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WILD SPECIES DIVERSITY IN RAINFED BARLEY IN THE WESTERN MEDITERRANEAN COASTAL AREA OF EGYPT

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Barley fields represent the most fertile area of the western coastal area and surrounded by vast area of uncultivated semi- desert. Fourteen weed species (18% of the total recorded species) were recorded in the Nile fed cultivated area. Specific Mediterranean elements were recorded in this study, of these: *Narcissus tazette, Urginea maritime, Onopordium alexandrinum, Anemone coronaria, Ornithgallum trichophyllum, Deliphinum peregrinum, Anacyllus monthos, Scrzonera alexandrina, Lycium europaeum* and *Carrichtera annua.* Therophytes are the main life form representing 61% of the total recorded species. Application of TWINSPAN and DECORANA classification and ordination techniques to the obtained data have produced four groups. Group A which is characterized by *Deverra tortuosa* as the indicator species. The group B has no indicator species. Group (C) is characterized by *Arisarum vulgare* as indicator species. Group (D) includes *Achillea santolina* and *Calendula arvensis* as indicator species. Soil factors in relation to vegetation groups indicate highly significant correlation with cation (sodium) and anion (bicarbonate). Vegetation group C is characterized by high richness value (46 species) and high species diversity (3.8 ±0.01) while group A has low richness value (10 species) and low species diversity (2.30 ± 0.045). In the last 50 years, the main floristic studies in the area along the Mediterranean coastal area were compared with this study. Seventy-six species were recorded with *Deverra tortuosa* as new association.

Keywords: Mediterranean coast, rainfed barley, associated weeds, Egypt, flora.

The Mediterranean coastal land of Egypt extends for about 970 km between Sallum in the west to Rafah in the east with an average width ranging

between 15- 20 km in the north - south direction, with a total area of about 16500 km^2. This territory comprises the highest number of the recorded species, 1060 species or 51% of the total species represented in the flora of Egypt. El Hadidi (2000) recorded 321 species specific to this territory.

The western section (Mariut coast) extends from Sallum to Abu Qir for about 550 km .The western section is the northern coast of the western desert. It is a thin belt of land parallel to the Mediterranean Sea that narrows or widens according to the position boundary. In the western province of Mariut coast, the plain is narrow or lacking (Zahran and Willis, 1992). It increases gradually in the level westwards and attains a maximum elevation of 20 m above sea level at Sallum, sloping gently northwards. Eastwards, it decreases gradually in level until it loses its line of demarcation with the coastal plain. Soil is uniform and composed of a great thickness of clay and calcareous sands.

Barley fields represent the most fertile area of the western coastal area, recognized and exploited by the Bedouins since remote times and inherited from generation to generation. The farming operation practiced in this area include shallow ploughing followed by throwing grains during October-November, and then left to occasional rainfall. Some of the cultivated areas may not be ploughed regularly and are left fallow in some seasons. In years with low rainfall or unbalanced distribution, the crop may dry out before reaching maturity (Hassib, 1951 and Tadros and Atta, 1958).

STUDY AREA

Six sites were sampled along the coastal area between Mersa Matruh and Sidi Brani : Site 1 (31° 30 N, 26° 13′ 02 E) includes 12 stands (S1-S12), Site 2 (31° 27′ 57 N, 26° 13′ 06 E) has 3 stands (S13- S15), Site 3 (31° 32′ 6 N, 26° 12′ 10 E) includes 6 stands (S16- S21), Site 4 (31° 32′ 0 N, 26° 14′ 02 E) comprises 4 stands (S22-S25), Site 5 (31° 16′ 04 N, 27° 20′ 24 E) have 7 stands (S26- S32) and Site 6 (31° 15′ 15 N, 27° 19′ 43 E) includes 5 stands (S33- S37). Fig (1) shows the location of the study area.

The climatic province of the study area belongs to semi- arid zone with winter rainfall (100-200 mm) and mean temperatures of mild winter (15-18°C) and mild summer (23- 28°C). (UNESCO, 1977 and Ayyad and Ghabbour, 1986).

The aim of the work is to study the phytosociology of barley weeds in relation to the different environmental parameters using the multivariate techniques, and comparing the weed flora with the previous studies.

