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Pollen Grains Indicators to Plant Habitat Conditions at Some Arid Regions Sadat Area Egypt

Ashraf A. Salman. [1*] **and Mohamed. F. Azzazy** [2]
[1] Botany Department, Faculty of Science, Port Said University, Port Said, Egypt
[2] Natural Survey Resource Department, Environmental Studies and Research Institute, Minufiya University, Egypt

ABSTRACT

Nine profiles were studied at Sadat desert area. Xerophytes growing during rainy season represent the common plant cover. The studied soil samples revealed that soils contain high alkalinity, and sandy texture. Palenological studies of the present and the past vegetation (in soil profile strata) revealed the presence of pollen of seventeen families, twelve belonging to present cover (*Poaceae, Typhaceae, Tamaricaceae, Cyperaceae, Chenopodiaceae, Fabaceae, Apiaceae, Lamiaceae, Cruciferae, Plantaginacea, Convolvulaceae* and *Asteraceae*) of present day, while five families recorded at the deep layers of the profiles not represented in the surface layers (*Juncaceae, Caryophyllaceae, Oleaceae, Cucrbitaceae,* and *Geraniaceae*). Also eleven families were represented in the lower layers and uppermost ones. Ecological changes took place in the uppermost layer of the profile, changing into desert habitat. This may be due to climatic changes and man interference.

Key words: Arid habitats, Climate change, Palynology, Sadat area Egypt, Xerophytes pollen.

INTRODUCTION

The value of pollen grains as a tool for reconstruction of the past vegetation and environment, and its applications in archaeology, geology, honey analysis, archaeobotany and forensic science is now widely known (Moore *et al.,* 1992). Pollen grains are valuable indicators of environmental conditions in the past (Webb and Clark, 1977 and Birks, 1979), and can be used in reconstruction the past flora and plant populations (Birks, 1973).

On the other hand, Hanson and Churchill (1965) showed that plants growing within the optimal range of ecological amplitude exhibited best vigor and greatest density, but even under such conditions competition may have detrimental effects. Moreover, Kassas and El-Abyad (1962) stated that there is a complex interrelationship between plants, habitat and among individual plants. (Chamberlin, 1975). While used indicator plants to determine boundaries of landforms on aerial photographs.

The presence percentages of species as well as indices of halophytism and xerophytism express tolerances of natural vegetation to water and salt stresses, also, zonation of plants is often caused by differences in the ecological amplitude of species (Abd El-Fattah, 1994). While, the vegetation-pollen relationships are of ecological interest and the density of the pollen grains is closely related to the abundance of plants (Zahran *et al.,* 1992). Also, the soil mechanical composition affects the vegetation distribution (Lihong *et al.,* 2005).

Arid vegetation patterns are affected by environmental factors more intensively than in humid areas. Efforts have been made to reveal the vegetation-environment relationships in the arid zones. In This paper, we try to demonstrate the role of pollen grains as a tool in the study of the plant habitat conditions at Sadat desert area, reconstruct the past vegetation and climate using pollen analysis and compare present and past.

MATERIALS AND METHODS

Study Area

Sadat City was established in 1976: to become a new residential based on industrial and agricultural activities, it has been a unique location between Cairo, Alexandria and adjacent Delta making it a center for attracting domestic and foreign investments. Sadat City is located in the north and west of Cairo at the Kilo 93 through Cairo– Alexandria Desert Road and an area of 500 Km^2.

The total mass of the Urban 18Km^2 divided the twelve residential area inhabited by 70 thousand people and includes five industrial zones on an area of five million $meters^2$, and takes the city's green belt area of 30 thousand acres making by the World Health Organization (W.H.O) to classify the best ten industrial societies in the Middle East.

Vegetation Analysis

The present vegetation was analyzed in spring and summer, 2007. Soil samples were collected at depths, surface (0-25cm) and bottom (125-150cm) one sample each 25cm. The soil samples were analyzed for physical, chemical and pollen grains contents.

