



## Diatom Assemblage in the Lake of Gaber Oun, Southern Libya

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**Abstract:** The lake of Gaber Oun in the southern district of Libya was studied to assess the diatom community composition in the littoral zone. Planktic and attached diatoms were listed and information on the constituent species made known (images are shown). Some criteria of the water characteristics are also given such as the pH, which is an average of 8.3, electrical conductivity which accounted for  $1.4 \mu\text{Sim}/\text{cm}^{-1}$  and total dissolved salts (TDS) of  $189.0 \text{ mg}/\text{L}^{-1}$ .

### 1. Introduction

Gaber Oun (Grave of Aoun) is one of the largest of the Saharan lakes, measuring about 250m by 300m. The lake is very deep and is surrounded by reeds and palm trees.

Studies concerning aquatic organisms are relatively fewer than those concerned with terrestrial ones (Bold & Wynne, 1978). The status of knowledge about algae in the North African countries is poor and this is also true in the case of Libyan environments, especially in the southern districts of the country. The Libyan studies that have been conducted are typically concentrated on the marine algae of the Mediterranean. In the Fezzan district, algae has received minimal attention, perhaps because of the scarcity of surface water bodies. Of the few studies, those on Fezzan aquatic plants were conducted during the Belgium expedition, which targeted the sector between the longitudes  $20\text{-}25^\circ\text{E}$  and the latitudes  $20\text{-}32^\circ\text{N}$ . This study was conducted by Compere (1986), whose method was based on the works of Leonard (1969) at Kufra Oasis.

Saline lakes in the Libyan Desert represent a unique ecosystem with specific physio-geographic and physicochemical characteristics. The Lake Gaber Oun is one of these lakes. It is believed that such isolated environments should have their own flora and fauna in which new taxa may exist (Van den Heuk *et al.*, 1997).

The increasing tourist activities and projects aimed at landscape management in the lake area are expected

to introduce environmental change; hence, the importance of recording biotic and abiotic phenomena, before changes occur. Therefore, to fulfill this need in part, the aim of the present study is to determine the species composition of the diatom community to provide a reference point for the environmental evaluation of any future changes that may take place (Elnaghy *et al.*, 2005).

Algae of the Libyan and Fezzan district in particular requires extensive investigation in order to outline as far as possible the floristic composition of the flora of these organisms, which will enable subsequent studies concerning biological processes and the functioning of them in their environment.

This work has been conducted in combination with the activities of the Libyan team of the co-operation programme among the universities, Sebha; Libya; Sosa; Tunisia and Charlemagne; Belgium.

### 2. Materials and Methods

The physicochemical properties of the water, the pH, its electrical conductivity and total dissolved salts (TDS) were measured. pH and electrical conductivity were measured using electrode methods through the facility, Hanna device, Germany. TDS was measured using the gravimetric method, in which 1 l of filtered lake water was heated till evaporation and the residual salts then gravimetrically weighed after desiccation.

Samples of diatoms were collected during December, 2007 and January 2008 from the banks of Gaber Oun Lake (Fig. 1). Four sampling sites were chosen for sample collection purposes. Samples were collected at depths ranging from 20-40cm at well illuminated areas. Water was clear at all the sites and samples were also collected from solid objects in the water; for example stones, submerged parts of aquatic higher plants and from the mud on the bottom of the lake. Samples of planktonic diatoms were collected by filtering water (ca. 20 l) through a plankton net (No. 20) reducing the volume to 200ml.

Figure (1): Map of Libya showing the area of study.



Table 1: Physicochemical properties of water of Gaber Oun Lake during the period of study.

Measurement / Sites	1		2		3		4		Average
	D	J	D	J	D	J	D	J	
pH	8.12	8.21	8.19	8.42	8.37	8.39	8.40	8.30	8.30
Electrical conductivity ( $\mu\text{Sim}/\text{cm}^1$ )	1390.0	1420.0	1380.0	1415.0	1394.0	1410.0	1380.0	1419.0	1406.00
Total Dissolved Salts TDS ( $\text{mg}/\text{L}^1$ )	189.40	188.60	188.85	189.35	187.95	190.00	194.00	184.01	189.02

D - samples of December 2007 and J - samples of January 2008.

Table 2: Occurrence and abundance of diatom species in the Lake Gaber Oun during winter 2007/ 2008.

