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Analysis of Habitats and Anatomy of *Juncus subulatus* Forssk, Deltaic Mediterranean Coast, Egypt

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ABSTRACT. *Juncus subulatus* is a salt tolerant rush growing in the coastal and inland salt affected wetlands of Egypt. Its dense growth usually occurs in the wetlands associated with the northern deltaic lakes of Egypt.
The floristic composition and vegetative yield of *Juncus subulatus* community were studied in eight sites of the deltaic Mediterranean coastal belt of Egypt. The associate species are mainly halophytes and helophytes. The means of moisture content, fresh weight and dry weight of *Juncus subulatus* culms were: 70%, 351 gm/m^2 and 102 gm/m^2 respectively. The anatomical studies show that these culms contain highly developed chlorenchyma tissues and the sclerenchyma are absent except in the vascular bundles. Sclereides and calcium oxalate were not detected. This may explain that *J. subulatus*, unlike *Juncus rigidus* and *Juncus acutus*, is not a fibre producing rush but it may be proposed as a fodder halophyte for domestic animals.

The flora of Egypt comprises nine species belonging to the genus *Juncus* (family Juncaceae), viz: *J.acutus*, *J.bufonius*, *J.rigidus*, *J.fontanesii*, *J.inflexus*, *J.littoralis*, *J.punctorius*, *J.hybridus* and *J.subulatus* (Mohamed 1980), most of them are salt tolerant and are growing in areas with hot and dry climate. For these advantages, these plants attracted the attention of the workers particularly in the arid region of the world. Many studies have been published on *Juncus rigidus* and *J.acutus*, these include: Täckholm and Drar (1954), Walter (1961), Boyko (1966), Zahran *et al.* (1972, 1977, 1979), Osman *et al.* (1975), Zahran (1975, 1986, 1993), Zahran and Abdel Wahed (1982), El-Demerdash (1978, 1984), Hammad (1989) and El-Katony (1991). These studies throw light on the ecological, physiological and anatomical characteristics as well as on the agro-industrial potentialities of these two rushes as fiber producing halophytes. However, and as far as the writers are aware, fewer studies were dealt with *Juncus subulatus e.g* Willis and Davies (1960) and Mohamed (1980).

Egypt is an arid country with vast areas of saline and non-saline deserts and high rate of population increase. The agricultural production of Egypt is so limited that the government imports the major parts of its essentials (foods, fodder for livestock, raw materials etc.) from abroad (Zahran 1992). Thus, a search for non-conventional crops that can be cultivated under salinity and/or aridity stress is badly needed.

Field observation on the wetlands of the deltaic Mediterranean coastal belt of Egypt indicate that the domestic animals are grazing *Juncus subulatus* culms. Thus, it is a salt tolerant rush worth to be studied aiming at considering it as one of the forage potential halophytes in Egypt and other countries of the arid region.

The present paper includes ecological and anatomical investigation on *Juncus subulatus* growing in the wetlands associated with the northern lakes of the Nile Delta in the Mediterranean coastal belt of Egypt. It is the first step towards its establishment in the salt affected and non-productive lands of the arid and semi-arid countries.

The Study Area

The coastal area bordering the Nile Delta (the deltaic Mediterranean coastal belt) of Egypt (Fig. 1) is built up of coarse and fine sand, silt and clay deposited by the River Nile (Abu Al-Izz 1971 and Zahran and Willis 1992). The climate is arid of the warm coastal desert type (Meig 1973 Ayyad *et al.* 1983). The mean maximum air temperature varies from 17.4 °C in winter and 31.0 °C in summer and the mean minimum temperature ranges between 8.4 °C in winter to 24.9 °C in summer. Relative humidity is lower in winter (65%) than in summer (81%) and evaporation rate ranges between 2.8 mm/day in winter and 7.8 mm/day in summer. Winter is the rainy season, more than 80% of rain falls during November- February period. Mean annual rainfall ranges between 91.6 mm to 175.2 mm. (Anonymous 1976).

According to Zahran *et al.* (1990), the main habitats of the Deltaic coastal belt are: salt marshes, sand formations, swamps (wetlands) and fertile non-cultivated lands. The wetlands, where *Juncus subulatus* grows, are found in depressions where water is accumulating through seepage from the nearby lakes of the Nile Delta, namely: Manzala, Burullus and Idku (Fig. 1).

Geographical Distribution

Juncus subulatus is a maritime species which is mainly distributed in the Mediterranean Basin and around the Capsian Sea (Täckholm and Drar 1950, Maire and Weiller 1957). In Egypt, it occurs around the Mediterranean and in salt marshes