MATERIALS AND METHODS

Thirty-seven stands along the area between Mersa Matruh and Sidi Barani, each stand contains 2-3 quadrats (10x10 m). For each stand a floristic list with plant cover percentage and presence percentage were determined according to Müller- Dombois and Ellenberg (1974). Two Way Indicator Species Analysis, TWINSPAN, (Hill, 1979a) was applied as a classification technique. The major gradients in vegetation composition were identified using Detrended Correspondence Analysis, DECORANA, Hill, 1979b).

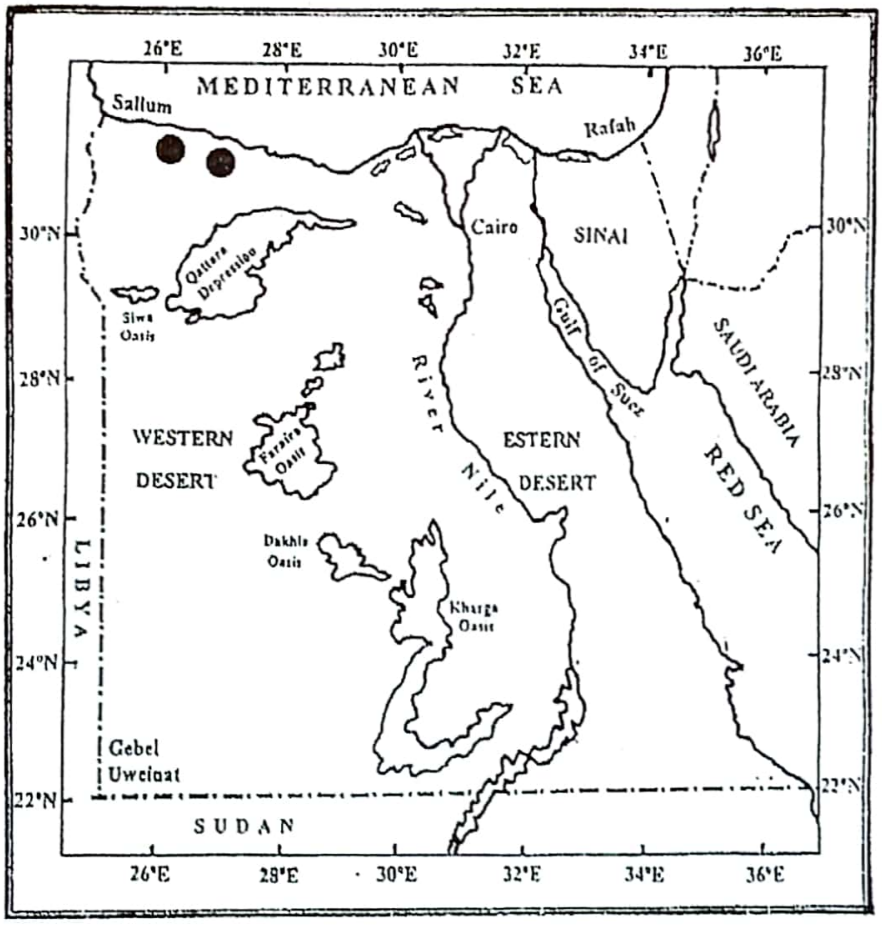

Figure 1. Map of Egypt indicating the study area (•).

Three soil samples were taken from each stand at depth of 0-50 cm. Soil texture was determined using Bouyoucos hydrometer (Jackson, 1962). Soil moisture content was estimated by weighing method according to Allen *et al.* (1986). pH value of soil samples were determined by pH meter. Conductivity meter measured total soluble salts. Sulphate were determined

turbidimetrically as barium sulphate and the transmittance was measured with reference to blank by spectrophotometer at 500 nm from standard curve of sulphate (Harrison and Perry, 1986). Chlorides were determined by titration with standard silver nitrate, carbonates and bicarbonates by acid titration. Na, K and Ca were estimated by flame photometry and Mg by atomic absorption spectrophotometry. All these procedures were according to Jackson (1962) and Allen *et al.* (1986). Species diversity (Shannon-Wiener index (H') (Magurran, 1988). Species richness (alpha diversity) of each vegetation group was calculated as the number of species per stand.

ANOVA test was done for one way of variance analysis of soil characters for the vegetation groups using Minitab program . Species were identified according to Taeckholm (1974), Boulos and El Hadidi (1984), Boulos (1995) and Boulos (1999, 2000 and 2002). Voucher specimens were deposited in the Faculty of Science Herbarium, Helwan University, Egypt.