The vegetation analysis and floristic composition were carried out according to Hanson and Churchill (1965) and Kershaw (1973). Indices of halophytism (IH) and xerophytism (IX) are obtained by analysis of vegetation composition according to the equations:

$$IH = \frac{H \times 100}{T} \quad , \quad IX = \frac{H \times 100}{T}$$

Abundance: ab % =

$$\frac{\text{No. individuals of a given species X 100}}{\text{Tota l No. of all individuals}}$$

* *Corresponding Author:* Dr_Ashraf11@yahoo.com

27stands 10 x 10 m for each were selected represent the plant communities in the study area which about (20Km). Within each stand, species present were recorded. Taxonomic nomenclature followed Täckholm (1974), updated with Boulus (1995, 1999). Plant cover was estimated quantitatively by the line intercept method (Canfield, 1941). Physical and chemical analysis of soil carried out according to Jackson (1962) and Widle *et al.* (1972). Pollen analysis, identification routinely used x400 magnification with x1000 magnification for small and difficult types with reference to standard keys (Andrew, 1984; Faegri and Iversen, 1989; Moore *et al.*, 1991) and the reference collection key pollen of Environmental Studies and Research Institute Minufiya University (ESR).

Climate

The data showed in Table 1, was obtained from the Egyptian Meteorological Department. The monthly mean rainfall varied from 10.1mm in January to no rainfall in May, June, July, August and September. The monthly mean temperature was between 36.5^{0}C in July And 17^{0}C in January, while relative humidity varied between 58% in August and 43% in March. The evaporation varied from 5.7mm/day in June to 2.7mm/day in January. The wind velocity varied from 12.8km/hr in March to 8.4km/hr in September.

Pollen Analysis

Three profiles were dug in three locations at the study area, at different depths. The abundances of the different pollen grains in the soils at different levels are illustrated in figure 4 (a-q); this shows that the pollen abundances of the families *Poaceae (Gramineae), Typhaceae, Tamaricaceae*, *Cyperaceae*, *Chenopodiaceae, Fabaceae (Leguminosae), Apiaceae (Umbelliferae), Lamiaceae (Labiatae) Cruciferae, Plantaginaceae, Convolvulaceae* and *Asteraceae (Compositae)* were the most frequent pollen types at the upper most layers of the profiles (present day layers) with abundances, 50, 3, 15, 10, 18, 10, 20, 3, 10, 5, 7 and 25% .

Vegetation Analysis

Table 2 showed: the floristic composition of naturally growing weeds at the study area in April 2007. Three dominant plants: *Artemisia monosperma, Tamarix aphylla* and *Typha domingensis*. The *Artemisia monosperma* associate communities were: *Fagonia Arabica*, *Panicum turgidum*, *Pulicaria crispa*, *Senecio glaucus*, *Spurbolus spicatus* and *Zygophyllum simplex* with abundance 25, 10.7, 17.85, 10.7, 14.28 and 21.42%, respectively. *Tamarix aphylla* associates were: *convolvulus lanatus, cornulaca monacantha*, *Cotulla cinerea*, *Cyprus rotundus* and *Salsola imbricata*, with abundance 9, 27, 36.36, 18.1 and 9%. While *Typha domingensis* associates were: *Phragmites australis, Cyperus articulatus, Cyperus rotundus and Cyperus difformis* with abundance 46, 20, 24 and 20%, respectively.

RESULTS

Soil Analysis

Table 3 showed: physical and chemical analysis of soil profile. The data obtained showed that moisture content varied from 13.9% at depth 125-150cm to7.5% surface lager 0-25cm. The granules varied from 19% depth 50-75cm to 9% surface 0-25cm. The main bulk of soil mainly of fine and medium sand was varied from 40.1% at depth 125-150cm to 38.9% surface at 0-25cm. The finer sediments varied from15.6% at 125-150cm to 9.3% at 50-75cm.

The soil reaction pH was alkaline while varied from 8.6 at 0-25cm surface and 7.6 at 125-150cm depth. Calcium carbonates varied from 7.6% surface 0-25cm to 2% at 125 150cm depth. Total nitrogen varied from 23ppm (0-25cm) to 6ppm at 125-150 cm depth. Electro-conductivity (E.C) varied from 1.7mmohs/cm at 0-25 cm to 0.35mmohs/cm at 125-150cm depth. The anions Cl, SO_4 and HCO_3 varied from 2.25, 3.93 and 1.2ppm at depths 0-25cm, respectively to 0.75, 0.12 and 0.5 at depths 125-150cm, respectively. The cations Na, K, Ca and Mg varied from 3.41, 1.15, 14.2 and 4.8ppm at 0-25cm respectively to 0.97, 0.35, 0.6 and 0.1ppm at 125-150cm, respectively.