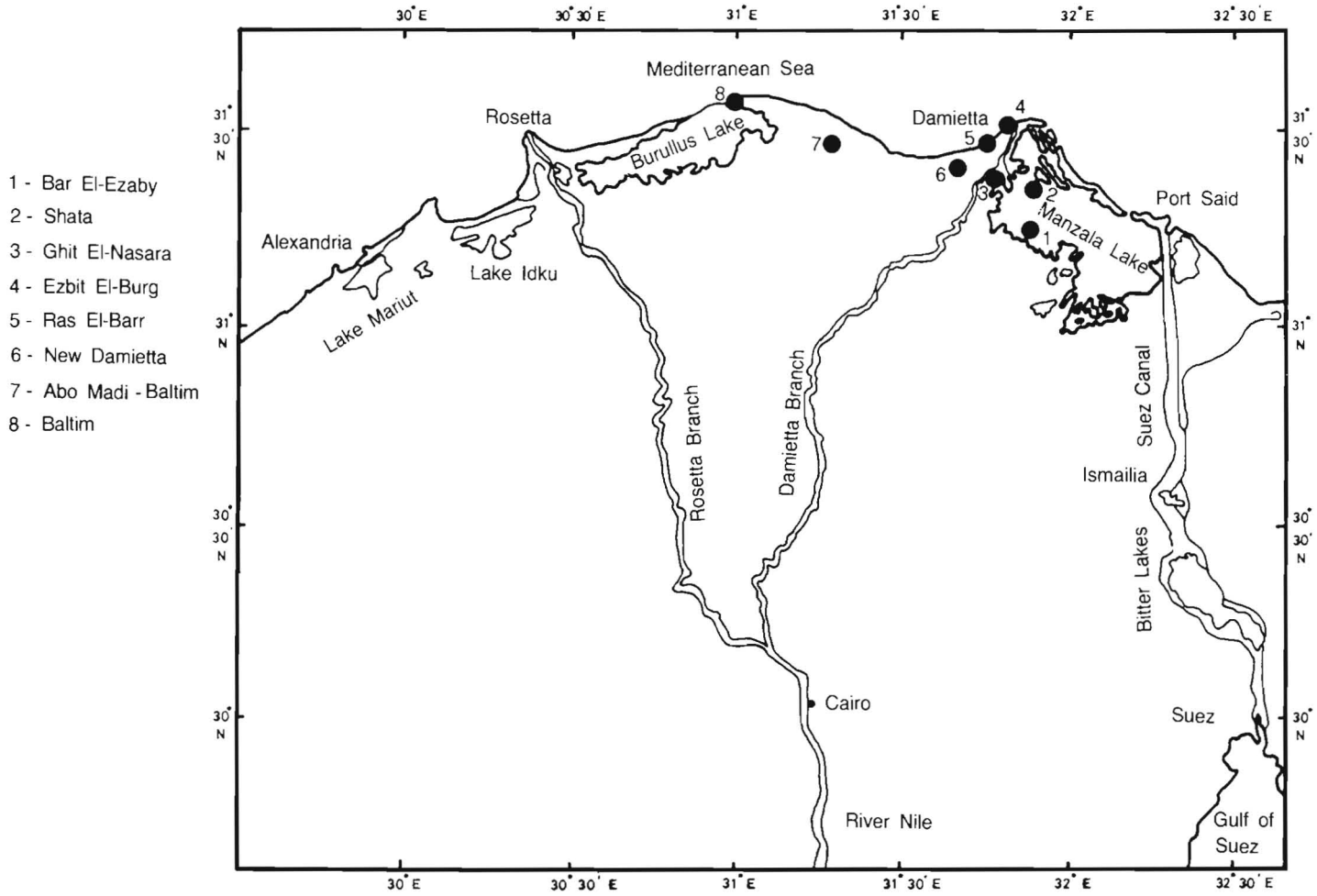


Fig.1. Map of the Nile Delta of Egypt showing the eight studied sites.

not far from the sea and is especially abundant between Port Said and Alexandria. According to Mohamed (1980), this rush is common moist places and marshes of the Mediterranean coast, in the depressions of the western desert, the Nile Delta, the Nile Valley to Lake Nasser, and the Faiyum.The plant is recorded along fresh water canals at Port Said, and appears to survive in non-saline habitats (Maire and Weiller 1957). It extends westwards along the Mediterranean coast of North Africa as far as Morocco, inland in the Ahaggar region of the Sahara, and at high altitudes of the Algerian plateaux (Braun-Blanquet 1932). *Juncus subulatus* occurs also along the eastern Mediterranean shores from Syria and Turkey to Spain as well as in the British Isles (Willis and Davies 1960). The rush is also recorded growing along the irrigation canals and marshy places in Saudi Arabia (Migahid 1978).

Materials and Methods

A. The Vegetation

After a preliminary survey of the wetland areas in the coastal area of the Nile Delta, eight localities were selected for the present study. These sites were: Bar El-Ezaby, Shata, Ghit El-Nasara, Ezbit El-Burg, Ras El-Barr, New Damietta, Abo Madi and Baltim. Ten stands (10×10 m each) dominated by *Juncus subulatus* were analysed. The selection of stands was based on the following criteria:

1. A minimum degree of disturbance.
2. Floristic composition and structure of the community.
3. A reasonable degree of physiographic and physiognomic homogeneity.

B. The Soil

Soil samples were collected from each stand at two depths. From the surface (0-25 cm) five samples were taken, pooled together to form one surface sample. Also, at subsurface depth (25-50 cm) five samples were collected and combined to a composite sample and treated as one sample unit. All these samples were taken to the laboratory in plastic bags shortly after collection. The samples were spread over sheets of paper, air dried, thoroughly mixed and then passed through a 2-mm sieve to remove gravel and debris, packed in plastic bags and made ready for analysis.

Soil-water extracts at a 1:5 ratio (100 g dry soil was dissolved in 500 ml distilled water) were prepared. Soil reaction (pH value) was determined using a digital pH-meter. The electrical conductivity (mmhos/cm) was measured using a conductivity meter. Oxidizable organic carbon was determined using Walkely and Black rapid titration method whereas calcium carbonate was determined by titration against hydrochloric acid (Piper 1947 and Jackson 1962).

C. Standing Crop

In each stand, three quadrats (0.5 m× 0.5 m) equal to 0.25 m^2 were harvested. The selection of quadrats was based on the fact that a minimum disturbance *i.e.* no grazing as well as the production was not influenced by previous harvesting or firing. The above-ground material was sorted in the field into dead and live shoots. Live shoots were cleaned, put into plastic bags and brought to the laboratory shortly after harvesting. Fresh weight was determined and the harvested shoots were oven dried to constant weight at 70 °C Dry weight (g/m), water content, and succulence (fresh weight/ dry weight) were determined. The succulence was calculated according to Tiku (1975). The percentages were calculated on fresh weight basis.

D. Anatomical Investigations

For anatomical investigations, samples of culms, rhizomes and root were fixed in formalin- acetic acid- alcohol. After fixation, specimens were dehydrated in tertiary butyl alcohol series and embedded in paraffin wax according to Johansos (1940). Sections of 10-12 micron thick were made using a rotatory microtome and doublestained with safranin and fast green, and mounted in canada balsam.