RESULTS

Seventy-six species were collected in the study area, belonging to 26 families (Table 1). Nine families represented by one species: *Amaryllidaceae, Araceae, Caryophyllaceae, Cistaceae, Fumaraceae, Papaveraceae, Primulaceae, Solanaceae* and *Thymelaceae.* Family *Compositae* included 14 species, *Leguminosae* had 11 species, *Cruciferae* and *Poaceae* were represented by 6 species.

Therophytes constitute 61% of the total number of species while geophytes constituted 11.8% of the total species and represented by 9 species; *Arisarum vulgare*, *Asphodelus microcarpa*, *Narcissus tazetta*, *Urginea maritima*, *Scrzonera alexandrina*, *Leopoldia comosa*, *Ornithagalum trichophyllum*, *Anemone coronaria* and *Allium* roseum (Table 1). Phanerophytes were represented by *Lycium europaum* and *Thymalaea hirsuta* and constituted 2.6 % of the total number of species. Chamaephytes included; *Anabasis articulata, Haloxylon salicornicum, Deverra tortuosa, Helianthemum spherocalyx* and *Polygonium equisetiforme* and constituted 6.6% of the total species. Hemi-cryophytes constituted 18.4% of the total species.

TABLE (1). Life forms spectrum of the recorded species according to Raunkiaer (1964)

Life form	Number of species
Therophytes	46
Chamaephytes	5
Hemicryptophytes	14
Geophytes	9
Phanerophytes	2

Vegetation Analysis

Four vegetation groups were recognized by TWINSPAN in the study area (Fig. 2), for 37 stands and 76 species. Each group represents the distribution of the weed species and its association as in DCA (Fig. 3 and Table 2).

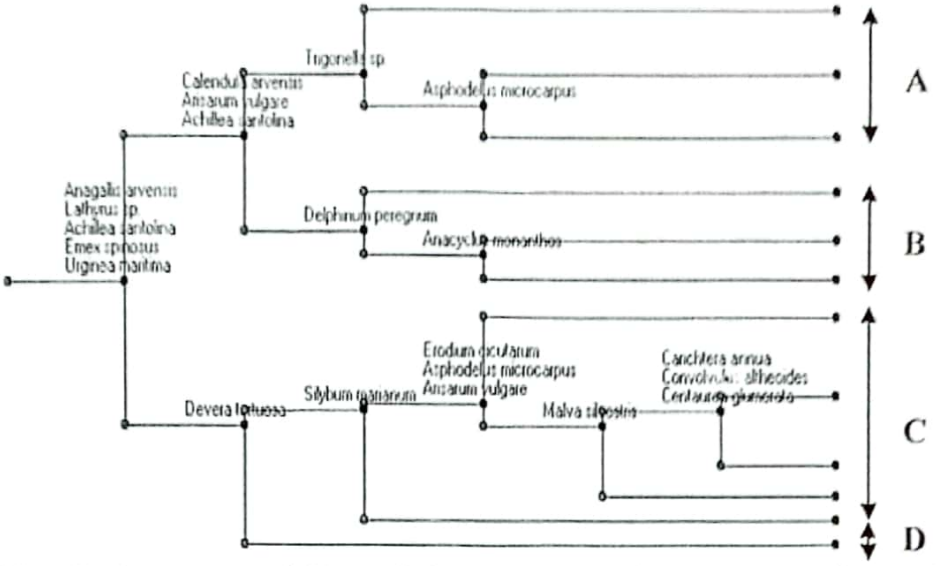

Fig. (2). Dendogram of 37 stands based on vegetation cover- abundance of 77 species in the study Area. Four vegetation groups (A,B, C & D) with their indicator species produced from TWINSPAN technique.

