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ECOLOGICAL STUDIES ON THE SOIL ALGAE OF WADI ALLAQI BIOSPHERE RESERVE AREA IN SOUTH EASTERN DESERT, EGYPT.

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Abstract

First comprehensive data on the floristic composition of the soil algae in relation to edaphic factors in Wadi Allaqi Biosphere Reserve were recorded during 1996-7. Twenty-four species of soil algae belonging to 15 genera and three divisions *viz.*, Cyanophyta (15 species), Chlorophyta (six species) and Bacillariophyta (three species) were isolated and identified. Among them, 13 species; *Lyngbya allorgei, Microcystis pulverea, Oscillatoria pseudogeminata, Phormidium foveolarum, Phormidium subfuscum, Schizothrix calcicola* (Cyanophyta); *Bracteacoccus cohaerens, Gloeococcus minutissimus, Keratococcus bicaudatus, Muriella terrstris, Pseudococcomyxa simplex* (Chlorophyta); *Navicula cincta* and *Navicula rhyncocephala* (Bacillariophyta) were recorded for the first time in the soils of Upper Egypt.

Some physico-chemical characteristics of the soil correlated significantly with the number of species and total counts of soil algae. However, no significant correlation were noticed between the soil algae and soil texture.

Key words: biosphere reserve, desert,soil algae, Wadi Allaqi.

Introduction

Soil algae are significant components of many terrestrial ecosystems where there is an intermittent water supply and considered the only photoautotrophic organisms in some extreme arid deserts. The communities of soil algae that inhabit favourable micro-environments in desert habitats have to withstand not only long periods of water stress but also a large range of temperature fluctuations and high irradiation. The extent to which a visually obvious community develops on soils of hot deserts depends mainly on the extent to which any particular area holds water after the rare periods of rainfall. However, the water requirements of most desert algae are probably met by regular dew rather than infrequent rainfall (Friedmann and Galun, 1974).

The presence of algae in arid soils has been known since a long time (Cameron, 1964) and their geographical pdistribution is apparently worldwide (Feher, 1948). Consequently, the soil algae of semi-arid and arid ecosystems have attracted the attention of several authors (Friedmann *et al.*, 1967; Friedmann, 1971; Novichkova-Ivanova, 1980; Potts and Friedmann, 1981; Johansen, 1984; Arif, 1992; Painter, 1993) who have studied their survival, abundance and distribution in various countries.

In Egypt, the soil algal flora has been repeatedly investigated by several authors. Most of these investigations dealt with algae inhabiting the cultivated soils of various localities (El-Ayouty and Ayyad, 1972; Abu-Elkheir and Mekkey, 1987; Kobbia and Shabana, 1988; El-Gamal, 1990; Kobbia *et al.*, 1991; Yanni, 1991; Matter, 1992; Atia, 1993; Ahmed, 1994; Hifney, 1998). Only a few investigations dealt with the soil algae of desert habitats (Hamouda, 1981; Salama and Kobbia, 1982).

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The southern region of Egypt at Aswan in terms of algal studies has received great attention by Ahmed *et al.* (1989), Mohammed *et al.* (1989) and El-Otify (1991) who studied intensively the freshwater algae of Lake Nasser and the Nile system at Aswan. However, no attention has been paid to study the soil algae of Aswan paticulary those occurred in the extreme arid desert habitat in this region.

The aim of this investigation was to study the floristic composition and distribution of the soil algae in relation to edaphic factors of a hyperarid ecosystem in Wadi Allaqi Biosphere Reserve.

Study Area

Wadi Allaqi is the most extensive drainage system in the South Eastern Desert (Nubian Desert) of Egypt. It lies between 22° 00 and 23 ° 00 N latitudes, 31 ° 01´ and 32 ° 80´ E longitudes. It has a length of 350 km. The area of Wadi Allaqi basin was estimated to be about 44000 km^2.