Results

Habitat Analysis

In Ghit El-Nasara site *Juncus subulatus* dominates, stands growing along the margins of swampy habitats and wet salt marshes of Lake Manzala. Also, this rush was recorded in the depressions in the dry salt marsh where water is accumulated by seepage. *Juncus subulatus* may reach more than 1 m in height with vigorous growth especially along the ditches used as fish pond. Discussions with fishermen revealed that they are using fresh water to increase water level of fish pond to recycle the added artificial food as well as renew oxygen supply for fish in the pond. They pointed out that they are using *Juncus subulatus* as a fodder for cattle and donkeys. Field observations indicated that the rush is a palatable fodder to animals and is usually overgrazed.

The most commom associate perennial helophytes include: *Typha domingensis, Scirpus tuberosus, Phragmites australis, Juncus acutus, J.rigidus* and *Cyperus laevigatus.* In the relatively dry saline areas, the associates are halophytes including: *Arthrocnemum macrostachym, Atriplex portulacoides, Inula crithmoides , Frankenia hirsuta, Tamarix tetragyna*, and *Pluchea dioscoridis.* The associate annuals recorded are: *Chenopodium murale, Malva parviflora* and *Kochia indica* (Table 1).

Table 1. Perennial and annual species recorded in the stands of *Juncus subulatus* located in the Deltaic Mediterranean Coast of Egypt

Stand No.	Locality	Date	Perennials	Annuals
1	Ghit El-Nasra	24/12/91	*Typha domingensis* *Scirpus tuberosus* *Phragmites australis* *Arthrocnemum macrostachyum* *Inula crithmoides* *Juncus rigidus* *J. acutus* *Tamarix tetragyna* *Cyperus laevigatus* *Atriplex portulacoides* *Cressa cretica* *Frankenia hirsuta* *Pluchea dioscoridis*	*Chenepodium murale* *Malva parviflora* *Kochia indica*
2	Shata	31/12/91	*Arthrocnemum macrostachyum* *Inula crithmoides* *Phragmites australis* *Cyperus laevigatus* *Scirpus tuberosus* *Atriplex protulacoides* *Typha domingensis* *Frankenia hirsuta*	*Spergularia marina* *Sonchus oleraceus* *Kochia indica*
3	Ezbit El-Burg	7/1/92	*Diplachne fusca* *Phragmites australis* *Inula crithmoides* *Atriplex portulacoides* *Arthrocnemum macrostachyum*	
7	Ezbit El-Burg	27/3/92	*Phragmites australis* *Arthrocnemum macrostachyum* *Atriplex portulacoides* *Scripus tuberosus* *Tamarix tetragyna*	*Suaeda salsa* *Polypogon monspeliensis* *Chenopodium murale* *Senecio desfontaineii*
8	Ezbit El-Burg	8/4/92	*Arthrocnemum macrostachyum* *Atriplex portulacoides* *Inula crithmoides* *Phragmites australis*	*Polypogon monspeliensis* *Spergularia marina* *Chenopodium murale* *Cutandia memphetica* *Sonchus oleraceus* *Kochia indica*

Table 1. Contd.

Stand No.	Locality	Date	Perennials	Annuals
4	Ras El-Barr	13/3/92	*Scripus tuberosus* *Imperata cylindrica* *Arthrocnemum macrostachyum* *Inula crithmoides* *Juncus acutus* *J.rigidus* *Typha domingensis* *Cyprus laevigatus* *Halocnemum strobilaceum*	*Polypogon monspeliensis*
5	New Damietta	18/3/92	*Juncus rigidus* *J.acutus* *Inula crithmoides* *Arthrocnemum macrostachyum* *Phragmites australis* *Tamarix tetragyna* *Carex extensa*	*Spergularia marina* *Cutandia memphetica*
6	Bar El-Ezaby	23/3/92	*Juncus rigidus* *J.acutus* *Typha domingensis* *Inula crithmoides* *Arthrocnemum macrostachyum* *Atriplex portulacoides*	
9	Baltim	17/4/92	*Juncus acutus* *J.rigidus* *Inula crithmoides* *Arthrocnemum macrostachyum* *Phragmites australis* *Scripus tuberosus* *Tamarix tetragyna*	*Spergularia marina* *Cutandia memphetica* *Polypogon monspeliensis* *Mesembryanthemum crystallinum* *M.nodiflorum*
10	Abo Madi	17/4/92	*Juncus rigidus* *J.acutus* *Typha domingensis* *Inula crithmoides* *Alhagi graecorum* *Tamarix tetragyna*	*Mesembryanthemum crystallinum* *M.nodiflorum* *Chenopodium murale* *Polypogon monspliensis*

The results of soil analysis of this locality (Table 2A and B) show that the pH of the surface layers attains 7.9 while in the subsurface layers it is 8.2. Soil salinity varies from 2.2 mmhos/cm in the surface layer to 0.83 mmhos/cm in the subsurface layers. Organic carbon exhibited values ranged from 2.22% in the surface and 0.72%in the subsurface one. The highest percentage of $CaCO_3$ (90%) was obtanied in the subsurface layers whereas, it attained a precentage of 77% in the surface ones.

In Shata area *Juncus subulatus* showed a specific distribution. It is confined only to the depressed saline areas. The most common associates are: *Arthrocnemum macrostachyum. Inula crithmoides, Cyperus laevigatus, Scirpus. tuberosus, Atriplex portulacoides* and *Diplachne fusca.* Three annuals were recorded as associates namely: *Spergularia marina, Sonchus oleraceus* and *Kochia indica.*

The soil reaction of this site is alkaline with pH of 8.6 in surface and 8.4 in the subsurface layers. Soil salinity is 1.4 mmhos/cm in the surface and 1.5 mmhos/cm in the subsurface layers. In this locality, calcium carbonate is relatively low as it exhibits a value of 54% in the surface and 42% in the subsurface layers.