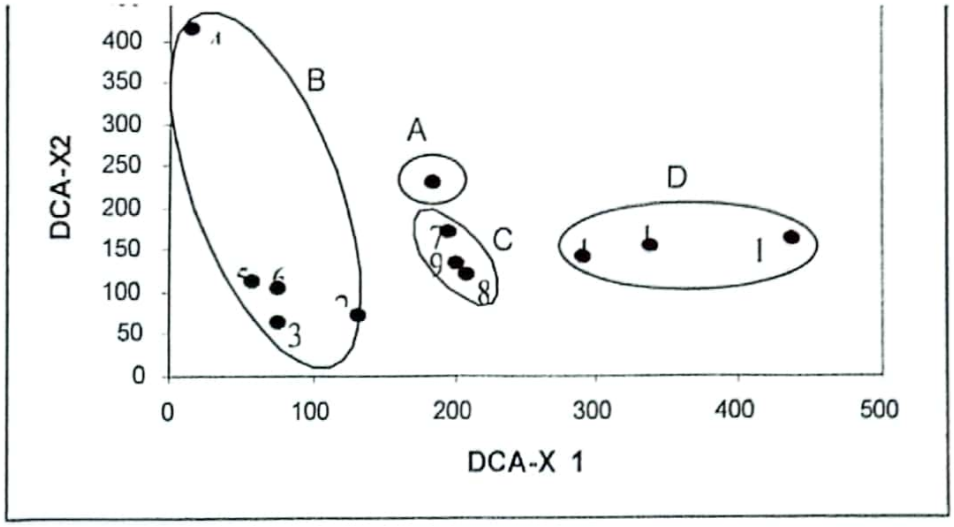

Fig. (3). DECORANA ordination of the 4 vegetation groups resulted after the application of TWINSPAN on the sampled stands.

TABLE (2). Presence percentage of the recorded species in the four vegetation groups (A-D) of the TWINSPAN classification..

List of species	A	B	C	D	P %
F.Amaryllidaceae					
Narcissus tazetta.	0	13	50	0	50
F.Araceae					
Arisarum vulgare	0	40	75	8	75
F. Alliaceae					
Allium roseum	0	7	25	0	50
F.Caryophyllaceae					
Paronychia arabica	0	7	25	0	50
F.Compositae					
Anacyclus monanthos	50	53	38	0	75
Silybum marianum	0	7	0	0	25
Achillea santolina	0	0	0	92	25
Calendula micrantha	50	0	0	13	50
Centaurea alexandrina	0	7	13	42	75
Centaurea glomerata	0	27	25	0	50
Atractylis cancellata	0	13	0	0	25
Glebionis coronarium	0	60	13	17	75
Launaea nudicaulis	0	13	25	25	75
L.mucronata	0	0	50	17	50
Onopordum alexandrinum	0	0	25	17	50
Reichardia tingitiana	0	27	50	0	50
Xanthium spinosum	0	7	0	0	25
Scrzonera alexandrina	50	27	0	33	75
F. Chenopodiaceae					
Anabasis articulata	0	0	0	17	25
Haloxylon salicornicum	0	7	0	0	25
Chenopodium murale	0	0	0	17	25
F. Cruciferae					
Carrichtera annua	50	47	50	17	100
Erucaria pinnata	0	0	0	25	25
Enarthrocarpus lyratus	0	7	13	0	50
Matthiola longipetala subsp. Hirta	0	0	0	33	25
Raphanus raphanistrum	0	0	50	0	25
Sinaps arvensis	0	0	0	17	25
F.Convolvulaceae					
Convolvulus arvensis	0	7	0	33	50
C.althaeoides	0	27	13	58	75
F.Geranaceae					
Erodium glaucophyllum	0	0	0	42	25
E.cicutarium	50	53	38	0	75
F.Labiatae					
Marrubium alysson	0	13	0	0	25
Salvia lanigera	0	27	38	33	75

F.Leguminosae					
Astragalus asterias	0	13	0	0	25
Trigonella sp.	0	0	0	50	25
Medicago polymorpha	0	0	0	25	25
Lotus creticus	50	0	25	42	75
L.polyphyllos	0	0	0	33	25
Hymenocarpos nummularis	0	40	13	17	75
Lathyrus sp.	0	0	75	42	50
Scorpiurus muricatus	0	0	0	33	25
Trigonella maritima	0	7	50	25	75
Vicia lutea	0	7	38	0	50
V.sativa	0	0	0	25	25
F.Liliaceae					
Muscari comosum	0	0	38	0	25
Urginea maritima	0	73	0	0	25
Ornithagalum trichophyllum	0	0	25	0	25
Asphodelus microcarpus	0	47	50	42	75
F. Malvaceae					
Malva parviflora	0	0	25	25	50
Malva sylvestris	0	0	50	0	25
F.Boraginaceae					
Echium sericeum	0	7	0	0	25
Alkanna tinctoria	0	0	13	7	50
F.Papaveraceae					
Papaver rhoeas	0	0	50	0	25
F.Ranunculaceae					
Adonis dentatus	0	13	0	0	25
Anemone coronaria	0	0	63	42	50
Delphinum peregrinum	0	13	63	0	50
Roemeria hybrida	0	0	25	0	25
F.Cistaceae					
Helianthemum sphaerocalyx	0	13	0	58	50
F.Primulaceae					
Anagallis arvensis	0	0	88	67	50
F.Solanaceae					
Lycium europaeum	0	13	0	0	25
F.Scrophulariaceae					
Linaria albifrons	0	0	25	0	25
L. haelava	0	0	25	0	25
F.Umbelliferae					
Deverra tortuosa	100	53	13	17	100
Daucus aureus	0	13	0	0	25
F.Plantaginaceae					
Plantago albicans	0	13	0	25	50
P.crypsoides	0	0	13	7	50
P.lanceolata	0	0	0	17	25

