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Plant Communities and Floristic Composition of the Vegetation of Wadi Al-Assiuty and Wadi Habib in the Eastern Desert, Egypt

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Abstract

Torrential rains (in January 2011) that have swept a limited area in the Eastern Desert, facing Assiut Province (Upper Egypt), resulted in enriching the vegetation in Wadi Al-Assiuty and its tributary Wadi Habib. Vegetation survey carried out shortly after this event (in May) revealed the prevalence of annuals which are hardly recognizable in such usually dry habitats. The normally scarce perennial vegetation has flourished. A total of 66 plant species, 33 perennials and 33 annuals, belonging to 53 genera from 22 different families were recorded. Therophytes are the predominant life form (50%) followed by chamaephytes (21%), phanerophytes (15%), hemicryptophytes (11%) and geophytes (3%). Chorological analysis revealed that Saharo-Arabian (81.8%) constitute the main bulk of the total flora of the studied area. The majority of the perennial species behave similarly to each other in their phenology, and usually perennials sprout at the end of February, become leafy in March, flower in April and produce fruits between April and July. The investigation revealed that the wadis studied are potential shelters of four vegetation groups. Twenty two of the recorded species (33.3%) are omnipresent and had a dominant degree of occurrence (Q-value ≥ 0.2). The highest among others were *Zilla spinosa* and *Zygophyllum coccineum* which recorded in 86% and 88% respectively of the studied stands and spread their dominancy all over the Eastern Desert of Egypt.

Keywords: chorology, cluster analysis, life forms, phenology, phytosociology

Introduction

The Eastern Desert of Egypt extends between the Nile Valley and the Red Sea. It is traversed by numerous canyon-like depressions (wadis) running to the Red Sea or to the Nile Valley. Wadi Al-Assiuty is one of the most notable features of the Egyptian Eastern Desert. It is the largest and greatest dry valley which runs in Sahara desert for a distance of about 115 km. Its width varies from 5 to 25 km. Although this wadi is generally dry all over the year, some seasonal rainfall is experienced in winter time, which may occasionally become torrential in autumn and spring times.

From the early beginnings of the last century, the Eastern Desert was studied botanically by different researchers: Schweinfurth (1901), Montasir (1938), Hassib (1951), Girgis (1965), Kassas (1953 a,b), Hassan (1987), Salama and Fayed (1989, 1990), Salama and El-Naggar (1991), Abd El-Ghani (1998) and Hassan (2003), Salama *et al.* (2012, 2013). Except that of Hassan (1987), most of the previous studies dealt with the different ecological aspect, with less attention to the floristic features of this desert.

The main trunk of wadi Al-Assiuty has an east-west orientation extending between latitude 27°10' and 27°20' N. Its tributaries cover an area between longitudes 31°16' and 31°50' E (Fig. 1). The main wadis, which debouch their water in wadi Al-Assiuty are: wadi Hubara, wadi Qird El-Farr from north and wadi Marahil, wadi Habib from the south (Said, 1962; Abu Al-Izz, 1971). Due to the variety of chances of water feeding of the tributaries of Wadi Al-Assiuty originating in the mountain range of Red Sea and pouring their flood waters into its principle channels, difference in floral characteristics and vegetation composition are something expectable. Kassas and Girgis (1972) studied the ecology of Wadi Al-Assiuty among other wadis in the region between latitude 27°30' and 25°30' N. Abd El-Wahab (1963) studied the Autecology of *Leptadenia pyrotechnica* in wadi Al-Assiuty. Migahid *et al.* (1972) and Batanouny (1973) investigated Eco-Phsiological characters of desert plants in Wadi Al-Assiuty. El-Khatib (1993) studied the ecophysiology and palynology of the vegetation of wadi Al-Assiuty and Wadi Qena based on recent floristic investigations by the author.

Phenological studies provide information on functional rhythms of plants and plant communities (Ralhan *et al.*, 1985). Moreover, various phenological events may be timed to biotic and/or abiotic environmental conditions (Estabrook *et al.*, 1982; Lee, 1971). It was also reported by Nilsen (1981) that desert plants exhibit phenologies that are closely related to moisture availability and temperature, as well as photoperiod and nutrient input (Abdel- Razik, 1980). The phenological cycles may represent physiological and morphological adaptations by species to utilize resources (Kemp and Gardetto, 1982; Salama *et al.,* 2012).

In last decades, Wadi Al-Assiuty was affected by human activities including; cultivation of the deltaic part, the intensive collection of plant species for its values (medicinal, fuel, fiber etc.), establishment of new Assiut city, new high

ways, farms and others. These activities affect the natural flora and changing the distribution of plants in Wadi Al-Assiuty. This means great changes in the distribution, species richness and extinction of the floristic composition of Wadi Al-Assiuty.

Torrential rains (in January 2011) that had suddenly swept a limited area in the Eastern Desert facing Assiut Province (Upper Egypt) resulted in enriching the vegetation of some extremely dry wadis at this location. This leads to the prevalence of annuals and the flourishing of the scarced perennial vegetation (El-Sharkawi *et al.,* 1982 a, b; Salama *et al*., 2013). It is worthy to mention that the last torrent sudden in this wadi was at 1994. This reflects the high aridity in the studied wadis.

Such an event was the inspiration to carry out this study with the aim of recognizing the potential of natural vegetation in the wadis as a result of an unexpected water supply. The plant communities and its associated species were investigated. This study deals with analyses of floristic composition, life forms, phenology, chorological spectrum, and analyses the vegetation inhabiting the deltaic part and the principal channel of Wadi Al-Assiuty and Wadi Habib.