Table 2A. Chemical characteristics of surface soil samples (0-25 cm.) collected from stands dominated by *Juncus subulatus*. EC = electrical conductivity, O C = organic carbon, SD = standard deviation

Stand No	Locality	Date	pH	EC (mmhos/cm.)	OC (%)	$CaCO_3$ (%)
1	Ghit El-Nasara	24/12/91	7.9	2.20	2.22	77
2	Shata	31/12/91	8.6	1.40	1.86	54
3	Ezbit El-Burg	7/1/92	8.8	1.90	1.86	43
4	Ras El-Barr	13/3/92	7.9	0.77	0.06	40
5	New Damietta	18/3/92	8.2	0.75	0.21	7
6	Bar El-Ezaby	23/3/92	7.2	8.30	6.00	43.5
7	Ezbit El-Burg	27/3/92	8.1	1.10	1.29	28
8	Ezbit El-Burg	8/4/92	8.4	1.75	1.47	28
9	Baltim	17/4/92	7.8	1.50	0.81	24.5
10	Abo Madi	17/4/92	7.5	1.40	0.15	41.5
Mean			8.04	2.11	1.59	38.7
SD			0.49	2.22	1.73	18.8

The vegetation around Ezbit El-Burg is mainly halophytic, the most common associate perennials are: *Phragmites australis*, *Diplachne fusca*, *Arthrocnemum macrostachyum*, *Inula crithmoides*, *Atriplex portulacoides*, *Scirpus tuberosus* and *Tamarix tetragyna*. Many annuals were also recorded including. *Polypogon monspeliensis*, *Spergularia marina*, *Chenopodium murale*, *Sonchus oleraceus*, *Kochia indica*, *Cutandia memphetica*, *Suaeda salsola* and *Senecio desfontaneii*.

The soil supporting the growth of *Juncus subulatus* in this site is alkaline with pH ranges from 8.1 to 8.8 in the surface and from 8.4 to 8.9 in the subsurface layers. Soil salinity varies from 1.1 to 1.9 mmhos/cm in the surface and from 1.4 to 1.9 mmhos/cm in subsurface layers respectively. Organic carbon and calcium carbonates are relatively low. Organic carbon varied from 1.3 to 1.9% in the surface and from 0.5 to 0.7% in the subsurface. The range of calcium carbonate was 28 to 43% in the surface and from 25 to 42% in the subsurface layers (Table 2A and B).

Table 2B. Chemical characteristics of subsurface soil samples (25-50 cm.) collected from stands dominated by *Juncus subulatus*. EC = electrical conductivity, O C = organic carbon, SD = standard deviation

Stand No	Locality	Date	pH	EC (mmhos/cm.)	OC (%)	$CaCO_3$ (%)
1	Ghit El-Nasara	24/12/91	8.2	0.83	0.72	90
2	Shata	31/12/91	8.4	1.50	0.21	42
3	Ezbit El-Burg	7/1/92	8.4	1.90	0.66	42
4	Ras El-Barr	13/3/92	7.9	0.80	0.15	28
5	New Damietta	18/3/92	7.8	1.40	0.63	12
6	Bar El-Ezaby	23/3/92	7.5	2.60	2.55	62.5
7	Ezbit El-Burg	27/3/92	8.8	1.50	0.6	26
8	Ezbit El-Burg	8/4/92	8.9	1.39	0.54	24.5
9	Baltim	17/4/92	8.2	0.70	0.15	22
10	Abo Madi	17/4/92	7.7	1.30	0.06	42.5
Mean			8.2	1.39	0.63	39.2
SD			0.46	0.57	0.72	22.9

The community of *Juncus subulatus* in Ras El-Barr site is confined to the depressed waterlogged stands. The associate perennials are: *Scripus tuberosus*, *Imperata cylindrica*, *Arthrocnemum macrostachyum*. *Inula crithmoides*, *Juncus acutus*, *J. rigidus*, *Typha domingensis*, *Cyperus laevigatus* and *Halocnemum strobilaceum*.

Soil reaction is slightly alkaline (pH is 7.9) in both surface and subsurface layers. soil salinity in relatively low, with a value of 0.8 mmhos/cm in both surface and subsurface layers. Organic carbon is very low where itexhibited avalue of 0.06%in the surface layer and 0.15% in the subsurface layers. Calcium carbonate attained a value of 40% in surface and 28% in the subsurface layers.

In the New Damietta site *Juncus subulatus* community occurs around a fish pond. It is associated with a complex rush growth of *Juncus acutus* and *J. rigidus*. Other associated species recorded are: *Inula crithmoides*, *Phragmites australis*, *Tamarix tetragyna* and *Carex extensa*. The soil of this site is alkaline: pH 8.2 in the surface and 7.8 in the subsurface layers. Soil salinity ranges between 0.8 mmhos/cm in the surface and 1.4 mmhos/cm in the subsurface layers.

Pure community of *Juncus subulatus* occurs on Bar El-Ezaby sandy island of Lake Manzala. The vegetation of this island in halophytic in the center of the island and helophytic on its borders.The halophytic vegetation is represented by the complex growth of rushes *(Juncus acutus* and *J.rigidus)*.The reed swamp vegetation is mainly exhibited by a vigorous growth of *Phragmites austarlis* and *Typha domingensis*. *Juncus subulatus* is confined to the depressed areas in the center of the island. The under ground water level was very shallow (about 10 cm). The most common associates are: *Arthrocnemum macrostachyum*. *Inula crithmodes*, and *Atriplex portulacoides*.

The soil of the island is highly saline and rich in organic matter. The relatively, highest value of organic carbon (6%) was recorded in the surface layers of this site. Soil salinity varied between 8.3 mmhos/cm. in the surface and 2.6 mmhos/cm. in the subsurface layers.

Abo Madi is a coastal village in the Nile Delta. It is characterized by huge mobile sand dunes which are practically barren. The interspaces between the dunes is covered by halophilous vegetation. This is probably due to the leaching of salts from dunes. *Juncus subulatus* was observed in a pure community in depressed areas between dunes. It is associated with *Juncus rigidus*, *J.acutus*, *Inula crithmoides*, *Alhagi graecorum* and *Tamarix tetragyna*. The annuals recorded on the margin of the community include: *Mesembryanthemum crystallinum ,M. nodiflorum,Chenopodium murale* and *polypogon monspeliensis*.

