*BIOSCIENCES BIOTECHNOLOGY RESEARCH ASIA*, December 2011. Vol. **8**(2), p. 385-392

# Preliminary Study of Soil Algae of Protected Saja Mother Elegans, Mother Elegans, Saudi Arabia

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(Received: 25 September 2011; accepted: 02 November 2011)

**Saja Mother Elegans area in Riyadh city of Saudi Arabia received the first study regarding to soil algae identification. It is a protected area under the control of the Saudi wildlife Commission (SWC). Description of the samples sites and the distribution of each algae are given. A total of 21 species of algae were found in 10 sites from Saja Mother Elegans Um Al-Rimth 21 species of algae, 14 Cyanophyta, 5 Chlorophyta, one Euglenophyta and one Xanthophyta were isolated and identified. Most of the recorded algae were mainly related to Cyanophytes with the most common species such as *Oscillatoria*, *Microcoleus, Nostoc*. Species of algae in this study were identified only to the genus. Results from this study indicate that before meaningful comparisons between Saudi soil algae can be made, more studies must be conducted.**

**Key words**: Taxonomy, Floristics, Phycology, Cyanobacteria, Chlorophyta, Euglenophyta, Xanthophyta, Saja Mother Elegans.

Microbiotic crusts, also known as biological soil crusts, are major components of most desert ecosystems in the world. They occur on most soil types where sunlight can reach the soil surface. However it appears to be less developed in the hottest and driest deserts, but they are typical in that they are colonized by many filamentous species of cyanobacteria (Johansen *et al.,* 2001; Flechtner *et al.,* 1998). Soil algal crusts play an important role in the integration and stability of arid and semi-arid regions worldwide, this role represented in many aspects of the ecosystem sustainability, including the interactive components that rely on each other to keep soil vitality. One of the most important roles of these crusts is building up soil ecosystem to accomplish diversity and increment of many macrobiotic soil members. Algae, fungi, lichens and mosses are colonized together forming soil algal crusts, within which blue-green algae found abundantly (West, 1990; Belnap and Gardner 1993; Belnap, 1994). In general, the factors that determine algae species abundance are light, temperature, water availability, soil texture, and PH (Karnieli *et al.,* 1999; Purcell *et al.,* 2006). Biological soil crust including Cyanobacteria species serve several important roles in the desert, chiefly soil aggregation and protection, nitrogen fixation, and varied effects on vascular plant establishment (Nishaa *et al.,* 2006; Prasanna *et al.,* 2008). Their architecture could be preserved among regions aside from low infiltration capacity and soil erosion caused by pastoral nomadism; this mechanical factor in

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addition to the chemical and physical factors could maximize algal colonization in such hima areas, considering the rarity of sharp climatic changes (Tiwari *et al.,* 2005). Although many studies of soil algae have been established from different soils around the world, very few papers based on taxonomic source, were published dealing with soil algal of the Saudi Arabia Soil. Arif studied saline soil of Al-Shiggah in Al-Qaseem in 1992 and he reported six species of blue-green algae and five green algae. Al-Fredan and Fathi in 2007 identified fifty two genera of algae of Al-Hasa region. New Algae species for the Saudi Arabian flora were recorded from South Western region of Saudi Arabia by Arif and El- Syed in 1997.

The present study represents the first attempt to identify algae species from a protected area Saja Mother Elegans of Riyadh City. For the fulfillments of the kingdom of Saudi Arabia government commendation to sustain terrestrial and marine wildlife, Saudi wildlife Commission (SWC) was established In 1986, by Royal Decree M/22 (Saudi wildlife Commission, 2011). SWC has been developing many projects for the purpose of confinement of specific areas all over the kingdom; so called protected area or hima. As its major goal is preservation, protection and development of wildlife to ensure an ecological balance in the Kingdom (Saudi wildlife Commission, 2011; Abuzinada, 2003), these areas conserve the integrity and stability of arid and semi-arid regions maintaining their characteristics, where microbiotic algal crusts are protected from destroying caused by soil erosion and lifelessness (Alwelaie, 1994; Abuzinada, 2003).