Wadi Allaqi is divided into three parts: downstream, midstream and upstream (Fig. 1) according to the rock formation, topography of the wadi and its vegetation. The upstream part of the wadi is elevated approximately 500 m ASL (Above Sea Level). The surrounding mountains are high, such as Gebel Eiqat in the upstream part rising 1400 m ASL. The upstream tributaries of the wadi receive occasional rainfall and their drainage

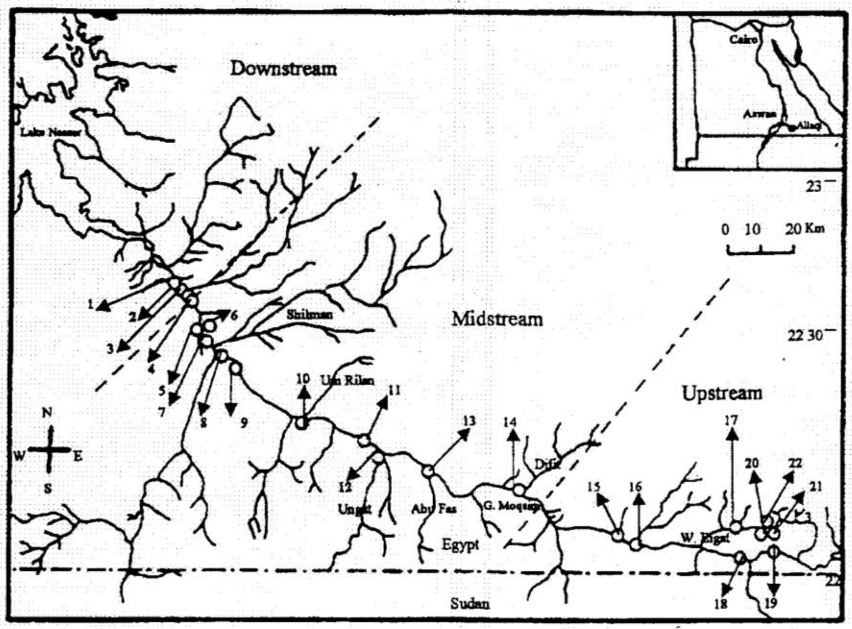

Fig. (1): Map showing locations of the sampling sites in Wadi Allaqi

accumulates in the main channel of the wadi forming accidental torrents which are considered as the main source of water in Wadi Allaqi. The midstream part (middle section) of Wadi Allaqi extends from the area of Gebel Muqsim (839 m ASL) to the area of Gebel Filat (530 m ASL). In this section the wadi receives numerous large effluents on both the north and the south sides. The downstream part of Wadi Allaqi is inundated annually, thus becoming part of Lake Nasser.

Soil forming materials in the downstream part of Wadi Allaqi have been deposited by one of three transport processes: wind, running water and Lake Nasser water. The floor of the wadi in the mid- and upstream part is covered by deposits that are transported by wind and running water.

The weather in Wadi Allaqi is extremely hot (the mean summer temperature is often in excess of 40°C) and arid (relative humidity about 29%). Rainfall is normally zero, but there may be occasional rains once or twice every few years (1 to 5) in little amounts not exceeding 10 mm/ year. However, the formation of the man-made reservoir (Lake Nasser) alters the hyper-arid conditions to more mesophelic in the close proximaty to the lake.

Regarding to the vegetation of Wadi Allaqi, almost 127 species belonging to 38 families have been recorded (Belal and Springuel 1997). The vegetation of the upstream part of wadi Allaqi is rich in phanerophytes, which form an open forest particularly in Eiqat area. The vegetation cover in the downstream part of the wadi is dominated by mesophytic species, particularly *Tamarix nilotica* and *Glinus lotoides.*

The area of Wadi Allaqi was declared a National Nature Reserve in 1989 and a Biosphere Reserve by the UNESCO-MAB Programme in 1993.

Materials and Methods

Soil samples were collected from 22 sites along the main channel including the upstream, midstream and downstream parts of Wadi Allaqi during 1996-7. There was no marked algal growth evident on the soil at the time of sampling. The samples were collected from the surface to a five-cm depth, from the wadi bed and placed in presterilized plastic bags. To estimate the soil moisture content of the surface layer (0-10cm), a known weight of soil was sampled in each investigated site and kept in a tightly closed aluminum container. In the laboratory, the samples were weighted, dried at 105°C for 24 hr., then reweighed and the percentages of moisture contents were calculated.