Materials and methods

Wadi Al-Assiuty is easily traversable by vehicle. The study was carried on two successive years: 2011-2012. The studied stands were randomly chosen at locations where considerable vegetation cover was encountered. Based on presence/absence of each species, 50 stands were studied in the deltaic part, and along the main trunk of the Wadi Al-Assiuty and Wadi Habib, and geo-referenced using GPS technique (Fig. 1). Meteorological data obtained from the Assiut University station at Assiut, through the last ten years (2003 to 2012) showed the temperature is regular in its seasonality. The average lowest minimum temperature through the last ten years is 8 °C recorded in January and the average highest maximum temperature is 39 °C recorded in June. The highest mean relative humidity in the study area is 50% recorded in December and the lowest mean is 24% recorded in May.

Ten species were selected randomly to study their phenological characteristics through one year, from January 2012 to December 2012. The species were *Acacia niotica, Acacia raddiana, Calotropis procera, Datura innoxia, Leptadenia pyrotechnica, Ochradinus baccatus, Tamarix aphylla, Tamarix nilotica, Zizyphus spina-christi and Zygophyllum coccineum.* Four phenophases were distinguished: vegetative, flowering, fruiting and seed dispersal and were recorded monthly. The recorded species are classified according to their life forms (Hassib, 1951; Raunkiaer, 1937). The number of species within each life form is expressed as a percentage of the total number of species in the study area. Plant specimens collected were identified and deposited at the herbarium of the Botany Department of Assiut University. Identifications were done according to Täckholm (1974) and Boulos (1995, 1999, 2000). Duplicates were checked for identification and deposited at the Cairo University Herbarium. Analysis of phytogeographical ranges was carried out according to Zohary (1966, 1972, 1973), Abd El-Ghani (1981) and Hassan (1987). A floristic data matrix of 50 stands and 66 species was subjected to classification by cluster analysis of the program Community Analysis Package (CAP) version 1.2 (Henderson and Seaby, 1999) using squared Euclidean distance dissimilarity matrix with minimum variance (also called Ward's method) as agglomeration criterion (Orlóci, 1978).

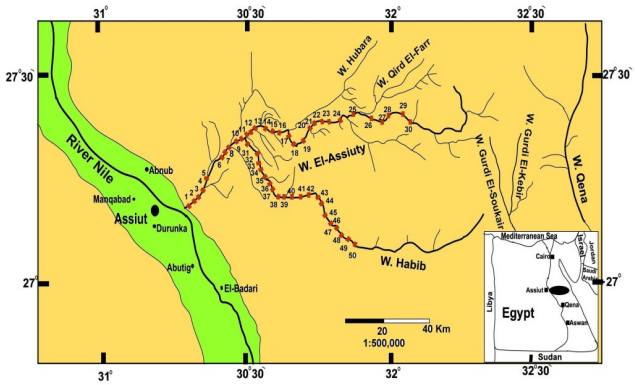

Fig. 1. Location map of Wadi Al-Assiuty and Wadi Habib in the Eastern Desert of Egypt; the stands are given by their numbers

Results and discussion

Floristic composition

The floristic composition of the species showed that 66 plant species were recorded in Wadi El-Assiuty and Wadi Habib. They include 33 perennials and 33 annuals, belonging to 53 genera from 22 different families (Tab. 1). The largest family was Asteraceae, which included 11 genera and 14 species. Six of them were perennials and the others were annuals (Tab. 1). The second family was Chenopodiaceae with six genera and eight species. Four of them were annuals and four were perennials. Brassicaceae, Boraginaceae and Zygophyllaceae had the same number of the recorded species (five for each). Family Brassicaceae included one perennial and four annuals. Family Boraginaceae have two perennial and three annuals. Family Zygophyllaceae included four perennials and one annual. Two genera and four species were recorded for family Fabaceae. Three of them were annuals and one was perennial. Four species were recorded as members of the Poaceae family. They were included in four genera. All of them were perennials except *Avena sterilis*, which was annual. For each of the Malvaceae, Polygonaceae, Resedaceae, Solanaceae, Mimosaceae, Tamaricaceae families two (for each) species were recorded. One genera belonged to family Tamaricaceae, was represented by two perennial species, *Tamarix aphylla and Tamarix nilotica.* One genera belonged to Mimosaceae family represented by two perennial species: *Acacia nilotica* and *Acacia tortilis*. The other families were represented by only one species, each. The largest genera were: *Astragalus*, *Fagonia* and *Pulicaria*, which include three species. Six genera, represented by two species: *Launaea*, *Bassia*, *Helliotropium*, *Chenopodium*, *Acacia* and *Zygophyllum*. Other genera were represented by one species, each (Tab. 1).

Life form

Fig. 2 shows the life forms of the recorded plant species according to Raunkiaer (1937). The total number of species in the study area was 66, which belong to five different life forms. Therophytes (50%) constitute the largest number of species (33 species). Chamaephytes had 21% including 14 species. Phanerophytes have 10 species represent about 15% of the flora. Hemicryptophytes represent about 7 % of the flora including 11 species. Geophytes (3%) are represented by two species; *Cynodon dactylon* and *Panicum turgidum*.

Chorological affinities

Results of the total chorological analysis of the surveyed flora presented in Fig. 2 revealed that 28 species belonging to monoregional region representing 42.4% of the total recorded species. There were 26 species recorded as Saharo-Arabian species (39%); while *Hibiscus trionum* belonging to Irano-Turanian region (2%) and *Ammi majus* belonging to Mediterranian region (2%). A total of 28 species are bi-regional elements representing 42.4% of the recorded species. It comprises the following four regions as followes: nine species belonging to the Saharo-Arabian, Sudano-Zambezian regions representing 14% of the recorded species. Mediterranian, Irano-Turanian regions, represented by five species, formed 8 % of the recorded species. Ten species, belonging to the Saharo-Arabian, Irano-Turanian regions represented 15% of the recorded species. Four species belonging to the Saharo-Arabian, Mediterranian region consist 6% of the recorded species. A total of five species (7.6% of the recorded species) are Pluri-regional taxa of wide geographical range. They were as follows: *Centaurea calcitrapa, Imperata cylinderica, Matthiola longipetala, Tamarix aphylla*and *Tamarix nilotica*. *Cynodon dactlyon* is the only species representing pantropic floristic region. Four species were recorded as cosmopolitan taxa comprising 6.1% of the recorded species.