F.Polygonaceae					
Rumex vesicarus	0	0	13	0	25
Emex spinosus	0	0	63	67	50
F.Poaceae					
Bromus rubens	50	27	50	50	100
Hordeum leporinum	50	27	50	50	100
Avena fatua	0	0	13	8	50
Cutandia dichotoma	0	0	13	50	50
Cynodon dactylon	0	20	25	0	50
Phragmites australis	0	7	0	0	25
F.Thymalaeaceae					
Thymelaea hirsuta	100	47	88	58	100

P= presence percentage

Group (A): has point 1 (stands 9 and 10 in site 1) which was characterized by *Deverra tortuosa* as the indicator species. The associated species included *Anacyclus monathos*, *Bromus rubens*, *Calendula arvensis*, *Carrichtera annua*, *Erodium cicutarium*, *Hordium leporinum*, *Lotus creticus*, *Scrzonera alexandrina* and *Thymalaea hirsuta*.

Group (B): has points 2 (stand 12), 3 (stands 14 and16), 4 (stands 4 and7), 5 (stands 1, 2, 3, 5, 6, 8 and 11) and 6 (stands 13, 15 and 24). This group has no indicator species. The associated species comprises 42 species. The dominating species were *Urginea maritima, Asphodelus microcarpus, Arisarum vulgare, Erodium cicutarium, Glebicris coronaria, Hymenocarpus cicrinatus, Plantago albicans* and *Trigonella maritima.*

Group (C): Comprised points 7 (stands 20 and 21), 8 (17,18 and 19), and 9 (stands 22, 23 and 25) which was characterized by *Arisarum vulgare* as indicator species. The dominating species included *Alkanna tinctoria*, *Anemone coronaria*, *Avena fatua*, *Launaea mucronata*, *Anagallis arvensis*, *Asphodelus microcarpus*, *Delephinum peregnum*, *Emex spinosa*, *Lycium europaeum*, *Malva silvestris* and *Vicia lutea.*

Group (D): included points 10 (stands 26, 27, 30 and 31), 11 (stands 28, 29, 35 and 36) and 12 (stands 32, 33, 34 & 37). *Achillea santolina* and *Calendula arvensis* were recorded as indicator species. The dominating species were *Anabasis articulata*, *Chenopodium murale*, *Convolvulus altheoides, Convolvulus arvensis, Erodium glaucophyllum, Erucaria pinnata, Lotus creticus, Matthiola longipetala, Medicago polymorpha, Onopordium alexandrinum, Plantago albicans, Scopirurus muricatus, Sinapsis arvensis, Trigonella* sp. and *Vicia sativa.*

SOIL CHARACTERISTICS

Soil textures in different vegetation group were nearly similar (Table 3), soil moisture values were high in group A (5.86 %) and group C (4.89 %) and low in group B (3.50 %) and group D (2.66 %). Total dissolved salts showed significant relation with the four vegetation groups. Anions groups (bicarbonates and sulphates) were highly different in the vegetation groups. Bicarbonate values in groups A and C were found to be 2 .15 mg/L, while in groups B and D were found to be 1.94 mg/L and 1.57 mg/L, respectively. Sulphates in group A is very low (0.16 mg / L), moderate in group C (0.50 mg/L) and high in groups B (0.64 mg/L) and D (0.62 mg/L).

Cations as sodium, magnesium, potassium and calcium had different values in the different vegetation groups. Magnesium had high value in groups D (3.70 mg/L) and C (2.78 mg/ L), moderate in group A (1.53 mg/L) and low values in group B (0.93 mg/ L). Sodium was high (0.57 mg/L) in group A and low in groups C (0.36 mg/L) and D (0.27 mg/L). Ec, Ca and Mg showed significant difference with the vegetation groups while Na and HCO_3 showed highly significant difference with four vegetation groups.