Each soil sample was screened in a 2-mm sieve, and the gravel content was estimated and discarded. The 2-mm fraction of the soil was kept for mechanical and chemical analyses as well as algal studies. The soil texture was determined by separation of the different size particles using the pipette method (Kilmer and Alexander, 1949) whereby, the percentage of coarse and fine sand, silt and clay were estimated. A soil/ distilled water extract (1:5 wt./ vol.) was prepared and used for physico-chemical analyses of the soil samples. The pH (using an Orion pH meter model 601 l/ digital ionalyzer with a glass electrode) and the electrical conductivity (using an Amber Science Inc Sandiego conductivity meter model 1062) were measured in each soil sample extract. Determinations of chloride, bicarbonate, nitrate-nitrogen, ammonia, dissolved inorganic orthphosphate-phosphorus, soluble reactive silica, sulphate, organic matter, the bivalent cations (calcium and magnesium) and the monovalent cations (sodium and potassium) contents were carried out according to the methods described by Jackson (1977) and the American Public Health Association, APHA (1981).

For cultivation and isolation of the soil algae, different concentrations of the soil suspension (1%, 5% and 10%) were prepared and then placed in a reciprocating shaker for 15 minutes. Four replicates of petri dishes containing different nutritional media solidified with agar were inoculated with one ml of the appropriate dilution of the soil suspension. The media described by Jeanfils and Tack (1992) were used for cultivation and isolation of prokaryotic algae. The eukaryotic algae were cultivated and isolated in Bold's Basal medium (Bischoff and Bold, 1963). The Chu 10 medium (Chu, 1942) was used for cultivation and isolation of diatoms. All cultures were incubated at 25°C to 28°C, with an incident light of 3000 to 4000 lux and a photo period of 12 hr. light: 12 hr. dark cycle. The colonies of algae were enumerated after eight weeks of incubation when the number of colonies became constant.

The different species of the soil algae were identified according to the following references: Geitler (1932), Desikachary (1959), Kimor and Pollingher (1965), Kantz and Bold (1969), Baker and Bold (1970), Sant' Anna and Azevedo (1995), Cox (1996) and Andreyeva (1998).

The statistical computer programme MINITAB was used to study the correlation of the qualitative and quantitative composition of the soil algae with edaphic factors.

Results

This investigation was performed to study the species composition and distribution of the soil algae in relation to edaphic factors of an extreme arid habitat (Wadi Allaqi Biosphere Reserve) in the south eastern desert of Egypt during 1996-7.

The data concerning the granulometric analysis of the soil samples that were collected from Wadi Allaqi (Table 1) revealed that the percentage compositions of gravel were always of relatively low values. The percentages of coarse sand increased gradually from the downstream towards the upstram part of the wadi. The mean values of the fine sand in the downstream part were higher than those in the mid- and upstream parts. The mean values of the silt and clay were always less than 20% and did not exhibit any remarkable regular variations among the different parts of the wadi.

Table (1): Mean values (± SD) of the percentage composition of the different size articles of the soil samples collected from Wadi Allaqi during 1996-7.

	Downstream	Midstream	Upstream
Gravel	2.48 ± 1.28	4.08± 2.41	7.30 ± 4.24
Coarse sand	30.76 ± 24.86	32.99 ±12.75	38.88 ± 10.03
Fine sand	45.41 ± 17.18	25.91± 8.06	37.44 ± 10.43
Silt	8.10 ± 7.12	17.25 ± 12.44	5.05 ± 5.47
Clay	13.25 ± 0.98	19.77 ± 5.02	11.33 ± 1.5

The mean values of various physico-chemical characteristics of the soil samples that were collected from different parts of Wadi Allaqi are given in Table (2). It could be noticed that the soil moisture, chloride, sulphate and organic matter contents varied considerably among the different parts of the wadi and were relatively high in the downstream part. The pH value was recorded to be somewhat slightly alkaline and lay always in the vicinity of 7. The electrical conductivity exhibited slight irregular variations and ranged between 217 and 289 µmohs. The contents of HCO_3, NO_3-N, NH_4, PO_4-P, SiO_3, Ca^{2+}, Mg^{2+}, Na^+ and K^+ did not exhibit remarkable variations among the different parts of Wadi Allaqi.