Species distribution pattern

Data of Tab. 1 revealed that four of the recorded species are omnipresent. *Zygophyllum coccineum* has presence value equal 88% and recorded in 44 studied stands in the study area. *Zilla spinosa* was recorded in 43 stands of 50 studied stands giving presence value 86%. *Calligonum polygonoides* has presence value 74% and recorded in 37 stands. *Cornulaca monacantha* was recorded in 35 stands giving presence value 70%.On the other hand, *Matthiola longipetala*, *Atriplex halimus* and *Cotula cinarea* showed the highest presence estimated among annuals (P=68%, 60% and 56%) respectively. *Matthiola longipetala* appeared in 34 stands, where *Atriplex halimus* appeared in 30 stands and *Cotula cinarea* was detected in 28 stands. *Artemisia judaica and Eremobium aegyptiacum* appeared in 27 stands giving P=54%. *Diplotaxis acris* and *Tamarix nilotica* recorded in 26 stands (P=52%). *Fagonia arabica* and *Bassia indica* presented in 23 stands (P=46%). 33 species or about 50% of the total recorded species are perennials, demonstrated a constant degree of constancy, while the other 33 species, 50% of the total recorded species, are annuals most of them recorded after 2011 rainfall. The presence of *Tamarix aphylla, Tamarix nilotica*, *Salsola imbricata* and *Atriplex halimus* refers to salinization.

Phenological pattern

As shown in Fig. 3, *Acacia nilotica* started the vegetative growth from July to October. Flowering is in October to December period. The plant began fruiting in January to `May. In about six months from January to June, *Tamarix aphylla* completes its vegetative growth. Flowering occurs in two months; July and August. Fruiting takes two months also; September and October. Finally seed dispersal occurs in November and December. *Tamarix nilotica* grows vegetatively from March to August. Flowering occurs in two months from September to October. Fruiting occurs in two months; November and December, seed dispersal in January and February. *Zizyphus spina-christi* grows vegetative from August to September. Flowering starts in October to mid of November. Fruiting starts in late of

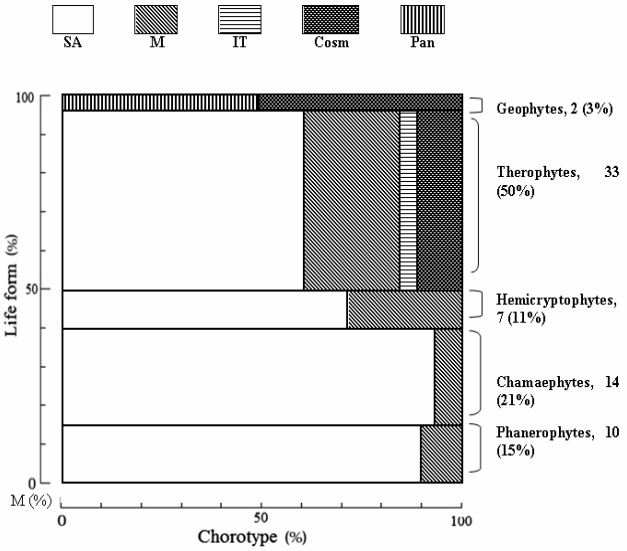

Fig. 2. Chorotype spectrum and life forms diagram of the study area. SA=Saharo Arabian, M= Mediterranean, IT= Irano Toranian, Cosm = Cosmopolitan, Pan= Pantropic (Kürschner, 1986)

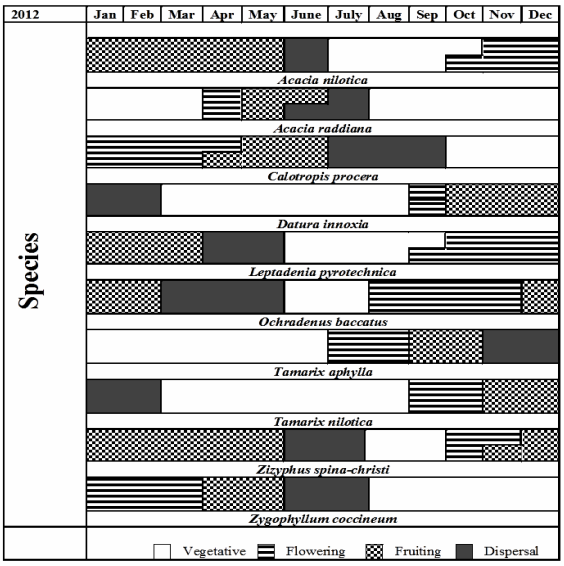

Fig. 3. Phenological spectrum of selected ten species from the study area of wadi El-Assuity during 2012

November to May. Seed dispersal occurs in June and July. *Zygophyllum coccineum* starts its vegetative growth from August to December. Flowering occurs from January to March. Fruiting takes two months, from April to May. Seed dispersal occurs after fruiting and lasts to July.