In the transitional area between the sand dunes and the salt marches of Baltim coastal site, there are depressed areas co-dominated by *Juncus subulatus* and *J.rigidus*. The most common associates are: *Inula crithmoides*, *Arthrocnemum macrostachyum*, *Phragmites australis* and *Scirpus tuberosus*.

The soil supporting this community is characterized by two defined layers:

1) A sandy surface layer with pH 7.8, relatively low salinity electric conductivity (1.5 mmhos/cm), very low organic carbon content (0.15%).
2) A loamy subsurface layer with pH equals to 8.2, very low salinity (E.C = 0.7 mmhos/cm), and very low contents of both organic carbon (0.15%) and calcium carbonate (22%).

Table 3. Standing of *Juncus subulatus* in the different localities in the Deltaic Mediterranean Coast of Egypt. FW=Fresh weight, DW = Dry weight WC = Water content and suc = succulence, SD = Standard deviation

Quadrat No.	Locality	Date	FW (g/m^2)	DW (g/m^2)	WC (%)	SUC
1	Ghit El-Nasara	25/1/92	132	42	68.2	3.1
2	Shata	25/1/92	108	48	55.6	2.3
3	Ezbit El-Burg	7/1/92	610	150	75.4	4.1
4	Ras El-Barr	13/3/92	200	52	74	3.8
5	Ghit El-Nasara	13/3/92	530	136	74.3	3.9
6	Shata	13/3/92	490	114	76.7	4.3
7	New Damietta	18/3/92	320	80	75	4
8	Bar El-Ezaby	23/3/92	266	108	59.4	2.7
9	Ezbit El-Burg	27/3/92	300	52	82.7	5.8
10	Ezbit El-Burg	8/4/92	372	106	71.5	3.5
11	Shata	15/4/92	694	238	65.7	2.9
12	Baltim	17/4/92	170	50	70.6	3.4
13	Abo Madi	17/4/92	370	148	60	2.5
Mean			351	102	70	4
SD			185	57	8	1

A

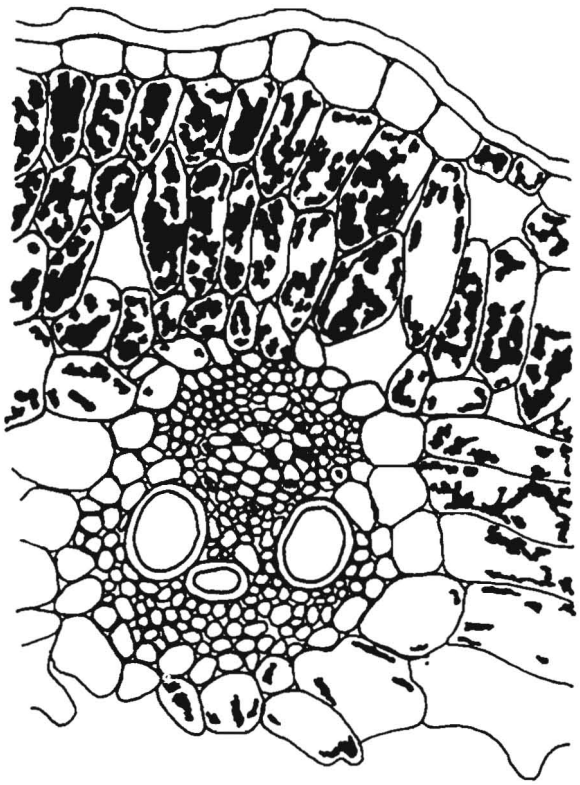
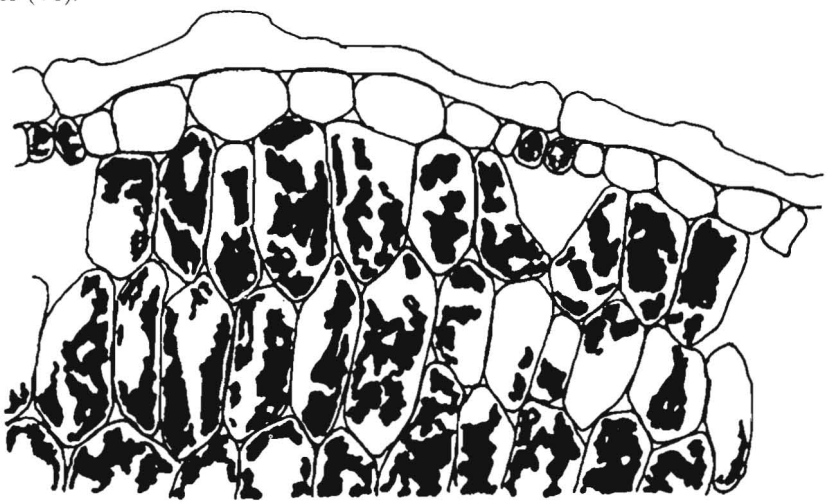


Fig.2. Transverse section in culm of *Juncus subulatus*.
A : Showing that the cortex is formed of palisade cells (Pl). sclerenchyma cells (Sc) are located outside the bundles (Vb).

B



B : Showing the thick cuticle overarched by small papillae (P) from margins and also covers the guard cells (g).

The standing crop of *Juncus subulatus* was studied in the different sites during the period from January to April, 1992. The results are presented in Table 3. The maximum fresh weight (FW) of 694 g/m^2 with a mean value of 370 g/m^2 and standard deviation (SD) 185 were obtained in a stand located in Shata on 15 April, 1992. The minimum FW of 108 g/m^2 was recorded in a stand of the salt marsh of the same site. This is probably due to the effect of salinity. The field observations and the measured height varies widely from 10 to 150 cm. The highest standing crop was obtained in the sites with relatively low soil salinity. The dry weight varied from 42 to 238 g/m^2 with a mean value of 102 g/m^2 (SD = 57). The water content, expressed as the degree of the succulence (SUC), varied from 2.5 in a stand located on Abo Madi on 17 April, 1992 to 5.8 in a stand of Shata on 27 March, 1992 The mean value of succulence is 4 (SD = 1.0 in all sites).