The assemblages of soil algae in Wadi Allaqi were quantitatively estimated as the total counts of algal colonies after eight weeks of cultivation of the soil samples on different nutritional media. Pronounced variations in the total counts of algal colonies/gm dry soil (Fig. 2) could be observed among the different parts of the wadi. The mean values of the total counts of algal colonies ranged between 576 colonies/ gm dry soil recorded in the upstream part and 3018 colonies/ gm dry soil recorded in the downstream part. It is evident that, the total count of the soil algae in the downstream part of the wadi was higher than that in the mid- or upstream part.

Qualitatively, the soil algal assemblages composed mainly of three divisions namely: cyanophyta, chlorophyta and bacillariophyta (Fig. 3). The number of species of cyanophyta exhibited high percentage compositions in all investigated soil samples. The mean values of the number of cyanophyta species ranged from 59.99% to 78.54%. The percentage copositions of the number of chlorophyta species were always lower than those of cyanophyta and ranged from 15.62 in the midstream part to 22.50% in the downstream part of the wadi. Otherwise, Bacillariophyta constituted relatively low species compositions and their mean values ranged from 5.84% recorded in the midstream part to 17.51% recorded in the downstream part.

Table (2): Mean values (± SD) of the physico-chemical characteristics of the soil samples collected from Wadi Allaqi during 1996-7.

	Downstream	Midstream	Upstream
Soil moisture (%)	9.38±4.70	1.65±0.82	0.059±0.038
pH value	7.51±0.17	7.81±0.10	7.66±0.25
Conductivity(µ mohs)	239±97.23	289±53.93	217±105.73
Cl (%)	0.045±0.028	0.013±0.0008	0.014±0.0036
HCO_3 (%)	0.058±0.002	0.082±0.0129	0.07±0.014
NO_3-N(%)	0.0006±0.0001	0.0007±0.0003	0.0008±0.0006
NH_4 (%)	0.0015±0.0007	0.0015±0.0007	0.001±0.0003
PO_4-P (%)	0.0088±0.0072	0.007±0.0059	0.0052±0.0073
SiO_3 (%)	0.048±0.002	0.065±0.013	0.056±0.01
SO_4 (%)	0.12±0.024	0.035±0.012	0.047±0.036
Organic matter (%)	9.93±0.058	4.23±0.7	4.46±0.18
Ca (%)	0.013±0.003	0.013±0.002	0.011±0.001
Mg (%)	0.004±0.001	0.009±0.005	0.009±0.003
Na (%)	0.028±0.007	0.012±0.003	0.009±0.006
K (%)	0.007±0.002	0.005±0.001	0.008±0.007

Twenty-four species belonging to 15 genera of soil algae were isolated and identified during the entire period of this investigation. Of which 15 species were blue-green algae, six species were green algae and three species were diatoms. The present study showed that 13 of the identified species from Wadi Allaqi were recorded for the first time in the soils of Upper Egypt.Those new records were represented by: six species of cyanophyta; *Lyngbya allorgei, Microcystis pulverea, Oscillatoria pseudogeminata, Phormidium foveolarum, Phormidium subfuscum, Schizothrix calcicola,* five species of chlorophyta; *Bracteacoccus cohaerens, Gloeococcus minutissimus, Keratococcus bicaudatus, Muriella terrestris, Pseudococcomyxa simplex* and two species of bacillariophyta; *Navicula cincta* and *Navicula rhynchocephala.*

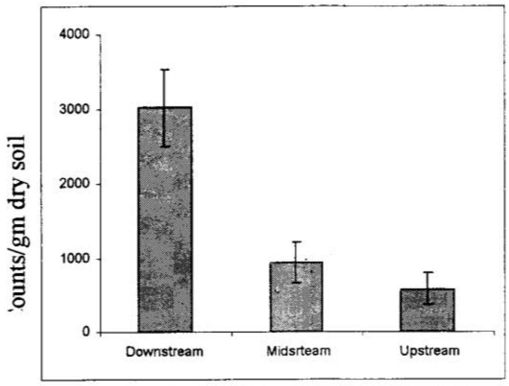

Fig. (2): Variations in the mean values (± SD) of the total counts of soil algae in different parts of Wadi Allagi.