Species Occurrence

The recorded plants were categorized according to the Q values (Tab. 1) as dominant species: twenty two of the recorded species (33.3%) are omnipresent had a dominant degree of occurrence (Q-value ≥ 0.2). Q values ranged between 0.88 - 0.20. Very common species: the very common species generally had Q values ranged between 0.1-0.199. In this study, twelve species were recorded belonging to this range (17.9% of the recorded species Q=0.10-0.18). Common species: according to Q value calculation (Q value ranged between 0.05–0.099) there were 5 common species. *Helliotropium bacciferum, Kickxia aegyptiaca, Schouwia purpurea*and*Trigonella stellata* were collected from four stands (Q=0.08), while *Astragalus vogelii* were collected from three stands (Q=0.06). Q value ranged between 0.08-0.06. Occasional species: most of the recorded species (28 species, 41.8% of total species number) were represented according to Q value as occasional (Q value ranged between 0.01-0.05). These plants had presence value was about 4% (Q=0.04), while *Acacia nilotica, Achillea fragrantissima*, *Amberboa lippii, Ammi majus, Arnebia hispidissima, Astragalus hamosus, Astragalus sieberi*, *Avena sterilis, Calotropis procera*,*Chenopodium ambrosioides*, *Cynodon dactylon*, *Datura innoxia, Echium rauwolfii, Hibiscus trionum, Hyoscyamus muticus, Ifloga spicata, Imperata cylinderica, Lactuca serriola, Panicum turgidum* and *Zizyphus spina-christi* were recorded in one stands (P=2% and Q=0.02). The sporadic species (Q-value ≤ 0.01) were not represented in this work.

Vegetation structure (Classification of vegetation)

Application of classification using cluster analysis to the floristic data of Wadi El-Assuity yielded four vegetation groups (Fig. 4). Most of the groups (A) and (B) stands were confined to the main trunk of Wadi El-Assuity, while those of groups (C) and (D) were belonging to the Wadi El-Assuity tributary (Wadi Habib). The *Artemisia judaica*, *Bassia indica, Cotula cinerea*, *Diplotaxis acris*, *Eremobium aegyptiacum, Fagonia arabic, Launaea nudicaulis, Leptadenia pyrotechnica, Matthiola longipetala, Pulicaria undulate, Salsola imbricate, Senecio glaucus, Tamarix nilotica, Trichodesma africanum, Zilla spinosa*and *Zygophyllum coccineum* were recorded with variable presence values in the four groups.

Group (A): *Senecio glaucus-Zygophyllum coccineum* group; this vegetation group comprised of 39 species recorded from 6 stands (Tab. 2). Sporadic species (species recorded in one stand only; P (presence value)=17%) were represented by 18 species or about 46.2% of the recorded species in this group and they were; *Acacia nilotica*, *Achillea fragrantissima*, *Ammi majus*, *Anabasis setifera*, *Artemisia judaica*, *Calotropis procera*, *Cynodon dactylon*, *Datura innoxia*, *Fagonia arabica*, *Hibiscus trionum*, *Hyoscyamus muticus*, *Imperata cylinderica*, *Launaea amal-aminae*, *Ochradinus baccatus*, *Oligomeris linifolia*, *Rumex vesicarius*, *Trichodesma africanum* and *Zizyphus spina-christi*. While *Launaea nudicaulis* and *Tamarix nilotica* show co-dominance with a presence value 67% (were represented by two species or about 5.1% of the recorded species in this group) (Tab. 2). The 12 species represent 30.8% of this group plants: *Acacia nilotica*, *Achillea fragrantissima*, *Ammi majus*, *Calotropis procera*, *Chenopodium murale*, *Cynodon dactylon*, *Datura innoxia*, *Hibiscus trionum*, *Hyoscyamus muticus*, *Imperata cylinderica*, *Zizyphus spina-christi* and *Zygophyllum simplex* had a degree of fidelity to this community.

Group (B): *Zilla spinosa-Zygophyllum coccineum* group. It comprised of 49 species recorded in 14stands (Tab. 2). The 24 sporadic species (49% of the recorded species in this group; P=7-14%) were: *Acacia tortilis*, *Amberboa lippii*,, *Anabasis setifera, Arnebia hispidissima*, *Astragalus hamosus*, *Avena sterilis*, *Centaurea calcitrapa, Chenopodium ambrosioides*, *Cleome amblyocera*, *Echium rauwolfii*, *Helliotropium bacciferum*, *Ifloga spicat*, *Kickxia aegyptiaca*, *Lactuca serriola*, *Leptadenia pyrotechnica*, *Pulicaria incis*, *Schouwia purpurea*, *Artemisia judaica*, *Fagonia bruguieri*,

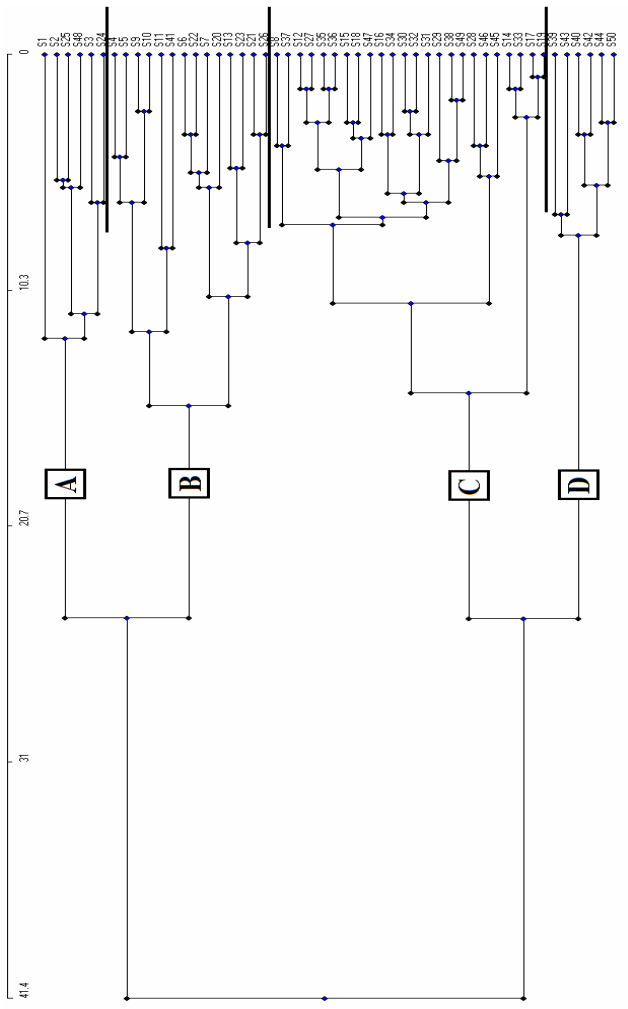

Fig. 4. Dendrogram showing cluster analysis of the studied 50 stands with the 4 vegetation groups (A-D) in Wadi El-Assuity and Wadi Habib