DISCUSSION

This paper describes the results of meteorological, vegetation analysis, soil physical and chemical and pollen analysis. The data obtained in table 1 showed that dry hot summer and rainy warm winter, in this connection. Zahran *et al*., (1995) stated that, Egypt is an arid country; hot and dry with Scanty and irregular rainfall usually occurs in winter. However, cloudburst is not unusual; particularly in the southern extreme arid part of Egypt. The relationships between soil, vegetation and atmosphere are extremely close in the arid lands (Zahran and Willis, 1992).

The study of floristic composition of plant growth in different habitats provides an indicator of soil salinity, moisture content and soil reaction (Abd El- Fattah *et al.,* 1993). The result in table 3 showed floristic composition of the study area, the results showed presence of three community types, three dominants in community types, fifteen associated species, in this connection Kassas and El- Abyad (1962) stated that differences in the presence values of the desert vegetation are due to ecological or geographical factors. The first community dominated with xerophytes e.g. *Artemisia monosperma*, the associates were *Fagonia Arabica, Panicum turgidum, Pulicaria crispa, Senecio glaucus, Sporbulus spicatus* and *Zygophyllum simplex.*

Xerophytes vegetation is the most important characteristic type in Egypt; it constitutes the major part of plant life in the Egyptian deserts (Zahran and Willis, 1992).

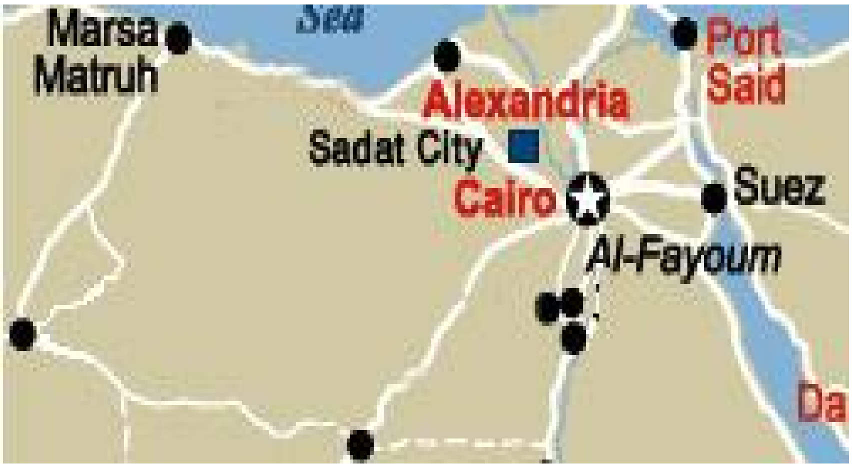

Figure (1): Showing Sadat City location and included the study area

Figure (2): showing floristic composition and most plant communities in the study area.

Table (1): Climatic data, Sadat City 2000 – 2010 including rainfall (mm), tempreture (C^O), relative humidity (%), evaporation (mm/day) and wind velocity for sadat city in 2000- 2010.

Climatic factors / Months	Rainfall (mm)	Temperature$(C)^0$	Relative humidity (%)	Evaporation (mm/day)	Wind velocity (km/hr)
January	10.1	17	56	2.7	10.2
February	7.0	19	53	2.9	11.5
March	5.2	26	43	3.5	12.8
April	1.2	30	48	4.6	12.2
May	0.0	34.6	49	5.5	10.3
June	0.0	35	53	5.7	10.5
July	0.0	36.5	57	4.9	10.2
August	0.0	35.5	58	4.7	8.5
September	0.0	30	58	4.1	8.4
October	1.0	27	58	4.3	8.6
November	2	24	57	3.1	8.7
December	9.1	20	57	2.9	10.3

Table (2): Vegetation Composition at Sadat study area

Dominants Species	Associates	Number Individuals	Abundance %
	***Fagonia arabica*.**	7	25.0
	***Panicum turgidum*.**	3	10.7
	Pulicaria crispa	5	17.85
Artemisia monosperma Delile.	***Senecio glaucus***	3	10.7
	Sporbulus spicatus	4	14.28
	Zygophyllum simplex	6	21.42
	Convolvulus lanatus	5	9.0
	Cornulaca monacantha	15	27.0
	Cotula cinerea	20	36.36
Tamarix aphylla (L.) H.Karst.	***Cyperus rotundulIs***	10	18.1
	Salsola imbricate	5	9.0
	Phragmites australis	23	46.0
	Cyperu s articulates	5	10.0
	Cyperus rotundus	12	24.0
Typha domingensis Pers.	***Cyperus difformis***	10	20.0

Table (3): Physical and chemical properties of soil samples at study area.