## MATERIAL AND METHODS

### Site description

Saja Mother Elegans northwest an area of 7190 square kilometers characterized by the average plant cover help to save the genetic origins of some mammals, birds and reptiles endemic and rare in there serve environments vary between low hills a few spikes, and the exposed gravel plains and valleys dominated by plants Alosmam and acacia trees, *Acacia gerrardii , Artemisia monosperma, Citrullus colocynthis, Rhazya stricta, Maerua crassifolia*, and *Lycium shawii*,. The Kingdom of Saudi Arabia has a desert climate with fluctuation in temperature and humidity, as temperature increase at daytime and drop at night, while humidity fluctuates between coastal and central regions. Al Zawad 2008.

Saja Mother Elegans protected area lies between the central and the eastern providence of Saudi Arabia. Central regions show relatively hot barren summer, cold rainy winter from the month of October to May. This area acquired several characteristics of the Najd plateau, where many landform units present including plateau, dune areas, shallow valleys, and open, undulating steppe desert (Sallam, 2002). The principle soil habitat consists of mixed sand and gravel plain. Upon analysis; soil sectors was found of low organic content, highly calcareous, very low Gypsum, and mostly non-saline to slight salinity medium (Sallam, 2002). Sectors for soil sampling was taken from areas that is suggested to maintain good microbiotic crust cover, where silt content and electrical conductivity is sufficient, maintaining the alkalinity of soil system, aside from soil exposed to heavy grazing in addition to soil erosion and increased aridity.

### Field method

### Samples collection

Soil samples were provided from the regions of the proposed study with approval of Saudi wildlife Commission (SWC) committee, Samples used in this study were all collected on 2010. Sample contained the most well developed microbiotic crusts. Site photographs, soil chemistry, and cover categories of vascular plants will be provided in this paper. 10 samples were taken from and around Saja Mother Elegans area, where each region was divided into 10 sectors within which sub-samples were taken. Sample were collected only once during December, 2010. Selection of these samples was based on areas with visible algae crusts as well as in undisturbed area.

Samples were collected using sterile scoops then transferred into small polyethylene bags. The soil samples were stored to the lab temperature. Duplicates of the samples were made for determination of soil physical and chemical parameters from the assigned sites. Each site was marked permanently by pounding an iron rod into the ground. Climatic data was compiled for the area from the historical data (1985 – 2008) collected between 35 East and 43 East longitudes and 25

North and 33 North latitudes, referring to meteorological units in Qasim and Hail cities.

Laboratory methods

**Isolation and culture**

Culture, isolation, and identification of algae were performed using dilution techniques with two series of cultures was sat up for each sample using two different media; Z-8 media and Chu's10 media (Gerloff *et al.,* 1950; Stein, 1979). Soil samples were crushed and mixed to produce homogenous samples. Subsamples (1.0 g) were dilution plated in triplicate on agar –solidified Z-8 medium (Carmichael 1986), as described in Flechtner *et al.,* (1998), and were incubated at 20 °C under fluorescent light (200 $\mu E^{-1} cmE^{-1}$) with a 16 h light / 8 h dark photoperiod until good growth was obtained (3-6 weeks). Regularly examined for visible algal growth after 2 weeks of incubation, then visible isolates was plated in triplicate on agar solidified media. All algae species were identified by direct microscopic examination. Algae were identified based on the morphological characteristics.