Anatomical Investigations

In the present work investigations were carried out on *Juncus subulatus* to show the differences between its anatomy and those of *Juncus rigidus* and *J.acutus* reported by Cutler (1969) and Zahran *et al.* (1972)

In the culms of *Juncus subulatus*, the cuticle is rather thick, overarched by small papillae from margins of surrounding epidermal cells (Fig. 2B). The epidermis is formed of a single layer. The cell walls of the epidermal cells differ in thickness, the outer walls are thicker than the inner ones. The stomata are superfical and the cuticle covers the guard cells. The cortex is formed of the chlorenchymatous tissue consisting of palisade cells in 2-3 layer following the epidermis. Haslinger (1914) stated that there is no sclerenchyma cylinder in the culm of *Juncus subulatus*, However, a sclerenchyma cylinder was found in materials examined by Cutler (1969). The present work showed that there is no sclerenchyma cylinder or strands next to the epidermis in the culm of the Egyptian materials of *Juncus subulatus*. The vascular bundles are arranged in a cycle of two rings soaked in the parenchymatous (ground) tissue. The vascular bundles of the outer ring are usually smaller than these of the inner ring. Generally, the bundles are enclosed with large parenchyma cells. Two groups of sclerenchymatous cells are located outside the bundles,one outside the phloem and the other outside the xylem (Fig. 2A).

The outer part of the rhizome in composed of entrant leaf or scale bases and adventitious roots. The cortex is normally parenchymatous, the cells being polygonal. There is an exodermis of several layers of cells with slightly thickened walls. The outer most vascular bundles are usually in a state of fusion and segregation and shows evidence of the collateral form. The inner vascular bundles run in various directions

throughout the center of the rhizome and are amphivasal. Individual bundles are usually enclosed in one layer of a sclerenchymatous sheath (Fig. 3).

In the roots of *Juncus subulatus* the piliferous layer is freqently persistant. The root-hairs show some variations. They may be as wide as or narrower than the cell from which they arise. Beneath the piliferous layer, there is a hypodermis composed of cells similar in size to the epidermal cells and exodermis which consist of 1-3 layers of cells with slightly thickened, lignified walls (Fig. 4). The cortex is composed of several layers of parenchyma cells with large intercellular spaces, followed by a layer of an endodermis separating it from the vascular tissue. The pericycle is normally well developed as 1-2 layers of narrow cells with cellulose walls. Phloem strands alternate with xylem arches in a peripheral ring next to the pericycle.

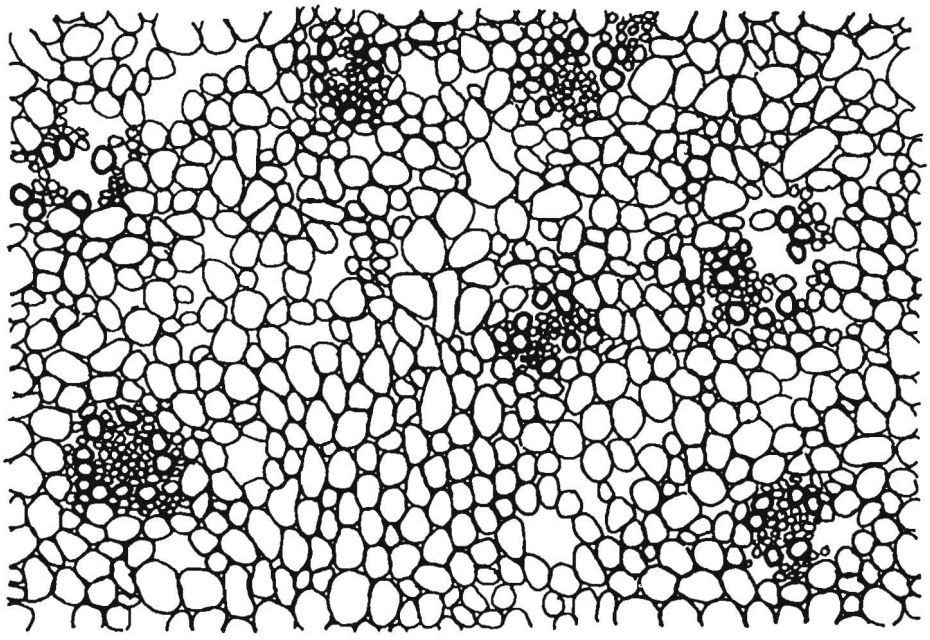


Fig.3. Transverse section in rhizome of *Juncus subulatus* showing that the outer part of the rhizome is composed of entrant leaf.

Conclusion

Juncus subulatus is one of the halophytes of Egypt (Zahran 1982), however, it may occasionally grow also in less saline wet lands. It is known that sclerenchyma tissue is the one of the fiber material used in fiber industry *e.g.* paper making as for example in *Juncus rigidus* and *J.acutus*. The absence of sclerenchyma tissue from *Juncus subulatus* may indicate that the rush is not fiber producing plant but it is a palatable forage halophyte. Furthermore, no calcium oxalate crystals nor sclereids were detected in *Juncus subulatus* and thus make it useful as a forage as proved by Hassan and Mohamed (1992). Intensive efforts should be directed to introduce this rush to revegetate the vast salt affected land along the deltaic coast of Egypt and make use of its vegetative yield as a fodder for domestic animals.