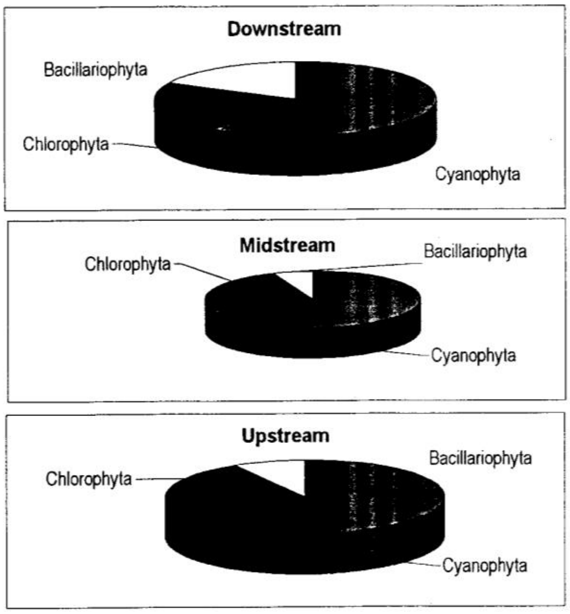

Fig. (3): Pie diagrams showing the variations in the percentage composition of the different groups of soil algae among the different parts of Wadi Allagi.

Table (3): Frequency of occurrences of the soil alga species in different in different parts of Wadi Allaqi.

	Downstream	Midstream	Upstream
Cyanophyta:			
Anabaena oscillaroids Bory	+++	+	+++
Anabaena subtropica Gardner	++++	+	+++
Anabaena sp.	+++	+	+++
Lyngbya allorgei Fremy*	++	+++	+++
Microcystis pulverea (Wood) Forti*	-	++	-
Nostoc ellipsosporum Rabenh	+++	+	++++
Nostoc humifusum (Carm) Born	++++	+++	++++
Oscillatoria brevis (Kuetzing) Gomont	++++	+++	++
Oscillatoria formosa (Bory) Gomont	+	+	+++
Oscillatoria pseudogeminata G. Schmid*	++++	++++	++++
Phormidium ambigum gomont	++++	+++	-
Phormidium foveolarum (Kuetzing) Gomont*	++++	++++	++++
Phormidium molle Gomont	++++	++++	++++
Phormidium subfuscum (Kuetzing) Gomont*	+++	+	++++
Schizothrix calcicola (Agardh) Gomont*	+	++	-
Chlorophyta:			
Bracteacoccus cohaerens (Bisch.) Bold*	++	+	++
Gloeococcus minutissimus King*	++	+	+++
Keratococcus bicaudatus (A.Br.) Boye-Pet.*	+	+++	+++
Muriella terrestris Boye-Pet*	+++	++	-
Pseudococcomyxa simplex (Mainx) Fott*	++	-	+++
Scenedesmus quadricauda (Turp.) Brebisson	++++	++++	+++
Bacillariophyta:			
Hantzchia amphioxys (Ehr.) Grunow	++++	++	+++
Navicula cincta (Ehr.) Ralfs*	++	+	+++
Navicula rhynchocephala (Kuetzing)*	+++	+	

++++ High occurrence recorded in ≥ 50%,
+++ Moderate occurrence recorded in ≥ 25- < 50%,
++ Low occurrence recorded in ≥ 12.5- < 25%,
+ Rare occurrence recorded in < 12.5% of the samples,
- Absent, and * New record.

The frequency of occurrence of the different algal species in different parts of Wadi Allaqi is provided in Table (3). In both of the downstream- and midstream part of the wadi, 23 species related to 14 genera of soil algae with slight variations in floristic composition were recorded. *Microcystis pulverea* was absent in the downstream part and *Pseudococcomyxa simplex* was absent in the midstream part of the wadi. In the downstream part, nine species exhibited a high frequency of occurrence, six species had moderate frequency of occurrence, five species had a low frequency of occurrence and three species were rare. In the midstream part, only four species exhibited high frequency of occurrence, five species were moderate, four species were low and 10 species were rare. In the upstream part, only 19 species related to12 genera were recorded, of which six species xhibited high frequency of occurrence, 11 species were of moderate and two species were of low occurrence.

The data concerning the correlation between the number of soil algal species, total counts of algal colonies per gram dry soil and edaphic factors (Table 4) revealed that, the soil algae were qualitatively and quantitatively correlated with some edaphic factors. The number of algal species and total counts of algal colonies/gm dry soil correlated significantly with the electrical conductivity, chloride, ammonia, sulphate and calcium, contents of the soil. In addition, there was a significant correlation between the total counts of algal colonies per gram dry soil and the soil moisture contents.