Launaea nudicaulis, *Monsonia nivea, Sonchus oleraceus,Tamarix aphylla* and *Tamarix nilotica*. While*Diplotaxis acris* (P=93%), *Fagonia arabica* (P=86%), *Atriplex halimus* (P=86%), *Cornulaca monacantha* (P=86%), *Cotula cinerea* (P=71%), *Matthiola longipetala* (P=71%), *Senecio glaucus* (P=71%), *Rumex vesicarius* (P=71%), *Salsola imbricate* (P=64%) represented as co-dominance species (18.4% of this group species). The following 10 species (20.4% of plants in this group) showed a degree of fidelity to this community and they were; *Amberboa lippii*, *Arnebia hispidissima*, *Astragalus hamosus*, *Astragalus vogelii*, *Avena sterilis*, *Chenopodium ambrosioides*, *Echium rauwolfii*, *Ifloga spicata*, *Lactuca serriola* and *Monsonia nivea*.

Group (C): *Calligonum polygonoides-Zilla spinosa* group. The species belonging to this group were 33 species in 24 stands (Tab. 2) with 17 sporadic species (about 51.5% of the recorded species in this group; P=4-17%) and they were *Bassia muricata*, *Pulicaria arabica, Trichodesma africanum, Centaurea calcitrapa, Helliotropium bacciferum*, *Tamarix aphylla*, *Senecio glaucus, Pulicaria incise, Launaea nudicaulis, Launaea amal-aminae, Salsola imbricate, Malva parviflora*, *Oligomeris linifolia*, *Ochradinus baccatus*, *Acacia tortilis, Paronychia arabica*, and *Panicum turgidum*. The co-dominance species were 7 species represent 21.2% of plant in this group (P=63-88%). They were *Zilla spinosa*, *Zygophyllum coccineum*, *Eremobium aegyptiacum, Artemisia judaica*, *Cornulaca monacantha, Matthiola longipetala* and *Tamarix nilotica*. Only *Panicum turgidum* showed a degree of fidelity.

Group (D): *Artemisia judaica-Matthiola longipetala* group. This vegetation group comprised of 31 species recorded from six stands (Tab. 2). This group included five characteristic species: *Zilla spinosa, Atriplex halimus*, *Calligonum polygonoides* and *Pulicaria incisa*had the dominance degree (P=100%) with *Artemisia judaica* and *Matthiola longipetala*. Sporadic species (species recorded in one stand only; P=17%) were represented by six species or about 19.4% of the recorded species in this group: *Astragalus sieberi*, *Cleome amblyocera, Fagonia arabica, Launaea nudicaulis, Trichodesma africanum* and *Trigonella stellate*. The co-dominant species were represented by 11 species with 35.5% of plant in this group. Seven species had presence value of 83% (*Bassia indica, Centaurea calcitrapa, Cornulaca monacantha, Fagonia bruguieri*, *Leptadenia pyrotechnica, Tamarix nilotica* and *Zygophyllum coccineum);* four species had presence value 67% **(***Diplotaxis acris*, *Pulicaria undulate*, *Rumx vesicarius* and *Salsola imbricate*). Two species *Astragalus sieberi* and *Helliotropium digynum* had a presence value of 17%, 33% with fidelity of degree.

The present study comprises an ecological survey in Wadi Al-Assiuty and its tributary Wadi Habib in the Eastern Desert of Egypt. The impact of extreme aridity and the scanty rains in Wadi Al-Assiuty and its tributaries is quite clear from the poverty of species encountered. The plant species collected from the study area of Wadi Al-Assiuty included 66 species, 33 perennials and 33 annuals, belonging to 53 genera from 22 different families. Most of the collected annuals were recorded after 2011 rainfalls. The largest family was Asteraceae which represented by 14 species (21.2% of the recorded species), followed by family Chenopodiaceae which represented by eight species (12.1%). It may be noted that the deltaic part of Wadi Al-Assiuty and a great part of its main course are parts of a great bay fringing the Nile Valley. The near of underground water reservoir from the surface in this area, at depth 2-5 m (Kassas and Girgis, 1972) is obviously an important source of water for plants with deep roots (perennials).