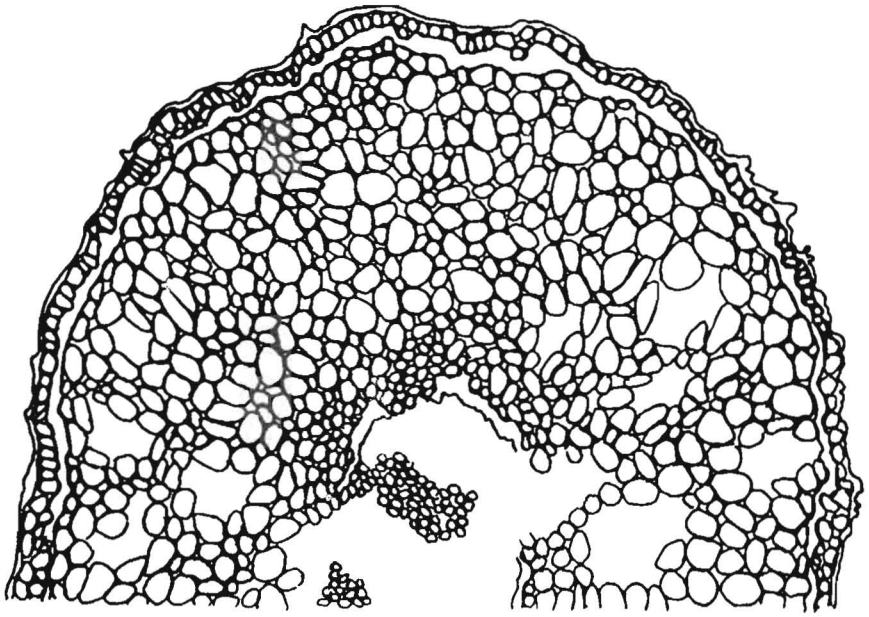


Fig.4. Transverse section in root of *Juncus subulatus* showing hypodermis (H) and exodermis (E) of slightly thickenned cells.

References

Abu Al-Izz, M.S. (1971) *Land forms of Egypt*, American Univ. Press. Cairo, Egypt, 281 p.

Anonymous, (1976) Climatological Normals for U.A.R. (Egypt)- Ministry of Military Production, Meteorological Department, Cairo, Egypt.

Ayyad, M.A., Abdel-Razik, M. and **Mehanna, A.** (1983) Climatic and vegetational gradients in the Mediterranean desert of Egypt. Pre-report of the Mediterranean Bioclimatology Symposium, Montpellier (France, 18-20 May pp. III-I-III-2-14).

Boyko, H. (1966) Basic ecological principles of plants growing by irrigation with highly saline or sea water. Chapter 2 Salinity ans Aridity. Junk. Publisher. The Hague pp. 131-200.

Braun-Blanquet, J. (1932) *Plant Sociology*. New York and London.

Cutler, D.F. (1969) *Anatomy of Monocotyledon*. IV J uncales. Claredon Press, Oxford.

El-Demerdash, M.A. (1978) *Comparative studies on the transplantation and economic potentialities of Juncus rigidus* C.A. Mey and *J.acutus* L.M.Sc. Thesis, Fac. Sci. Mansoura Univ., Egypt.

El-Demerdash, M.A. (1984) *Ecological studies on Juncus plants in Egypt*. Ph.D. Thesis, Fac. Sci. Mansoura Univ., Egypt.

El-Katony, S.T. (1991) *Comparative studies on some selected fiber-producing plants of Egypt*. Ph.D. Thesis, Fac. Sci. Mansoura Univ., Egypt.

Hammad, I.E. (1989) *Gene ecological and cytological studies on Juncus and Kochia plants*. Ph. D.Thesis Fac. of Science, Mansoura University, Egypt.

Haslinger, H. (1914) Vergleichende Anatomie der Vegetationsrgane der Juncaceen. Abh. Akad. Wiss. Wien Math-Naturw. Kl. **123**: 1147-1194.

Hassan, T.E. and **Mahamed, B. K.** (1992) Evaluation of the nutritive values and animal feeding on *Juncus subulatus* and *Diplachne fusca* chapters 9-10 In: Revegetation of the salt affected lands of the Deltaic Mediterranean coastal lands, Egypt. Project No. 90009 Phase II, Final Report Jan-June 1992. pp. 149-165.

Jackson, M.L. (1962) *Soil chemical analysis*. Constable and Co. Ltd, London.

Johanson, D.R. (1940) *Plant Microtechnique*. McGraw-Hill Co., New York.

Maire, R. and **Weiller, M.** (1957) In Maire, R, Flore de l'Afrique du Nord, 4,259 (Encyclopedia Biologique, 53). Paris.

Meig P. (1973) World distribution of coastal deserts. Coastal deserts, their natural and human environments Ed. by **David, H.K., Amiran** and **Wiloon, A. W.** The Univ. of Arizona Press: 3-12.

Migahid M.A. (1978) *Flora of Saudi Arabia*.Riyadh University,Riyadh, Saudi Arabia.Two Vols,939 p.

Mohamed, N.E. (1980) *Studies in the genus Juncus in Egypt*. M. Sc. Thesis, Fac. Sc, Cairo University, Egypt.

Osman, F., Zahran, M.A. and **Fiad, S.** (1975) Potentialities of the seeds of the Egyptian Flora for oil production. *Bull. Fac. Sci.* Mansoura University Egypt, **3**: 85-95.

Piper, C.S. (1947) *Soil and Plant Analysis*. Interscience Publishers, Ins, New York.

Täckholm, V. and **Drar, M.** (1950) Flora of Egypt 2 *Bull. Fac. Sci.* Cairo Univ. Egypt. **28:** 449-482.

Tiku, B. L. (1975) Ecophysiological aspects of halophyte zonation in sloughs. *Plant and sloughs. Plant and Soil.* **43:** 355-369.

Walter, H. (1961)The adaptation of plants to saline soils.In salinity problems in the arid zones, proceedings of the Tehran Symposium, UNESCO, Paris. Arid Research **14:** 129-134.

Willis, A.J. and **Davies, E. W.** (1960) *Juncus subulatus* Forssk in the Britsh Isles. Watsonia **4** (5): 211-217.

Zahran, M. A. (1975) On the germination of seeds of *Juncus rigidus* C.A. Mey and *J.acutus*. L.*Bull. Fac. Sc.* Mansoura Univ., Egypt. **3:** 75-85.