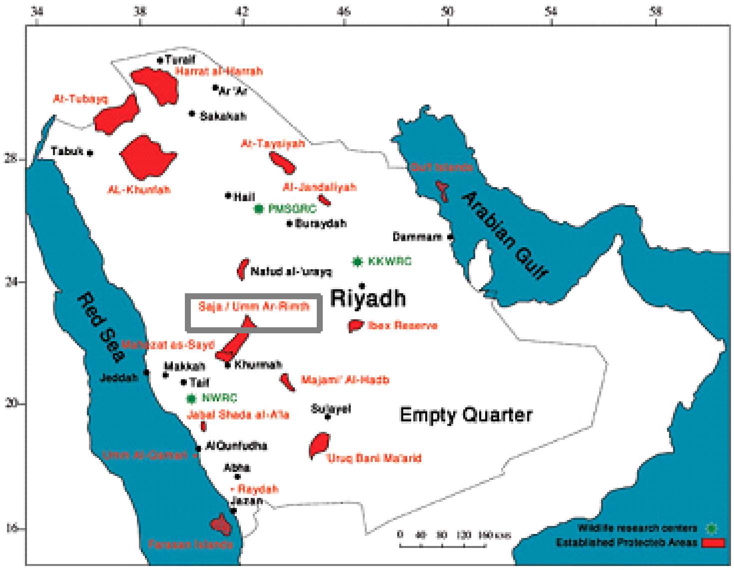


**Fig. 1.** Saja Mother Elegans protected area suited at the center of Saudi Arabia

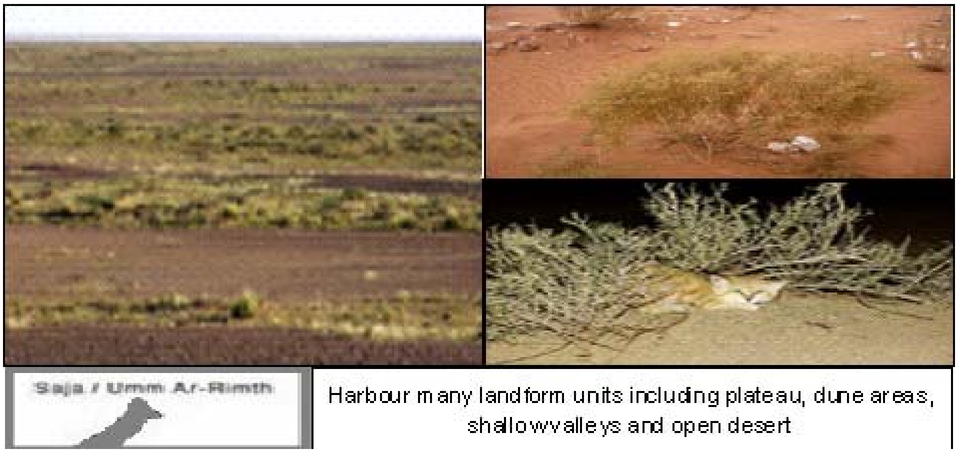


**Fig. 2.** The principle soil habitat of the described areas consists of mixed sand and gravel plain

**Soil analysis**

Soil analysis was conducted at the soil testing unit of Food and Agricultural Sciences college at King Saud University, including soil texture, soil organic matter, nitrate, ammonia, phosphorous, calcium, magnesium, sodium, potassium, sodium, electrical conductivity, and pH. Sub-samples within the 10 assigned sites were mixed to be representative for each protected area.

## RESULTS

**Physical and chemical analysis of soil**

Physico-chemical characteristics of the selected 10 sites around Saja Mother Elegans are presented in Table 1. On average, soil samples showed sandy texture (91.3%), with neutral to alkaline pH (7.5), and relatively high electrical conductivity. Moreover, chemical analysis revealed that the selected soils had Calcium-Sodium cationic, and Sulfate-Chloride anionic structure. With significant organic matters, low phosphorus, but high Iron, Potassium and nitrogen content. On the other hand, elevation in cationic, anionic structure, and accordingly high electrical conductivity was noticed within area 7 and 8.

**Identification of algae isolates**

Visible algal growth was observed after three weeks of incubation, total of 21 algal genera was isolated and identified from the investigated soils (Table 2), belonging to 4 algal divisions which predominated with Cyanophyta (14 genera) followed by Chlorophyta (5 genera), in addition to one genera from each of Euglenophyta and Xanthophyta. Modified Chu's.10 media had shown productivity toward all divisions, while Z8 media was suitable media only for Cyanophyta and Chlorophyta.

