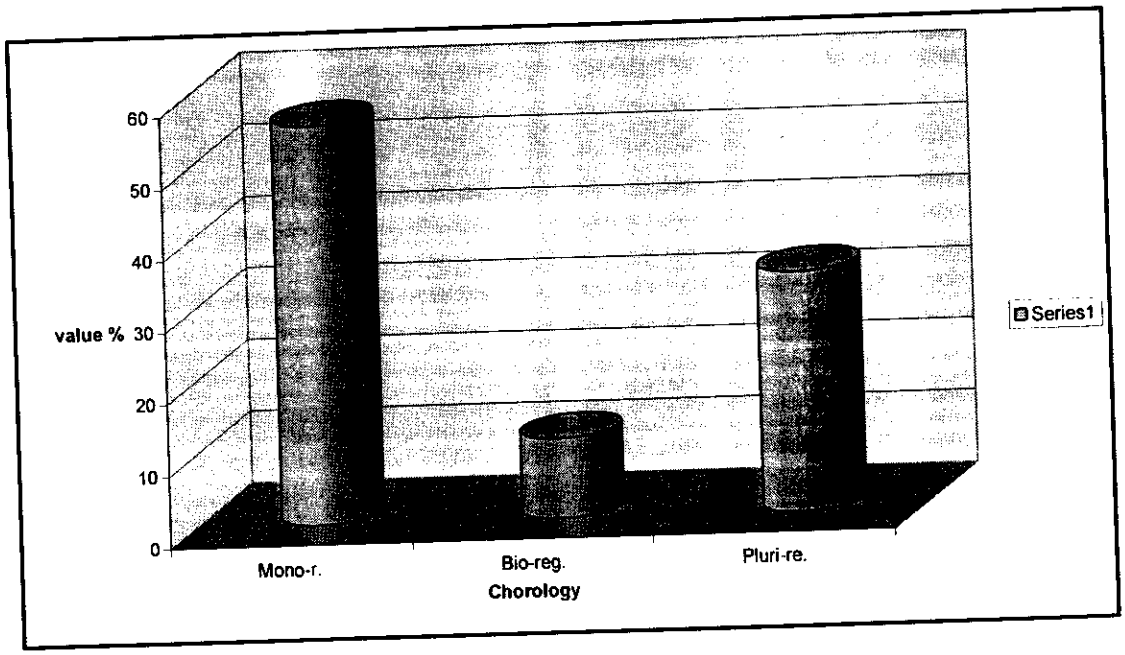


Figure (53): Histogram showing chorology of plants associated with *P.euphratica.*

7.3.4. Vegetation analysis

The vegetation analysis of the community dominated by *Populus euphratica* (table 34) based on the mean importance value show that, the dominance of *Populus euphratica* with a highest IV value (140.89) and also the highest presence value (P = 100%). The abundant species are *Phoenix dactylifera* and *Cornulaca monacantha* with IV value (36.61 & 20.46) and presence value (P=100%) respectively. Four of the associated with IV values ranges between (11.75 to 7.52): *Tamarix aphylla* (IV = 11.75 and P = 50 %), *Zygophyllum album* (IV = 11.5 and P = 100%) *Atriplex leucoclada* (IV = 9.9 and P = 50 %), and *Acacia saligna* (IV= 7.52 and P =50 %). The remaining three species are *Imperata cylindrical* (IV = 4.05 and P = 50 %), *Typha domingensis* (IV = 3.8 and P = 50 %), and *Phragmites australis* (IV =3.1 and P = 50 %).All the associated species are perennials.

7.3.5. Soil analysis

7.3.5.1. Physical properties of soil

7.3.5.1.1. Soil texture

The soil mechanical analysis (table 32) indicated that the soil is sandy. The percentages of coarse fraction was (85.7%) (including medium, fine and very fine sand). Percentages of medium sand was (3.0 %). While the percentages of fine sand were (24.3 %) and (25.8 %) for the (0-20) and (20-40) cm layers, respectively. On the other hand the value of very fine sand were 58.4 % and 57.1 % at the same layers. Silt and clay reached (14.3 %) at the surface layer (0-20 cm) and (13.5 %) at the (20-40 cm) layer.