Taking into account the Q-values of the recorded species, twenty two of the recorded species (33.3%) are omnipresent and had a dominant degree of occurrence (Q-value $\geq$ 0.2). Q values ranged between 0.88-0.20 (Tab. 1). The highest among others were *Zilla spinosa* and *Zygophyllum coccineum* which recorded in 86% and 88%respectively of the studied stands and spread their dominancy all over the Eastern Desert of Egypt. Their dominance over the communities of the Eastern Desert was documented by many scientists: Montasir (1938), Hassib (1951), Kassas and Imam (1954), Kassas and El-Abyad (1962), Kassas and Girgis (1964), Salama and El-Naggar (1991), Abd El-Ghani (1998) and Galal and Fahmy (2012). Fossati *et al.* (1998) recorded *Zilla spinosa* and *Zygophyllum coccineum* and indicated their wide range of distribution, often on fine calcareous neutral or alkaline substratum. The remaining dominant species showed a regional dominancy over certain sectors. The very common species generally had Q values ranged between 0.1-0.199. In this study, twelve species were recorded belonging to this range (17.9% of the recorded species Q=0.10-0.18). According to Q value calculation (Q value ranged between 0.05-0.099) there were five common species. *Helliotropium bacciferum, Kickxia aegyptiaca, Schouwia purpurea* and *Trigonella stellata* were collected from four stands (P=8%; Q=0.08), while *Astragalus vogelii* were collected from three stands (P=6%; Q=0.06). Q value ranged between 0.08-0.06. Occasional species were represented by 28 species such as*Acacia nilotica, Achillea fragrantissima*, *Amberboa lippii, Ammi majus, Arnebia hispidissima, Astragalus hamosus, Astragalus sieberi*, *Avena sterilis, Calotropis procera*, *Chenopodium ambrosioides*, *Cynodon dactylon*, *Datura innoxia, Echium rauwolfii, Hibiscus trionum, Hyoscyamus muticus, Ifloga spicata, Imperata cylinderica, Lactuca serriola, Panicum turgidum* and *Zizyphus spina-christi* were in one stands (P=2% and Q=0.02). The sporadic species (Q-value $\leq$ 0.01) were not represented in this work. *Zygophyllum coccineum, Zilla spinosa* and *Calligonum polygonoides* have the highest presence values in Wadi Al-Assiuty. The same species were identified in other wadis in the Eastern Desert as members of the alliance Zygophyllaeion (Salama and Fayed, 1990). *Calligonum polygonoides* has an analogue and previously recognized in Wadi El-Miyah (El-Sharkawi *et al*., 1982b). Salama and Fayed (1989) recognized *Zilla spinosa* and *Salsola imbricata* in one community in Wadi Barramiya. *Zilla spinosa* has also been recorded in the wadi system west of Qusseir province (Salama and El-Naggar, 1991); Wadi El-Matuli, Wadi Gimal, Wadi Qassab (El-Sharkawi *et al*., 1982a, 1982b, 1984) Wadi Kherit and Wadi El-Ghuza (El-Sharkawi *et al*., 1987, 1988). The 33 collected annual species (50% of total flora) in the present study may be

Tab. 1. Species composition of the study area classified according to the different families, together with their presence values (P%), chorology and occurrences. Choro=Chorology (SA=Saharo-Arabian, SZ=Sudano-Zambezian, M=Mediterranean, IT=Irano-Turanian, Cosm=Cosmopolitan, Pan=Pantropical). Q=Occurrence (D=Dominant, VC=Very common, C=Common, O=Occasional, S=Sporadic); L.F.=Life forms (Th: Therophytes, He: Hemicryptophytes, Ch: Chamaephytes, G=Geophytes and Ph: Phanerophytes; Dur.=Duration (Ann.=Annual and Per.=Perennial)

Families and species	Dur.	L.F	Choro.	P %	Q
Apiaceae					
Ammi majus L.	Ann.	Th	M	2	O
Apocynaceae					
Leptadenia pyrotechnica (Forssk.) Decne.	Per	Ph	SA+SZ	40	D
Asclepiadaceae					
Calotropis procera(Aiton) W. T. Aiton	Per	Ph	SA+SZ	2	O
Asteraceae					
Achillea fragrantissima(Forssk.) Sch. Bip	Per	Ch	SA+IT	2	O
Amberboa lippii (L.)DC	Ann	Th	SA+SZ	2	O
Artemisia judaica L.	Per	Ch	SA	54	D
Centaurea calcitrapa L.	Per	He	M+SA+IT	18	VC
Cotula cinerea Delile	Ann	Th	SA	56	D
Ifloga spicata (Frossk.) Sch. Bip.	Ann	Th	SA+SZ	2	O
Lactuca serriola L.	Ann	Th	M+IT	2	O
Launaea amal-aminae (Boiss.) Kuntze	Ann	Th	SA	20	D
Launaea nudicaulis (L.) Hook. f.	Per	He	SA+IT	16	VC
Pulicaria arabica (L.) Cass.	Ann	Th	M+SA	12	VC
Pulicaria undulata(L.) C. A. My.	Per	He	SA	44	D
Pulicaria incisa (Lam.) DC.	Per	He	SA	18	VC
Senecio glaucus L. subsp. *coropifolius* (Maire) C. Alexander	Ann	Th	SA+IT	40	D
Sonchus oleraceus L.	Ann	Th	Cosm	10	VC
Boraginaceae					
Arnebia hispidissima (Lehm.) DC.	Ann	Th	SA	2	O
Echium rauwolfii Delile	Ann	Th	SA	2	O
Helliotropium bacciferum Fross	Per	Ch	SA	8	C
Helliotropium digynum (Forssk.) C.Chr.	Per	Ch	SA	4	O
Trichodesma africanum (L.) R. Br.	Ann	Th	SA+SZ	22	D
Brassicaceae					
Diplotaxis acris (Forssk.) Boiss.	Ann	Th	M+IT	52	D
Eremobiuma egyptiacum (Spreng.) Asch. &Schweinf. ex Bioss	Ann	Th	SA	54	D
Matthiola longipetala (Vent) DC.	Ann	Th	M+SA+IT	68	D
Schouwia purpurea (Forssk.) Schweinf.	Ann	Th	SA	8	C
Zilla spinosa (L.) Prantl.	Per	Ch	SA	86	D
Caryophyllaceae					
Paronychia arabica (L.) DC.	Ann	Th	SA	10	VC
Chenopodiaceae					
Anabasis setifera Moq.	Per	Ch	SA	4	O
Atriplex halimus L.	Per	Ph	M+SA	60	D
Bassia indica (Wight) A.J.Scott	Ann	Th	SA+IT	46	D
Bassia muricata (L.) Asch	Ann	Th	SA+IT	28	D
Chenopodium ambrosioides L.	Ann	Th	Cosm	2	O
Chenopodium murale L.	Ann	Th	Cosm	4	O
Cornulaca monacantha Delile	Per	Ch	SA	70	D
Salsola imbricate Forssk. sub sp. *imbricate*	Per	Ch	SA+IT	32	D
Cleomaceae					
Cleom amblyocera Barratte & Murb.	Ann	Th	SA	4	O