Depth/ cm	M %	Physical: Particle size %: G %	Sand: C%	Sand: M%	Sand: F%	SC	pH	Caco$_3$ %	N PPm	E.C Ms/ Cm	Chemical: Anions / ppm: Cl	SO_4	CO_3	HCO_3	Cations / ppm: Na	K	Ca	Mg
0-25	7.5	9	3.8	38.9	36	12.3	8.6	7.6	23	1.7	2.25	3.93	-	1.2	3.4	1.15	14.2	4.8
25-50	8.0	17	5.4	37.5	29.	10.6	8.4	5.9	22	154	2	1.5	-	1.0	2.5	0.92	10.7	2.3
50-75	9.3	19	7.5	36.1	28.	9.3	8.2	3.0	20	0.97	1.75	1.18	-	0.9	2.4	0.86	10.5	2.1
75-100	12.6	12	5.7	36.2	36	9.8	8.1	2.5	17	0.58	1.5	0.95	-	0.8	1.7	0.67	6.3	1.6
100-125	13.1	10	3.2	32.7	37.2	15.3	7.9	2.2	9	0.36	1.0	0.82	-	0.7	1.8	0.43	3.8	0.4
125-150	13.9	9	2.8	32.5	40.1	15.6	7.2	2.0	6	0.35	0.75	0.12	-	0.5	0.97	0.35	0.6	0.1

NOTE: (G) : gravel, **(C) :** coarse sand **, (M):** medeim sand**, (F):** fine sand, (**SC**): Sih and clay.

Several studies described the ecology of the vegetation types and their relationships with soil and climate (Kassas and Zahran, 1965; Ayyad and Ammar, 1974; Ayyad and El-Ghonemy, 1976; Ayyad, 1981; Abdel Razik *et.al.*, 1984; Serag, 1991; Dargie and El- Demerdash, 1991). There are some similar studies on the relationship between desert vegetation and environmental factors (Pan *et al*., 1995). Halophytic vegetation is the second in importance, where it occupies the inland salt marshes and littoral of the country.

The data obtained in table 2 showed that halophytic community dominated with *Tamarix aphylla*, the associates were *Convolvulus lanatus, Cornulaca monacantha, Cotula cinerea, Cyperus rotundusand Salsola imbricate*, in this connection Zahran *et al*., (1995) stated that *Tamarix sp*. and *Salsola* are obligate halophytes. The reed swamp (helophytic) vegetation community type dominated with *Typha domingensis*, while the associates were, *Phragmities australis*, *Cyperus articulatus, Cyperus rotundus* and *Cyperus difformis* were common in the study area, wherever there is neglected shallow water (saline, brackish or fresh). The reeds predominate, table (2), stated that the most widely spread reeds are *Phragmities australis* and *'T'ypha domingensis*, other common species of the reed swamp vegetation include: *Cyperus articulatus, C. rotundus, C. difformis, Juncus subulatus,* and *Typha elephantina* are very limited in its distribution; it predominates in the swamps associated with the lakes of Wadi El-Natrun depression of the Western Desert of Egypt and absent elsewhere.