7.3.5.1.2. Moisture Content (MC)

Soil moisture content outlined in table (32) showed that there was gradual increase in soil moisture content with the soil depth. It was amounted 12.1 % at surface layer (0-20cm), and 12.6 % at lower layer (20-40cm).

7.3.5.2. Chemical properties:

7.3.5.2.1. Soil reaction (pH)

The soil reaction is neutral or slightly alkaline where it reached 7.33 at the surface layer (0-20 cm) and 7.59 in the bottom layer (20-40cm).

7.3.5.2.2. Electric conductivity (EC)

Table (32) show that the electric conductivity of the soil supporting growth of *Populus euphratica* is saline soil where it reached 5.5 mmhos/cm at the surface layer (0-20 cm) and 4.0 mmhos/cm in the lower layer (20-40cm).

7.3.5.2.3. Water soluble anions (Cl^- and SO_4^{--})

The data of soluble anions outlined in table (32) showed that, the concentration of soluble chloride ions in the studied habitat is high it reached 37.3 Meq/L at the surface layer (0-20 cm) and 35.7 Meq/L in the lower layer (20-40 cm) which show the same variation trend of the electrical conductivity. The soluble sulphate where reached 4.75 Meq/L at the surface layer (0-20 cm) and 2.42 Meq/L in the lower layer (20-40cm).

7.3.5.2.4. Water soluble cations (Ca^{++}, Mg^{++}, Na^+ and K^+)

The soluble calcium ions in the studied habitat reached 4.4 Meq/L at the surface layer (0-20 cm) and 3.5 Meq/L in the subsurface layer (20-40 cm). While magnesium ions reached 3.2 Meq/L at (0-20 cm) and 2.15

Meq/L in the subsurface layer (20-40cm). Sodium ions are the major soluble cation in the soil supporting the growth of Populus euphratica it reached 30.43 Meq/L at the surface layer (0-20 cm) and 27.82 Meq/L in the bottom layer (20-40cm). Table (32), indicates that the soil salinity induced by sodium chloride. Potassium ion concentration was the same in both of the soil layers; it reached 6.66 Meq/L (Table 32).

7.3.5.2.5. Calcium Carbonate ($CaCO_3$)

The percent of calcium carbonate ($CaCO_3$) reached 34.3 % at the surface layer (0-20 cm) and 28.4 % in the sub surface layer (20-40cm).

7.3.5.2.6. Organic carbon (O.C)

Percent of organic carbon reached to 0.28 and 0.22% at surface and subsurface layers of Siwa Oasis stands respectively.

7.4. Uses

Leaves are good fodder for sheep, goats and camels. May be used as a source of fiber for various grades of paper (fine paper, packing paper and newsprint). Wood is moderately hard and light; it is easy to saw and works to a good finish. Used for planking, lacquer work, artificial limbs, matchboxes and splints. It is also suitable for plywood, cricket bats, shoe heels and bobbins. Bark is vermifuge. Twigs are chewed and used for cleaning teeth. The spreading dense, conical crown acts as a windbreak and shelters. Forestation of saline soils in sandy desert regions. The tree crown intercepts rain and checks soil erosion, thereby improving soil physical properties. Ornamental tree for roadsides. *Populus euphratica* is an ideal for intercropping with agricultural crops as maize, wheat, cowpea, potatoes and sugarcane. The plant is used for detecting potable water either fresh or slightly saline water (Danin 1983, Michael *et al.*, 1999, Rüger *et al.*, 2005 and World Agroforsty Center 2006).