The most common soil algal genera present along different media and through all over the studied region were the ones that belong to Cyanobacteria (*Anabaena*, *Microcoleus*, *Chroococcus*, *Nostoc* and *Phormedium*), followed by (*Calothrix*, *Gleothece*, *Leptolyngbya*, *Lyngbya*, *Nodularia*, *Oscillatoria*, *Schixothrix*, *Scytonema* and *Tolypothrix*). In addition to genera identified among other divisions: Chlorophyta (*Chlaymydomonas*, *Chlorella*, *Cosmarium*, *Dunaliella* and *Pandorina*), *Euglena* and

**Table 1(a).** Soil physical and chemical properties of Saja Mother Elegans sites.

| | SP % | pH | EC | Cations (meq/l) | | | | Anions(meq/l) | | | | Partical size % | | | Texture | Ca |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $Ca^{2+}$ | $Mg^{2+}$ | $Na^{+}$ | $K^{+}$ | $HCO_3^-$ | $CO_3^=$ | $Cl^-$ | $SO_4^=$ | Sand | Silt | Clay | class | $CO_3$ % |
| 1 R | 24.0 | 7.2 | 2.9 | 31.5 | 4.5 | 5.5 | 0.8 | 1.3 | 0.0 | 2.3 | 26.3 | 92.7 | 2.0 | 5.3 | sand | 1.6 |
| 2 R | 22.6 | 7.3 | 20 | 77.5 | 16.5 | 131.9 | 2.2 | 5.0 | 0.0 | 220.0 | 28.0 | 89.7 | 3.0 | 7.3 | sand | 1.4 |
| 3 R | 20.0 | 7.8 | 2.47 | 8.3 | 2.3 | 11.0 | 1.3 | 2.3 | 0.0 | 13.3 | 4.6 | 92.7 | 2.0 | 5.3 | sand | 1.4 |
| 4 R | 22.0 | 7.8 | 1.05 | 7.5 | 1.0 | 4.9 | 0.6 | 3.8 | 0.0 | 3.8 | 3.8 | 89.7 | 2.0 | 8.3 | sand | 1.4 |
| 5 R | 21.6 | 7.7 | 2.45 | 22.0 | 6.0 | 5.3 | 0.8 | 4.0 | 0.0 | 4.5 | 4.1 | 90.7 | 4.0 | 5.3 | sand | 3.9 |
| 6 R | 20.3 | 7.5 | 4.27 | 29.0 | 3.0 | 19.8 | 1.7 | 5.0 | 0.0 | 21.0 | 23.7 | 92.7 | 2.0 | 5.3 | sand | 1.1 |
| 7 R | 18.6 | 7.0 | 94.8 | 280.0 | 65.0 | 1072.0 | 6.6 | 1.3 | 0.0 | 1412.0 | 13.1 | 91.7 | 2.0 | 6.3 | sand | 0.8 |
| 8 R | 21.6 | 7.6 | 67.3 | 160.0 | 49.0 | 625.0 | 4.4 | 4.0 | 0.0 | 800.0 | 15.6 | 92.7 | 2.0 | 5.3 | sand | 0.6 |
| 9 R | 24.0 | 7.6 | 11.6 | 30.0 | 3.0 | 66.0 | 1.7 | 3.0 | 0.0 | 110.0 | 8.5 | 92.7 | 2.0 | 5.3 | sand | 1.2 |
| 10 R | 23.0 | 7.4 | 1.3 | 4.0 | 1.0 | 6.2 | 0.5 | 3.0 | 0.0 | 5.0 | 2.5 | 87.7 | 5.0 | 7.3 | loamy sand | 2.4 |