TABLE (3). Mean ± St. Dev. of the soil variables of the four vegetation groups in the study area.

Soil variables	Vegetation groups			
	A	B	C	D
Coarse sand %	0.34±0.06	0.32±0.08	0.30±0.03	0.33 ± 0.08
Fine sand %	88.27±0.57	88.63±1.08	88.31±0.46	88.64 ± 1.08
Silt %	2.62±1.17	2.53±1.21	2.25±0.77	2.57 ± 1.21
Clay %	8.51±0.24	8.41±0.12	8.66±0.40	8.52 ± 0.26
Soil moisture %	5.86±1.48	3.50 ± 3.25	4.89±1.02	2.66 ± 0.63
PH	8.51±0.01	8.51±0 20	8.47±0.05	8.57 ± 0.04
EC mS cm^{-1}	0.43±0.01	0 34±0.07	0.36±0.04	0.29 ± 0
Ca mg/L	1.37±0.16	1.35 ±0.16	1.67±0.150	1.52 ± 0
Mg mg/L	1.53±0.83	0.93±0 33	2.78±1.49	0 .70 ± 0.11
K mg/L	0.30±0.01	0.40±0.23	0.31±0.02	0.15 ± 0.02
Na mg/L	0.57±0.04	0.36±0.13	0.43±0.08	0.27 ± 0.03
HCO_3 mg/L	2.15±0.15	1.94±0.26	2.15±0.15	1.57 ± 0.14
Cl mg/L	0.20±0	0.20 ± 0	0.20 ± 0	0.20 ± 0
SO_4 mg/L	0.16±0.03	0.64±0.09	0.50±0.06	0.62±0,09

Differences in species richness and species diversity are shown in Figures 4a and 4b. The vegetation group C is characterized by *Arisarum vulgare* as indicator species and has the highest species richness value (46 species / stand) while vegetation group A is characterized by *Deverra tortusa* as indicator species and has the lowest richness value (10 species / stand). Groups B and D have 42 and 44 species / stand, respectively. The highest value of the species diversity (H`) of 3.83 ± 0.011 was recorded in vegetation group C. Vegetation group A has the lowest diversity value (2.30 ± 0.045). The remaining groups B and D have values of 3.83 ± 0.011 and 3.78 ± 0.011, respectively.

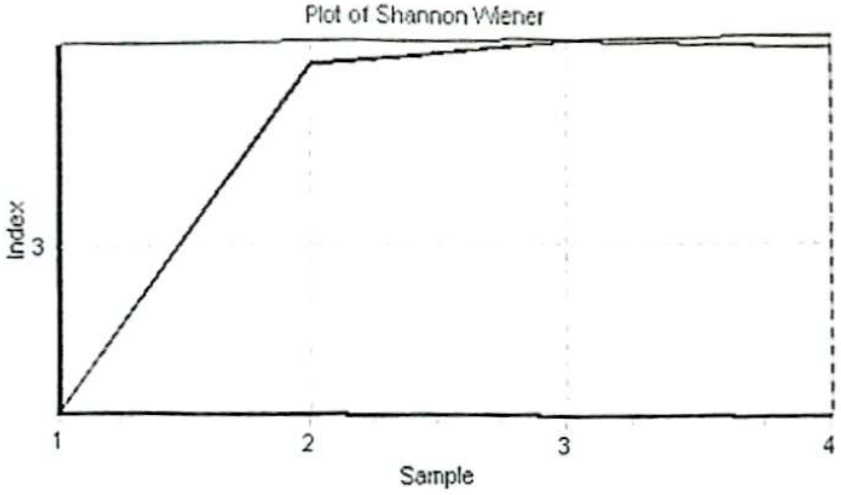

Fig .(4a). Shannon index (H') in different vegetation groups.

Fig. (4b). Species richness in different vegetation groups

Table (3) gives the records of the weeds assemblage with rainfed barley in the 5 vegetation groups. Six species were recorded in the 4 vegetation groups with high presence percentage (100%); *Carrichtera annua*, *Devrra tortuosa*, *Bromus rubens*, *Thymelaea hirsuta* and *Hordeum leporinum*. Fourteen species were recorded in 3 vegetation groups (75% presence), among these: *Arisarum vulgare*, *Glebionis coronarium*, *Scrzonea alexandrina*, *Convolvulus althaeoides*, *Salvia lanigera*, *Lotus creticus*, *Asphodelus microcarpus*, *Trigonella maritime* and *Hymenocarpos nummularis*. Twenty two species were recorded in 2 vegetation groups (50% presence) and 34 species were restricted to one vegetation group.