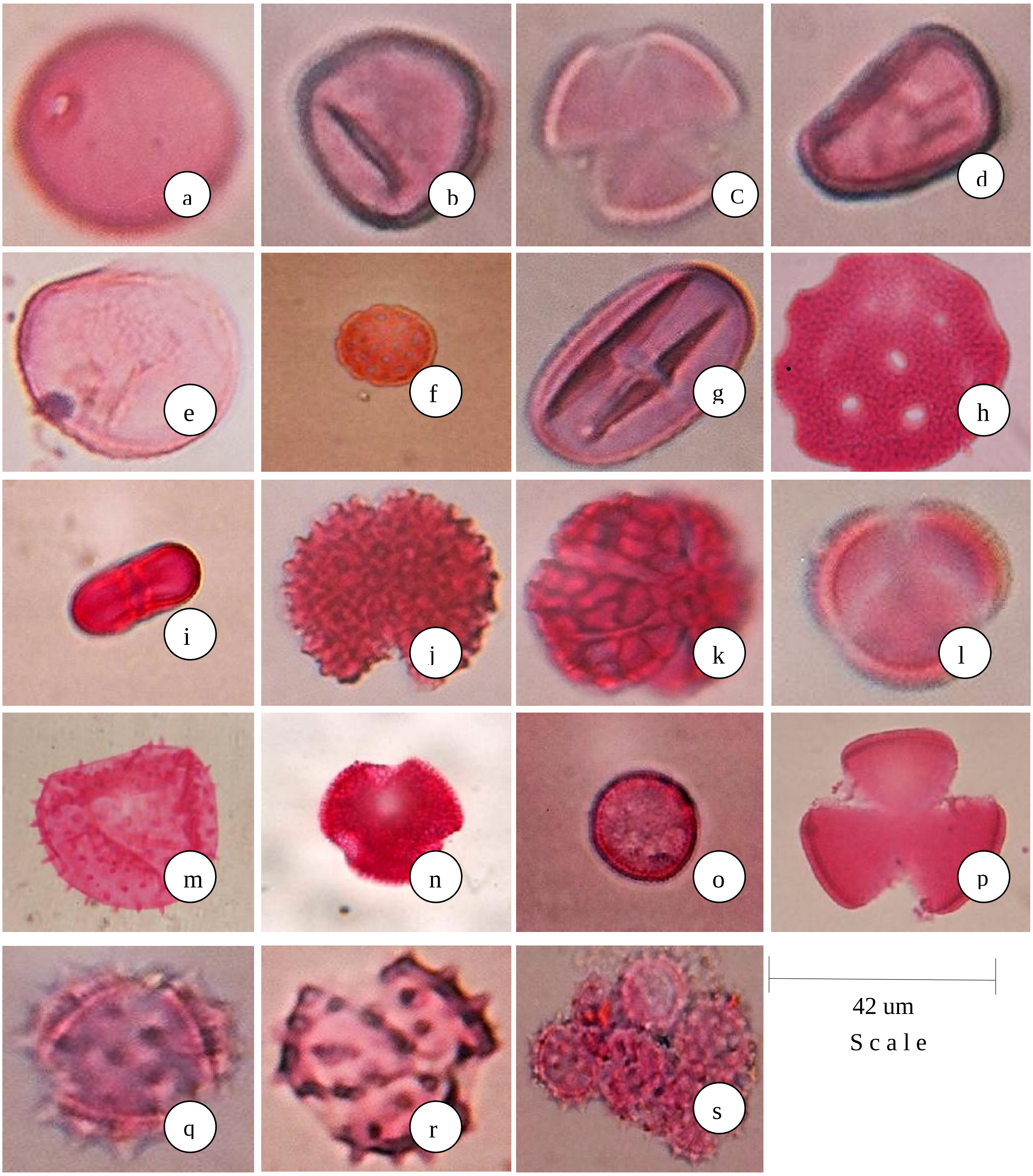

Plate (1): (a) Poaceae pollen type (b) Typhaceae (c) Tamaricaceae (d) Cyperaceae (e) Juncaceae (f) Chenopodiaceae (g) Fabaceae (h) Caryophyllaceae (i) Apiaceae (j) Oleaceae (k) Lamiaceae (l) Cruciferae (m) Cucurbitaceae (n) Geraniaceae (o) Plantaginaceae (p) Convolvulaceae (q-r-s) Asteraceae.

From the results in table 3, it is clear that the main bulk of the soil is mainly composed of fine and medium sand, while the salinity (E.C) decreased with depth; this may due to the continuous evaporation and decreased leaching of salts from the surface layers (Abd El- Fattah *et al*., 1993). The anions were mainly chlorides, partly sulphates and rarely bicarbonate. The soil reaction pH was alkaline. The soil salinity, fine sediments, organic matter and soil moisture content were demonstrated to be related closely with desert vegetation patterns, (Abd El-Ghani, 2000). Soil salinity and moisture conditions are associated with not only soil texture, but also ground water conditions (Beyer *et al*., 1998).