Zahran, M.A. (1982) Ecology of the halophytic vegetation of Egypt. In: Contributions to the ecology of Halophytes, edited by **Sen, D.N.** and **Rajpurohir, K.S.** Tasks for vegetation Science 2, Dr. **Junk, W.** Publishers, The Hague, London (Reference book): 3-20.

Zahran, M. A. (1986) Establishment of fiber producing halophytes in salt affected areas of Egypt. Prospects for Biosaline Research. Proc. of U.S-Pak. Biosaline Res. Workshop. Ed. by **Amad, R.** and **Pietro, san A.** pp. 235-251.

Zahran, M. A. (1992) *Juncus* and *Kochia: Fiber* and fodder producing halophytes under salinity and aridity stresses. In: Handbook of Crop Stress ed. by **Pessarakli, M.** Arizona Univ., U.S.A. Publ. Marcel Deker. Inc. New York , 697 p.

Zahran, M. A. and **Abdel Wahed, A. A.** (1982) *Halophytes and human welfare.* In: **David, N. Sen** and **Kiishan, S.** Rajparohit (ed.) Contributions to the Ecology of Halophytes: **Dr. Junk, M.** Publishers. The Hague, London. pp. 235-257.

Zahran, M. A. and **Willis A. J.** (1992) *The vegetation of Egypt.* Chapman and Hall Publ. London, 440 P.

Zahran M. A., Kamal El-Din, H. and **Boulus, S.** (1972) Potentialities of fiber plants of Egyptian Flora in National Economy. L. *Juncus rigidus* C. A. Mey. and paper industry. Bull. Inst. Desert D'Egypt **22:** 193-203.

Zahran, M. A., El-Bagouri, I.H, Abdel Wahed, A.A. and **El-Demerdash, M. A.** (1977) Transplantation of *Juncus* spp. on saline soils, Egypt. Proceeding of the International Salinity Conference, Managing saline water for irrigation, Texas, Tech. Univ, Lubbock, Texas, PP. 142-154.

Zahran, M. A., Abdel Wahed, A.A. and **El-Demerdash, M. A.** (1979) Economic Potentialities of *Juncus* plants. Proceeding of the International Arid land Conference on plant Rescoures, Texas Tech. Univ., Lubbock, Texas, pp. 244-260.

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

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دراسات على بيئة وتشريح نبات الحلين *(Juncus subulatus)* بساحل البحر الأبيض المتوسط لدلتا مصر

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نبات الحلين *(Juncus subulatus)* من نباتات الفصيلة السمارية الذي ينمو في الأراضي السبخة الرطبة الساحلية والداخلية في مصر ـ يغزر نموه على الشريط الساحلي لدلتا نهر النيل وخاصة في المستنقعات المتاخمة للبحيرات الشمالية (المنزلة ـ البرلس ـ إدكو ـ مريوط).

نبات الحلين من نباتات حوض البحر الأبيض المتوسط ولكنه ينمو أيضاً في بعض المناطق الأخرى بالعالم مثل الجزر البريطانية وشبه الجزيرة العربية.

إختص هذا البحث بإجراء دراسات بيئية وتشريحية على نبات الحلين بالمنطقة الساحلية لدلتا نهر النيل حيث تم إختيار ثمان مواقع يسودها هذا النبات وتم دراسة الكساء الخضري في كل موقع كما تم تقدير الإنتاجية والمحتوى المائي للنبات. تم جمع عينات من السوق الورقية لنبات الحلين من كل موقع لتحليلها تشريحياً. وقد أخذ في الإعتبار جمع عينات من التربة عند عمقين، العمق الأول يتراوح من صفر حتى ٢٥ سم والعمق الثاني يتراوح من ٢٥ حتى ٥٠ سم وقد تم تحليل عينات التربة طبيعياً وكيميائياً.

أوضحت النتائج ما يلي :

١ ـ نبات الحلين مثل باقي نباتات الفصيلة السمارية يغزر نموه ويكون كساؤه الخضري كثيفاً في الأراضي المنخفضة القلوية والتي تحتوي على نسبة مرتفعة من الأملاح الذائبة وكذلك على كميات كبيرة من كربونات الكالسيوم والمواد العضوية ـ وتربة هذه العشيرة غالباً ما تكون مشبعة بالماء أو مغمورة ـ تقل كثافة الكساء الخضري لعشيرة الحلين في الأراضي التي يقل فيها المحتوى المائي .

٢ ـ يصل الغطاء النباتي في بعض المواقع إلى أكثر من ٩٠٪ معظمه يكون من نبات الحلين وتشغل النباتات المرافقة التي كان أغلبها من النباتات الملحية ونباتات الجسور والمستنقعات القصيبية بالإضافة إلى عدد قليل من النباتات الحولية كلها تشغل حيزاً قليلاً جداً من هذه المواقع .

٣ ـ أوضحت الدراسات التشريحية خلو نبات الحلين ـ الذي يصل محتواه المائي إلى ٧٠٪ ـ من الألياف الطويلة والأسكلريدات وكذلك لا يحتوي على بلورات أوكسالات الكالسيوم ـ وهذه الصفة التشريحية تميز بعض أنواع الجانكاس وخاصة نوعي *J.acutus* و *J.rigidus* اللذان يستخدمان كمصدر لصناعة الورق .

ويستنتج من هذه النتائج أن نبات الحلين *(Juncus subulatus)* من النباتات البرية التي يمكن إستزراعها في أراضي سبخة رطبة أو مشبعة بالماء لا تصلح لنمو النباتات الأخرى ـ ولعدم إحتوائه على الألياف ولا الأسكلريدات وكذلك بناء على المشاهدات الحقلية ـ فإنه يمكن إقتراح أن تجرى بعض التجارب على زراعة هذا النبات لإستخدامه كعلف للأغنام والأبقار والأرانب وخاصة وأنه يوجد مناطق ملحية شاسعة على إمتداد السواحل المصرية وكذلك حول الآبار والعيون في الصحاري الداخلية .