DISCUSSION

The western Mediterranean coastal belt is by far the richest part of Egypt in its floristic composition owing to its relatively high rainfall (Zahran and Willis, 1992). Human disturbance (e.g. cultivation, clearing of vegetation and grazing) are common in the western Mediterranean region (Heneidy and Bidak, 1998). In this study 77 species belonging to 26 families were recorded in the cultivated plots associated with barley crop. Therophytes are the main life form representing 61% of the total recorded species. This result coincides with Hassib (1951).

Application of TWINSPAN and DECORANA classification and ordination techniques to the obtained data have produced four groups. Group A, which is characterized by *Deverra tortuosa* as the indicator species. The group B has no indicator species. The associated species comprises 42 species. The dominating species are *Urginea maritima*, *Asphodelus microcarpus*, *Arisarum vulgare*, *Erodium cicutarium*, *Glebicris coronaria* (=*Chrysanthemum coronarium*), *Hymenocarpus cicrinatus*, *Plantago albicans* and *Trigonella maritima*. Group C characterized by *Arisarum vulgare* as indicator species. The dominating species include *Alkanna tinctoria*, *Anemone coronaria*, *Avena fatua*, *Launaea mucronata*, *Anagallis arvensis*, *Asphodelus microcarpus*, *Delephinum peregnum*, *Emex spinosa*, *Lycium europaeum*, *Malva silvestris* and *Vicia lutea*. Group D includes *Achillea santolina* and *Calendula arvensis* as indicator species. Mediterranean desert of Egypt vary along two gradients of habitat factors, moisture availability and physiographic heterogeneity (Shaltout, 1985). Soil factors in relation to vegetation groups indicate highly significant correlations with cation (sodium) and anion (bicarbonate).

Vegetation group C is characterized by high richness value (46 species) and high species diversity (3.8 ±0.01) while group A has low richness value (10 species) and low species diversity (2.30 ± 0.045). Group A characterized by high values of EC (0.43 ± 0.01 mS/cm) and Na (0.57 ± 0.04 mg/ L) and lowest richness value. These results coincide with Shaltout and El Ghareeb (1992) and Heneidy and Bidak (1998).

The main studies on weeds assemblage of barley rainfed at last 50 years were shown in fig. (5).

I- Tadros and Atta (1958) recorded *Achillea santolina mareoticum* as the main association in the barley field (Mersa Matrouh and Burga El Arab area) with subassociation of *Chrysanthemetosum coronariae* and *Arisarum vulgare* with 49 associated species.

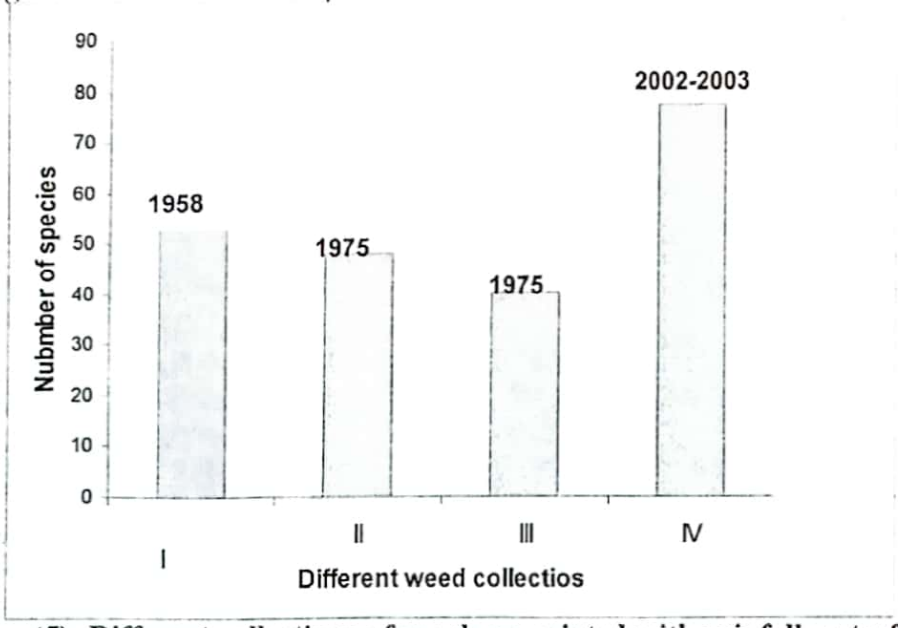

Fig. (5). Different collections of weeds associated with rainfall waterfed barley in the western Mediterranian costal area.