Fabaceae					
Astragalus hamosus L.	Ann	Th	M+IT	2	O
Astragalus sieberi DC.	Per	Ch	SA	2	O
Astragalus vogelii (Webb) Bornm.	Ann	Th	SA	6	C
Trigonella stellata Forssk.	Ann	Th	SA	8	C
Geraniaceae					
Monsonia nivea (Decne.) Webb	Per	He	SA	4	O
Malvaceae					
Hibiscus trionum L.	Ann	Th	IT	2	O
Malva parviflora L.	Ann	Th	M+IT	12	VC
Mimosaceae					
Acacia nilotica (L.) Delile	Per	Ph	SA	2	O
Acacia tortilis (Forssk.) Hayne subsp. *raddiana* (Savi) Brenan	Per	Ph	SA+SZ	4	O
Plantaginaceae					
Plantago ciliate Desf.	Ann	Th	SA+IT	12	VC
Poaceae					
Avena sterilis L.	Ann	Th	M+IT	2	O
Cynodon dactylon (L.) Pers.	Per	G	Pan	2	O
Imperata cylinderica (L.) Raeusch.	Per	He	M+SA+IT	2	O
Panicum turgidum Frossk.	Per	G	M+SA	2	O
Polygonaceae					
Calligonum polygonoides L`Hèr.	Per	Ph	SA+IT	74	D
Rumx vesicarius L.	Ann	Th	SA+IT	30	D
Resedaceae					
Ochradinus baccatus Delile	Per	Ph	SA+SZ	4	O
Oligomris linifolia (Hornew) J. F. Macbr.	Ann	Th	SA+SZ	18	VC
Rhamnaceae					
Zizyphus spina-christi (L.)Desf.	Per	Ph	SA	2	O
Scrophulariaceae					
Kickxia aegyptiaca (L.)Na`belek	Per	Ch	M+SA	8	C
Solanaceae					
Datura innoxia Mill.	Ann	Th	Cosm	2	O
Hyoscyamus muticus L.	Per	Ch	SA	2	O
Tamaricaceae					
Tamarix aphylla (L.) H. Karst.	Per	Ph	SA+SZ+IT	14	VC
Tamarix nilotica (Ehreub.) Bunge	Per	Ph	SA+SZ+M	52	D
Zygophyllaceae					
Fagonia arabica L.	Per	Ch	SA	46	D
Fagonia bruguieri DC.	Per	He	SA+IT	18	VC
Fagonia indica Burm. f.	Per	Ch	SA	34	D
Zygophyllum coccineum L.	Per	Ch	SA+SZ	88	D
Zygophyllum simplex L.	Ann	Th	SA	4	O

attributed to a heavy rainfall in January 2011.

Plant life forms resulted from evolved adaptation to environment and climate (Kassas, 1955). The life form spectrum of Wadi El-Assiuty (Fig. 2) showed that the proportion of therophytes (50%) is higher than that of other life forms, while the proportion of chamaephytes (21%) and phanerophytes (15%) are not worthy. High percentages of therophytes and chamaephytes coincide with the floristic characters of the arid zones and semi-arid zones (Bornkamm and Kehl, 1985; Migahid *et al*., 1971; Pignatti and Pignatti, 1989). Danin and Orshan (1990) pointed out that the life form pattern of the desert plants correlates mainly with rainfall. Life form distribution of the desert plants is also correlated with topography and land form (Kassas and Girgis, 1965; Orshan, 1986; Zohary, 1973).

Results of the total chorological analysis of the surveyed flora (Fig. 2) revealed that 28 species (42.4% of the total flora) are mono-regional, of which 26 species (39.4%) are native to the Saharo-Arabian chorotype. Cosmopolitan ranked second with 3.1%. About 50% of the recorded species are 33 bioregional and pluri-regional, extending their distribution all over the Saharo-ArabianSudano-Zambezian, Irano-Turanian and Mediterranean regions. The Saharo-Arabian chorotype (bi- and pluri-), part of the Saharo-Arabian region, constitutes 34.8% and 7.6%, respectively, of the recorded species (total 81.8%) and it forms the major component of the floristic composition of this study. These results coincide with Hassan (1987), Sheded (1992) and

Tab. 2. Floristic composition in the vegetation groups of Wadi El-Assuity and Wadi Habib. Figures in bold are species with highest presence values