Table (4): Correlation between the soil algae and edaphic factors in Wadi Allaqi. *High significant ($p<0.01$) ** Very high significant ($p<0.001$)

	Number of algal species	Total counts of soil algae
Gravel	-0.194	-0.357
Coarse sand	-0.13	-0.183
Fine sand	0.255	0.178
Silt	-0.337	-0.064
Clay	0.014	0.217
Soil moisture (%)	0.387	0.594*
pH value	-0.356	-0.356
Conductivity (μ mohs)	0.662**	0.884**
Cl (%)	0.573*	0.695**
HCO_3 (%)	0.271	0.207
NO_3-N(%)	0.043	-0.150
NH_4 (%)	0.547*	0.670**
PO_4-P (%)	-0.167	0.020
SiO_3 (%)	-0.107	-0.140
SO_4 (%)	0.704**	0.831**
Organic matter (%)	0.174	0.338
Ca (%)	0.656**	0.814**
Mg (%)	0.130	0.018
Na (%)	0.045	0.338
K (%)	0.026	-0.005

Discussion

The floristic diversity, population density and distribution of soil algae in various habitats were controlled by different environmental factors and correlated significantly with edaphic factors (Metting, 1981; Ruble and Davis, 1988). However, it was not possible to correlate community structure with any specific environmental factor (Davey and Rothery, 1993) since each taxon varied independently of the others.

The quantitative composition of the soil algae correlated significantly with the moisture content of the soil and relatively high values of soil moisture content as well as total counts of soil algae were recorded concomitantly in the downstream part of Wadi Allaqi. In accordance with this, Metting (1981) and Johansen *et al.* (1984) related the spatial changes in qualitative and quantitative composition of soil algae to the environmental conditions, particularly the moisture content of the soil. In this respect, water was regarded as a critical factor in limiting the growth of microorganisms in arid lands (Boyd, 1967).

The pH values of the soil in Wadi Allaqi were slightly alkaline and lay in the vicinity of 7. This might partially explain the wide distribution of the blue-green algae being represented in all investigated samples. The neutral and alkaline soils are favourable habitats to the development (Shield and Durell, 1964) and dominancy of blue-green algae (Metting, 1981; Starks *et al.*, 1981). Similarly, it was reported that species of blue-green algae flourish under pH values of more than 7 (Dooley and Houghton, 1973).

The qualitative and quantitative composition of the soil algal assemblages in Wadi Allaqi exihibited a positive significant correlation with the electrical conductivity. However, the high levels of salinity was inhibitive to desert soil algae (Salama and Kobbia, 1982) and the decreasing of the soil algal biomass appeared concomitantly with the low values of electrical conductivity (Atia, 1993), even in the presence of other promotive factors in some Egyptian soil habitats. The sulphate content that could be regarded as a suitable sulphur source for the growth of some blue-green algae (Naguib *et al.*, 1985; 1987) correlated significantly with the soil algal assemblages in Wadi Allaqi. In addition, the data obtained in the present investigation revealad that the algae correlated positively with chloride, calcium, and ammonia contents of the soil in Wadi Allaqi. Otherwise, the soil algae had no significant correlation with the soil contents of bicarbonate, organic matter, nitrate, phosphate, silicate, magnesium, sodium or potassium. However, positive or negative correlations were recorded bettween the soil algae and organic matter (Metting, 1981; Starks *et al.*, 1981), nitrate, phosphate, silicate, sodium and potassium (Shubert and Starks, 1979).

No significant correlation could be noticed between the soil algae and the soil texture. This was in agreement with Gonzalves and Gangla (1949) who reported that the distribution of soil algae was not directly related to the soil texture. However, the soil texture could be regarded as an important factor affected indirectly the distribution of soil algae by its influence on infiltration and retention of water (Shield and Durell, 1964).