II- El Hadidi and Ayyad (1975) recorded 40 species in the barley fields in Wadi Habas (Mersa Matrouh). The *Chrysanthemum coronaria, Launaea nudicaulis, Convolvulus altheoides* and *Plantago albicans* were co-dominated in the study area while *Achillea santolina* was common and *Arisarum vulgare* was rare. The fallow areas between barley cultivation are co-dominated by *Chrysanthemum coronaria, Trigonella maritima, Picris sprengeriana* and *Lolium rigidum*.

III- Kosinova (1975) described the main weed communities of rainfed barley in the Mediterranean coastal area. She recorded thre presence of the alliance of *Achillea santolina mareoticum* with 45 associated species. The cultivated plots were surrounded by vast areas of uncultivated semi-desert (represent winter aspect of private Bedouins in Burg El Arab area).

IV- In this study (2002-2003), 76 species were recorded associated with rainfed barley. *Deverra tortuosa, Arisarum vulgare* and *Achillea santolina* and *Calendula arvensis* were recorded as the indicator species. *Urginea maritima, Asphodelus microcarpus, Arisarum vulgare, Erodium cicutarium, Glebioris coronaria, Hymenocarpus nummularis, Plantago*

albicans, Trigonella maritima, Alkanna tinctoria, Anemone coronaria,, Launaea mucronata, Anagallis arvensis, Asphodelus microcarpus, Emex spinosa, , Malva silvestris and *Vicia lutea* were recorded as dominant species.

Vast areas especially in Burg El Arab district now practice the same farming practices in other Nile –fed farmland of Egypt. Consequently, the barley's field weeds of *Achillea santolinae mareoticum* association has practically disappeared (El Hadidi, 2000). In this study the *Achillea santolinae* was recorded as associated species. Fourteen weed species (18%) recorded in the present study were also recorded in the Nile- fed cultivated areas (El Hadidi and Boulos 1984). Among those, *Convolvulus arvensis, Emex spinosa, Medicago polymorpha, Anagallis arvensis, Malva parviflora, Sinapsis arvensis, Enarthrocarpus lyratus, Vicia sativa, Erucaria pinnata, Avena fatua, Xanthium spinosum, Polygonum equisetiforme, Vicia lutea and Cynodon dactylon.* Specific Mediterranean elements were recorded in this study, of those; *Narcissus tazette, Urginea maritima, Onopordium alexandrinum, Anemone coronaria, Ornithgallum trichophyllum, Deliphinum peregrinum, Anacyleus monanthos, Scrzonera alexandrina, Lycium europaeum* and *Carrichtera annua.*

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التنوع النباتي في زراعات الشعير بالساحل الشمالي الغربى للبحر المتوسط بمصر

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تعتبر حقول الشعير من أخصب المناطق في الساحل الشمالي و تحيط بها مناطق واسعة من الأراضي الشبه صحراوية.

في هذه الدراسة سجل ١٤ نوعا نباتيا تنمو في مناطق وادي النيل كما سجل أيضا بعض الأنواع المميزة لمنطقة البحر الأبيض المتوسط مثل نبات بصل العنصل ، النرجس ، العوسج ، النعمان ، القليقلة ، شوك الحنش و بصل الحنش.

تمثل الحوليات أهم صور الحياة السائدة حيث تبلغ نسبتيا ٦١% من الأنواع المسجلة.

باستخدام برامج الإحصاء للتصنيف و التسلسل تم فصل أربع مجموعات :

١- المجموعة الأولي و يتميز بها نبات القزاح .
٢- المجموعة الثانية و لا توجد بها كواشف نباتية.
٣- المجموعة الثالثة و تتميز بنبات الينريش.
٤- المجموعة الرابعة و تتميز بنبات البشرين و عين الشمس.بدراسة علاقة التربة بالكساء الخضري و جد أن المجموعات النباتية الأربع ذات علاقة إيجابية مع الصوديوم والبيكربونات.

في هذه الدراسة تم عمل مقارنة للتركيب الفلوري علي مدي الخمسون عاما الأخيرة حيث تم تسجيل ٧٧ نوعا نباتيا كما سجل نبات القزاح كأحد الكواشف المصاحبة لنبات الشعير المطري.