Table 4 and figure (3a-q) showed: the proportions of the different pollen grains in the soil at different levels. The pollen abundances of the families: *Poaceae (Graminea), Typhaceae, Tamaricaceae, Cyperaceae, Chenopodiaceae, Fabaceae (Leguminosae), Apiaceae (Umbelliferae), Lamiaceae (Labiatae), Cruciferae, Plantaginaceae, Convolvulaceae* and Asteraceae (*Compositae)* were the most frequent pollen types at the uppermost layers of the profiles (present day layers). It is also clear from the figures that the pollen grain assemblage of *Poaceae* 40%, *Asteraceae* 25%, *Chenopodiaceae* 18%, *Tamaricaceae* 15% and *Cyperaceae* 10%. The *Poaceae* represented with grasses pollen type, *Asteracea, Chenopodiaceae*, and *Cyperaceae* are extremely arid vegetation (Singh *et al*., 1973), this may indicate the aridity of the study area.

While, *Chenopodiacea, Tamaricaceae,* and *Cyperaceae* are halophytic plants, their pollen were recorded with high abundance at depths (0-25) and (25-50cm), this may suggest that the site was a-salt marsh. On the other hand the pollen grains percentage of *Poaceae, (Gramineae), Fabaceae (Leguminosae*) and *Cruciferae* types decreased with depth, reaching 7%, 2% and 1% in the lower most layers, respectively. While their corresponding values in the uppermost layer were, 40%, 10, and 10% respectively. The species representing the families *Poaceae, Fabaceae* and *Cruciferae* are mostly *xerophyte*, which suggests that the studied area is changing towards xeric habitat (Zahran *et al*., 1995).

In the deep layer, the species representing families , *Juncaceae, Caryophyllaceae, Oleaceae, Cucurbitaceae*, and *Geraniaceae* were recorded with abundances, 5%, 5%, 6%, 5%, and 7%, respectively, while their corresponding values in the uppermost layer were zero for all. So members of five plant families were absent from the present day plant cover ,this may be related to climatic changes from humid to arid, with associated change in the vegetation types (Butzer, 1959). Members of 11 families were represented both in lower layers and in the uppermost layers, *Poaceae, Typhaceae, Cyperaceae, Chenopodiaceae, Fabaceae, Apiaceae, Lamiaceae, Cruciferae, Plantaginaceae, Convolvulaceae,* and *Asteraceae.*

This agreed with (Ayyad, 1988), which stated that members of Cyperaceae, Asteraceae,Chenopodiaceae, and Apiaceae species were growing in wet or dry places. However, better comparison with pollen data have been obtained for the reconstruction of potential natural vegetation rather than actual vegetation altered by land use (Gachet *et al*., 2003; Hely *et al*., 2006).

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حبوب اللقاح كادلة لظروف البيئة النباتية فى بعض المناطق القاحلة - منطقة السادات، بمصر

أشرف سالمان[١]، محمد فتحى عزازى[٢]

[١] قسم النبات، كلية علوم ببورسعيد، جامعة قناة السويس
[٢]قسم مسوح الموارد الطبيعية، معهد الدراسات والبحوث البيئية، جامعة المنوفية

الملخص العربى

أجريت الدراسة على ثلاثة مقاطع طولية فى تربة صحراء السادات لمحتواها من حبوب اللقاح والخواص الفيزيقية والكيميائية والكساء الخضرى الطبيعى وثبت من المسح النباتى سيادة للمجتمع النباتى الصحراوى. أوضحت تحاليل التربة زيادة فى نسبة القلوية علاوة عن قوامها الرملى. أثبتت دراسة حبوب اللقاح الموجودة فى طبقات المقاطع الثلاث وجود سبعة عشر نوعاً للفصائل النباتية المختلفة منها أثنى عشر نوعاً تمثل فصائل الكساء الخضرى الحالى وهى (النجيلية ــ البوطية ــ التماركسية ــ السعدية ــ الرمرامية ــ البقولية ــ الخيمية ــ الشفوية ــ الصليبية ـ لسان الحمل ــ العلاقية والمركبة)، بينما سجلت خمسة فصائل أخرى فى الطبقات العميقة للمقطع وهى (الفصيلة السمارية ــ القرنفلية ــ الزيتونية ــ القرعية و الجارونية) وهذة الفصائل غير ممثلة فى الطبقات السطحية والغطاء النباتى الحالى . وكذلك إحدى عشر فصيلة ظهرت فى الطبقات العميقة والسطحية من الكساء الخضرى الحالى ثم حدث إنتقال بيئى للبيئة النباتية الصحراوية فى الطبقات السطحية و يرجع ذلك إلى التغيرات المناخية المتعاقبة وأيضا إلى تدخل الإنسان وزيادة نشاطه.