Groups	A	B	C	D
No.of stands	6	14	24	6
No.of species	39	49	33	31
Bassia indica (Wight) A.J.Scott	50	43	38	83
Cotula cinerea Delile *Ann*	50	71	54	33
Diplotaxis acris (Forssk.) Boiss.	33	93	29	67
Eremobium aegyptiacum (Spreng.) Asch. &Schweinf. ex Bioss	33	36	75	33
Fagonia arabica L.	17	86	38	17
Launaea nudicaulis (L.) Hook. f.	67	14	4	17
Leptadenia pyrotechnica (Forssk.) Decne.	50	7	46	83
Matthiola longipetala (Vent) DC.	50	71	63	100
Pulicaria undulata(L.) C. A. My.	33	36	46	67
Salsola imbricata Forssk.	33	64	4	67
Senecio glaucus L. subsp. *coropifolius* (Maire) C. Alexander *Ann*	100	71	8	33
Tamarix nilotica (Ehreub.) Bunge	67	14	63	83
Trichodesma africanum (L.) R. Br.	17	43	13	17
Zilla spinosa (L.) Prantl.	33	100	88	100
Zygophyllum coccineum L.	100	100	79	83
Artemisia judaica L.	17	14	75	100
Bassia muricata (L.) Asch *Ann*	50	50	17	
Fagonia indica Burm. f.	50	57	25	
Launaea amal-aminae N. Kilian	17	57	4	
Malva parviflora L.	33	21	4	
Oligomeris linifolia (Vahl.) ex Hornew J. F. Macbr.	17	50	4	
Fagonia bruguieri DC.	33	14		83
Rumx vesicarius L.	17	71		67
Anabasis setifera Moq.	17	7		
Schouwia purpurea (Forssk.) Schweinf.	50	7		
Sonchus oleraceus L.	50	14		
Ochradinus baccatus Delile	17		4	
Acacia nilotica (L.) Delile	17			
Achillea fragrantissima (Forssk.) Sch. Bip	17			
Ammi majus L.	17			
Calotropis procera(Aiton) W. T. Aiton	17			
Chenopodium murale L.	33			
Cynodon dactylon (L.) Pers.	17			
Datura innoxia Mill.	17			
Hibiscus trionum L.	17			
Hyoscyamus muticus L.	17			
Imperata cylinderica (L.) Raeusch.	17			
Zizyphus spina-christi (L.)Desf.	17			
Zygophyllum simplex L.	33			
Atriplex halimus L.		86	50	100
Calligonum polygonoides L`Hèr.		50	100	100
Centaurea calcitrapa L.		7	13	83
Cornulaca monacantha Delile		86	75	83
Pulicaria incisa (Lam.) DC.		7	8	100
Tamarix aphylla (L.) H. Karst.		14	13	33
Acacia tortilis (Forssk.) Hayne subsp. *raddiana* (Savi) Brenan		7	4	

Heliotropium bacciferum Fross	7	13	
Paronychia arabica (L.) DC.	29	4	
Cleom amblyocera Barratte & Murb.	7		17
Kickxia aegyptiaca (L.)Na`belek	7		50
Plantago ciliata Desf.	21		50
Trigonella stellata Forssk.	21		17
Arnebia hispidissima (Lehm.) DC.	7		
Amberboa lippii (L.)DC	7		
Astragalus hamosus L.	7		
Astragalus vogelii (Webb) Bornm.	21		
Avena sterilis L.	7		
Chenopodium ambrosioides L.	7		
Echium rauwolfii Delile	7		
Ifloga spicata (Frossk.) Sch. Bip.	7		
Lactuca serriola L.	7		
Monsonia nivea (Decne.) Webb	14		
Pulicaria arabica (L.) Cass.		17	33
Panicum turgidum Frossk.		4	
Astragalus sieberi DC.			17
Heliotropium digynum (Forssk.) C.Chr.			33

Fossati *et al.* (1998).

The phenological events of perennials are fairly constant regardless of the rainfall. This is because these plants depend on a permanent source of the underground water. The majority of perennial species behave similarly to each other in their phenology. Usually perennials sprouted in the end of the month of February and become leafy in March, flowered in April and produced fruits between April and July (Abd El-Rahman and Batanouny, 1959; El-Adawy, 2001; Salama *et al.*, 2013).

Classification of the presence/absence data set of 66 species recorded in 50 stands using cluster analysis yielded four vegetation groups at level two of the hierarchy (Fig. 5; Tab. 2). Most of the groups (A) and (B) stands were confined to the Main trunk of Wadi El-Assuity, while those of groups (C) and (D) were belonging to the Wadi El-Assuity tributary (Wadi Habib). These groups are named after the first and second dominant species as follows: (A) *Senecio glaucus-Zygophyllum coccineum*, (B) *Zilla spinosa-Zygophyllum coccineum,* (C) *Calligonum polygonoides*, and (D) *Artemisia judaica-Matthiola longipetala.* Group B was the largest (14 stands) group, including 49 species, followed by Group A (6 stands, 39 species). Some species showed a certain degree of fidelity, e.g. *Acacia nilotica*, *Achillea fragrantissima*, *Ammi magus, Calotropis procera. Chenopodium murale*, *Cynodon dactylon and Datura innoxia* was confined to Group A; *Arnebia hispidissima, Amberboa lippii, Astragalus hamosus, Astragalus vogelii, Avena sterilis, Chenopodium ambrosioides, Echium rauwolfii, Ifloga spicata , Lactuca serriola and Monsonia nivea*to to Group B; *Panicum turgidum* to Group C; and *Astragalus sieberi* and *Heliotropium digynum* to Group D. Sixteen species were recorded in all groups, including *Bassia indica*, *Diplotaxis acris*, *Eremobium aegyptiacum*, *Matthiola longipetala*, *Trichodesma africanum*as annuals and *Cotula cinerea*, *Fagonia arabica*, *Launaea nudicaulis, Leptadenia pyrotechnica, Pulicaria undulata*, *Salsola imbricata*, *Senecio glaucus*, *Tamarix nilotica*, *Zilla spinosa*, *Zygophyllum coccineum*, *Artemisia judaica* as woody perennials (Tab. 2).

In their detailed study on the plant communities in the vicinity of this study area, El-Sharkawi *et al.* (1982a) described three major community types. The first included *Zilla spinosa*, *Zygophyllum coccineum*, *Schouwia thebaica*, *Zygophyllum simplex*, *Cotula cinerea*, *Salsola baryosma*, *Pulicaria undulata*, *Tribulus pentandrus*, and *Launaea capitata*. Certainly, the identified vegetation group B belongs to these community type. Kassas and Girgis (1972) stated that the plant growth in WAdi Al-Assiuty and Wadi Habib differes in obvious relations to the size of the catchment area. They recognized also *Zilla spinosa, Zygophyllum coccineum,* and *Leptadenia pyrotechnica* community types among other communities recorded in the studied wadis.

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