**Table 1(b).** Soil physical and chemical properties of Saja Mother Elegans sites.

| Cust. No | Available nutrients (mg/kg) | | | | | | | O.M |
|---|---|---|---|---|---|---|---|---|
| | N | P | K | Fe | Mn | Zn | Cu | % |
| 1 R | 9.8 | 0.8 | 85.7 | 10.1 | 1.2 | 0.34 | 0.6 | 1.85 |
| 2 R | 42.0 | 1.3 | 177.0 | 10.4 | 1.4 | 0.26 | 0.6 | 1.57 |
| 3 R | 21.0 | 2.1 | 167.4 | 10.1 | 1.4 | 0.29 | 0.6 | 1.54 |
| 4 R | 129.5 | 1.9 | 135.7 | 13.4 | 2.4 | 0.34 | 0.6 | 1.63 |
| 5 R | 10.7 | 3.6 | 107.4 | 10.0 | 2.7 | 0.40 | 0.8 | 1.25 |
| 6 R | 39.2 | 3.7 | 167.4 | 11.0 | 4.0 | 0.40 | 0.6 | 1.06 |
| 7 R | 53.2 | 1.0 | 119.1 | 10.4 | 3.2 | 0.66 | 0.6 | 1.05 |
| 8 R | 144.2 | 1.8 | 63.6 | 11.2 | 4.2 | 0.35 | 0.6 | 0.85 |
| 9 R | 113.4 | 2.7 | 96.3 | 10.6 | 1.6 | 0.32 | 0.6 | 0.91 |
| 10 R | 183.4 | 2.3 | 92.7 | 12.2 | 1.7 | 0.36 | 0.6 | 0.81 |

*Tribonema* that belong to Euglenophyta and Xanthophyta respectively.

## DISCUSSION

Algal colonization within soil biological crusts sustain ecosystem integrity for various soil communities, especially in arid and semi-arid regions being deficient in nitrogen fixing bacteria as reported by many studies (Loftis and Kurtz, 1980), our physio-chemical parameters of the selected region had shown little silt with sandy calcified texture; alkaline pH; relatively high electric conductively and nitrogen contents, with decline in organic matter and other nutrients as phosphorous, these soil characteristics is in agreement to that reported for Najd plateau (Sallam, 2002). Diverse forms of green and blue green algae was reported in our study, confirming the fact that these species characterize arid and semiarid regions (Hahn and Kusserow, 1998; Chun-Xiang *et al.,* 2002; Nayak *et al.,* 2004), where aggregation and colonization happened mainly within saline to alkaline conditions with good salt content. In accordance to climatic conditions and sampling time, at this time of the year, the region exhibit significant humidity with drop in temperature (5 – 26ºC), interestingly this has been positively correlated with algal diversity.

High nitrogen content was observed in the studied soils confirming the believes of the effective role of cyanobacteria in nitrogen fixation, thus, sustaining many macrobiotic soil members (Hahn and Kusserow, 1998; Singh *et al.,* 2008).

Four algal divisions were reported in the subjected soils. Among the detected genera, Species of Cyanobacteria were the most abundant and dominant within the selected sectors, the result mostly agree with the study of Al-Fredan and Fathi in 2007 .Therefore, no correlation was assessed between Cyanobacterial distribution and physyco-chemical parameters within the selected 10 sites, although, some sites exhibited high electrical conductivity and salt contents, this finding support the suggestion of Cynobacterial adaptation in fluctuated desert conditions, to tolerate extremely dry and at the same time, saline habitat (Wierzchos *et al.,* 2006).

Studying algal species emanating all over Saudi Arabia; coastal regions, peninsulas, oasis, lakes, rain-fed pools and rice fields, have been screened for algal distribution, sufficient data was presented by studying aquatic ecosystems in several areas: rain-fed pool at Al-Kharj (Al-Homaidan and Arif, 1997), Asir (Mohammed and Al-Shehri, 2008), gizan coastal region ( Basahy, 1993) , Jedda (Al-Amoudi *et al.,* 2009), Al-Hasa oases (Fathi and Al-Kahtani, 2009). Phycological analysis in these studies have been shown a notable diversity of algal groups including; Chlorophyta, Cyanophyta and Euglenophyta (Fathi and Al-Kahtani, 2009). most of the recorded algae were mainly related to cyanophytes within the regarded regions such as *Oscillatoria*, *Chroococcus*, *Microcoleus, Pseudanabaena*, *Nostoc*, *Aphanothece*, and *Pannus* spp. (Al-Homaidan and Arif, 1997; Mohammed and Al-Shehri, 2008). Although These results was obtained