Table (31): Morphological characters (Stem and Leaf) of *Populus euphratica* measured as mean value. growing in Siwa Oasis (juv.= juvenile and mat. = mature)

Locality	Stem					Leaf			
	plant Height (m)	Number of Main Branch / Plant	Number of Lateral / Main Branch	Crown Cover (m2)	Crown Volume (m3)	Number of Leaf / Lateral Branch	Length of Leaf blade (cm)	Width of Leaf blade (cm)	Length of Leaf Petiole (cm)
Siwa Oasis	7.0	1	70.0	14.3	65.9	130	9.0	6.6	3.0
Range	4-10	1-2	60-80	8 -18.2	45-70.3	110-150	2.3-13.0 juv. 3.7-15.5 mat.	2-2.9 juv. 5.4-11.3 mat.	1-2.2 juv. 2.7-5 mat.

Table (32): Results of physical and chemical analyses of soil supporting *Populus euphratica* growing in Siwa oases. (M.C = moisture content, F = fine, s = sand, m = medium, V = very and S +C = Silt +Clay, Fra. = Fraction and O.C = Organic carbon)

Locality	Profile depth cm	Physical characters						Chemical characters								
		M.C %	Soil particles %				Sandy fra. %	pH	Ec mmohs / cm	Cations and anions (Meq/L)						O.C %	$CaCO_3$ %
			m.s	F.s	V.F.s	S +C				Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CL^{-}	SO_4^{--}		
Siwa Oasis	0- 20	12.1	3.0	24.3	58.4	14.3	85.7	7.33	5.5	4.4	3.2	30.4	6.66	37.3	4.75	0.25	46.0
	20-40	12.6	3.6	25.8	57.1	13.5	86.5	7.59	4.0	3.5	2.15	27.8	6.66	35.7	2.42	0.22	28.0

Table (33): Floristic composition of *Populus euphratica* community, for each species: chorology, family and life form were mentioned.

Species	Chorology	Family	Life form
Populus euphratica	Irano-Turanian , Saharo-Arabian	Salicaceae	Phanerophyte (tree)
Acacia saligna	Australian	Leguminosae (Mimosoideae)	Phanerophyte (tree)
Atriplex leucoclada	Irano-Turanian , Saharo-Arabian	Chenopodiaceae	Chamaephyte (semi-shrub)
Cornulaca monacantha	Saharo-Arabian	Chenopodiaceae	Chamaephyte (semi-shrub)
Imperata cylindrical	Med , Irano-Turanian , Saharo-Arabian	Gramineae (Poaceae)	Hemicryptophyte
Phoenix dactylifera	Saharo-Arabian	Arecaceae (Palmae)	Phanerophyte (tree)
Phragmitis australis	pluriregional; boreal-tropical	Gramineae (Poaceae)	Hemicryptophyte
Tamarix aphylla	Sudanian	Tamaricaceae	Phanerophyte (tree)
Typha domingensis	Med , Irano-Turanian , Saharo-Arabian	Typhaceae	Helophyte
Zygophyllum album	Saharo-Arabian	Zygophyllaceae	Chamaephyte (semi-shrub)

Table (34): Importance and Presence value (P %) of the perennial species associated with *Populus euphratica* growing in Siwa Oasis. (A, B - Siwa Oasis)

Species	Stand No		Mean IV	P %
	A	B		
A- Dominant species *Populus euphratica*	151.17	130.62	140.89	100
B- Associated species a- perennials: *Acacia saligna*	15.04	-	7.52	50
Atriplex leucoclada	19.81	-	9.90	50
Cornulaca monacantha	30.53	10.4	20.46	100
Phoenix dactylifera	33.227	40	36.61	100
Tamarix aphylla	23.51	-	11.75	50
Zygophyllum album	18	5	11.5	100
Typha domingensis	-	7.6	3.8	50
Imperata cylindrica	-	8.1	4.05	50
Phragmites australis	-	6.2	3.1	50