The assemblages of soil algae in Wadi Allaqi during the present study period, composed of various algal taxa belonging to cyanophyta, chlorophyta and bacillariophyta. Similarly, these groups represented the main constituents of the soil algal flora (Metting, 1981; Johansen, 1984). In addition, cyanophyta constituted the majority of species as compared with the other recorded groups. In accordance with this, the blue-green algae were the most abundant individuals in the desert soils of the western Libyan Desert of Egypt (Feher, 1948 and Novichova-Ivanova, 1980), USA (Johansen, 1984) and Saudi Arabia (Arif, 1992). Other investigators; Ashly *et al.* (1985), Johansen and Rushforth (1985), Ruble and Davis (1988), Grondin and Johansen (1993) in USA; Broady (1989) in Antarctica; Azevedo (1991) in Brazil and El-Ayouty and Ayyad (1972), Matter (1992), Atia (1993), Ahmed (1994) in Egypt found that the soil algal flora of the cultivated soil ecosystems were dominated by different species of blue-green algae.

The presence of numerous cyanophycean members among the soil algae in Wadi Allaqi could be a matter of tolerance and adaptability. In hot deserts, the blue-green algae are often important components of terrestrial microflora (Friedmann, 1980) since, they can survive adverse conditions and withstand long periods of water stress (Hoffman, 1988). The properties and cell structure of such prokaryotic algal organisms enable them for the widespread in different habitats with relative high abundance (Lange, 1974; Kobbia and Shabana, 1988) as compared with the other algal groups.

In Wadi Allaqi soils, chlorophyta represented the second important group of soil algae. Similar results were recorded by Novichkova-Ivanova (1980) and Arif (1992) in desert soils. On the contrary, some studies in USA, (Norton and Davis, 1991; Sukala and Davis, 1994) and in Russia, (levanets, 1999) revealed that the number of species of green algae surpassed that of blue-green algae. The paucity in the number of diatom species in Wadi Allaqi could be related to the low values of soil moisture content (Arif, 1992) or probably due to the sensetivity of several diatoms to drought (Trainor, 1970).

Twenty-four species of soil algae were isolated and identified during the whole period of this investigation. Fifteen species were blue-green algae, six species were green algae and three species were diatoms. The results concerning the species composition of algae in Wadi Allaqi soils were more or less similar to those recorded in the soils of various Egyptian desert habitats; in Sahara region (Feher, 1948), in Libyan desert (Novichkova-Ivanova, 1980) and in the Mediterranean desert ecosystem in north Egypt (Hamouda, 1981).

The present investigation was directed to study the floristic composition and distribution of soil algae in relation to edaphic factors of a hyperarid environment in Wadi Allaqi Biosphere Reserve area. Further work is required to demonstrate the role of soil algae in this ecosystem particularly its role in the stabilizing and in enrichment of the soil with organic matter which crucial to the further development of the desert areas.

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دراسات بيئية على طحالب التربة فى محمية المحيط الحيوى بوادى العلاقى فى جنوب الصحراء الشرقية — مصر

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يدور هذا البحث حول بعض الدراسات البيئية على طحالب التربة الصحراوية فى محمية المحيط الحيوى بوادى العلاقى فى جنوب الصحراء الشرقية (الصحراء النوبية) بمصر. وقد تمت هذه الدراسات على عينات التربة التى تم تجميعها من مواقع مختلفة على امتداد المجرى الرئيسى فى كل من الأحباس الدنيا والوسطى والعليا للوادى خلال عامى ١٩٩٦-١٩٩٧. وقد تمت دراسة كل من التركيب النوعى والكمى للطحالب وكذلك الصفات الفيزيائية والكيميائية للتربة.

تم تنمية وعزل وتعريف ٢٤ نوعا منتمية الى ١٥ جنسا وثلاثة مجموعات رئيسية من الطحالب الخضراء، وثلاثة انواع فقط من الدياتومات. أوضحت الدراسة أن ثلاثة عشر نوعا من بين الانواع المعزولة من وادى العلاقى تم تسجيلها لأول مرة فى جنوب مصر. منها ستة أنواع من الطحالب الخضراء المزرقة وخمسة أنواع من الطحالب الخضراء ونوعين فقط من الدياتومات.

أثبتت التحاليل الإحصائية للنتائج وجود ارتباط بين كل من التركيب النوعى والكمى للطحالب وبعض الصفات الفيزيائية والكيميائية للتربة. بينما لم تتضح أى علاقة أو ارتباط بين الطحالب والقوام الطبيعى للتربة.