ALWATHNANI, *Biosci., Biotech. Res. Asia,* Vol. **8**(2), 385-392 (2011)

**Table 2.** List of algae species identified by the use of tow algae media (Z8 an Chu's no. 10) in the selected sites of Saja Mother Elegans protected area in the present study

| Division | Genus | R1 | | R2 | | R3 | | R4 | | R5 | | R6 | | R7 | | R8 | | R9 | | R10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Z8 | Chu 10 | Z8 | Chu 10 | Z8 | Chu 10 | Z8 | Chu 10 | Z8 | Chu 10 | Z8 | Chu 10 | Z8 | Chu 10 | Z8 | Chu 10 | Z8 | Chu 10 | Z8 | Chu 10 |
| Cyanophyta | *Anabaena* | | | | + | + | + | | + | | | | | + | + | | | + | + | | + |
| | *Calothrix* | | + | | | | | | | | | | | | | | | | | | |
| | *Chroococcus* | | | + | | | | | | + | + | + | | | + | + | | + | | | + |
| | *Gleothece* | | | | | | | + | | | | | | | | + | | | | | |
| | *Leptolyngbya* | + | | | | | | | | | | | | | | | | | | | |
| | *Microcoleus* | | + | + | | + | + | + | | + | + | + | + | + | | + | | + | | | |
| | *Lyngbya* | | | + | | | | | | | | | | | | | | | | | |
| | *Nodularia* | | | | | | | | + | | | | + | + | + | | | | | | |
| | *Nostoc* | + | + | + | + | + | + | + | + | | | | + | | + | | + | | + | | + |
| | *Oscillatoria* | | | | | | | | | | | | | | | | | + | | | |
| | *Phormedium* | + | + | + | | + | + | | + | + | + | + | + | + | | | | + | + | | + |
| | *Schixothrix* | | | + | | | | | | | | | | | | | | | | + | |
| | *Scytonema* | + | | | | | | | | | | | | | | | | | | | |
| | *Tolypothrix* | | | | | | | | | + | + | | | | | + | | | | | |
| Euglenophyta | *Euglena* | | | | | | | | | | | | | | | | + | | | | |
| Xanthophyta | *Tribonema* | | | | | | | | | | | | | | + | | | | | | |
| Chlorophyta | *Chlaymydomonas* | | + | | | | | | | | | | | | | | + | | | | |
| | *Chlorella* | | | | | | + | | | | | | | + | + | + | | | | | |
| | *Cosmarium* | | | | | | | | | | | | | | | | + | | | | |
| | *Dunaliella* | + | | | | | | | + | | | | | | | | | | | | + |
| | *Pandorina* | | | | | | | | | | | | | | | + | | | | | |

within aquatic habitats in Saudi Arabia, there is some concordance with that recorded in our study. Taking in consideration the ecological discrepancy of both environments, we can conclude that seasonality could retain some characteristics of aquatic habitats that affect algal groups development in semi-arid areas (Ostergaard *et al.,* 1985; Romo and Miracle, 1993; Dokulil and Teubner, 2000).

Furthermore, algal composition found in our study have been shown the same pattern of that in world deserts (Wierzchos *et al.,* 2006; Bhatnagar *et al.,* 2005; Jafari *et al.,* 2004; Rios et al., 2004; Pichel *et al.,* 2001). It was revealed that spp. of *Anabaena*, *Chroococcus*, *Nostoc* and *Phormedium* are the most widely distributed algae in the sampling sites, in addition (*Calothrix*, *Gleothece*, *Leptolyngbya*, *Lyngbya*, *Nodularia*, *Oscillatoria*, *Schixothrix*, *Scytonema* and *Tolypothrix*). Chlorophyta, Euglenophyta and Xanthophyta was observed to less extent, periodical sampling should be obtained from the studied area within different seasons, in order to characterize patterns of algae colonization, and rule out overlapping factors affecting genus diversity.

## ACKNOWLEDGMENTS

The study was supported by the Deanship of Scientific Research Center, King Saud University; I also thank the College of Science Research Center, King Saud University, Saudi Arabia, for support.

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