Species / Sites	1		2		3		3		Figure	% Presence
	s	p	s	p	s	p	s	p		
<i>Achnanthes longipes</i>	++		++						2	37.5
<i>Anomoeneis sphaerophora</i>	+++		+++		+++				2	50.0
<i>Amphora holsatica</i>	++		+						2	37.5
<i>Amphora ovalis</i>	+	+			+				4	50.0
<i>Aulacoseira italica</i>		++	+			+	+	++	4	50.0
<i>Aulacoseira granulata</i>		++				++	++		n	25.0
<i>Cyclotella meneghiniana</i>		+	+		+	+	+	+	4	50.0
<i>Cyclotella ocellata</i>		+	+		+	+	+	+	n	50.0
<i>Cymbella minuta</i>	++				++				4	25.0
<i>Cymbella naviculiformis</i>	+	+	+		+			+	3	75.0
<i>Diatoma elongatum</i>		++			++			++	2, 3	37.5
<i>Eunotia fabae</i>	+		+						3	25.0
<i>Eunotia lunaris</i>	+		+		+				2	50.0
<i>Fragilaria intermedia</i>	+								3	12.5
<i>Fragilaria ulna</i>			+						n	12.5
<i>Gomphonema olivaceum</i>					++				3	25.0
<i>Gomphonema parvulum</i>					+	+	+		n	37.5
<i>Mastogloia baltica</i>	+++	+++		+++					n	50.0
<i>Navicula lanceolata</i>			++		+				3	37.5
<i>Navicula radiosa</i>	+								2	25.0
<i>Navicula reinhardtii</i>			+						2	12.5
<i>Navicula rhynchocephala</i>	+								2	25.0
<i>Navicula slesvisensis</i>	+			+					2	37.5
<i>Navicula viridula</i>	+								2	12.5
<i>Nitzschia angustata</i>			++		++				2	37.5
<i>Nitzschia bilobata</i>	+++		+++		+++				3	50.0
<i>Nitzschia dissipata</i>	+++	+++	+++	+++	+++	+++	+++		2, 4	75.0
<i>Nitzschia obtusa</i>	+	++	++	+++					4	62.5
<i>Nitzschia palea</i>	+			+		+	+		2	50.0
<i>Nitzschia punctata</i>	++				+++			++	2	50.0
<i>Rhopalodia gibba</i>	++	++	+++	++		++	++	++	3	87.5
<i>Stauroneis anceps</i>	+				++	++	++	++	2	50.0
<i>Stauroneis sp.</i>	++				+			+	n	37.5

Scale of abundance uses: + as sporadic; ++ as moderately abundant; +++ as abundant population; S denotes sessile; P planktonic diatoms; n denotes no photos are included in figures.

Samples were then preserved in 4% formaldehyde solution. In the laboratory, aliquots of 20ml samples were digested in a mixture of concentrated Chromic acid and H<sub>2</sub>O<sub>2</sub> and thereafter were suspended in 10ml of 70% ethanol. Aliquots of 50µl of the diatom preparation were mounted in the synthetic Eljaszew resin (Pajak, 1986) to prepare permanent slides. Slides were examined by light microscopy using a Carl Zeiss microscope and diatoms were then identified using the monographs of Kramer and Lange-Bertalot (1986, 1988, 1991a,b). For scanning electron microscopy, aliquots of the digested samples were gently spread on cover slips, allowed to air-dry and thereafter carbon-coated. The digestion and processing of samples was performed according to Wojtal and Sobczyk (2006). Examination of the preparations was made using a Philips XL 30 ESEM scanning electron microscope.

### 3. Results and Discussion

Daily water temperatures were measured in the field and found to range from 20-22°C during the sample collection period. It appears from Table (1) that water was alkaline (average of 8.3) and highly saline with 189.0 mg L<sup>-1</sup> TDS. The salinity of the water far exceeded that typically reported for marine environments (Round, 1986).

Microscopic examination revealed the presence of 32 diatom species (Table 2). It seems that this number of recorded species is too low when compared with data reported from marine environments (Witkowski *et al.*, 2000 and Elshahed, 2006). This may be due to the hypersalinity of the water that favors only those few organisms which possess highly adaptive mechanisms, especially in relation to high osmosis (Boney, 1989).

Some of the species recorded were found to be sporadically present; such as *Fragilaria intermedia*, *F. ulna*, *Navicula reinhardtii* and *N. viridula*, which appeared only once during the period of study accounting for 12.5% presence. Their abundance was also low; these species can be considered as non-endemic to the lake because they are typical freshwater forms (Krammer and Lange Bertalot, 1986, 1991a). On the other hand, typical halophilic species such as, *Anoemoeneis sphaerophora*, *Amphora holsatica*, *Nitzschia tryblionella*, *N. dissipata*, *N. bilobata*, *Diatoma elongatum* and *Mastogloia baltica* were found to have achieved large populations and a higher percentage presence, exceeding other species by 50% (Table 2). These species were reported by Krammer and Lange Bertalot (1986, 1988, 1991a,b) as inhabitants from marine or highly saline brackish water.

Of special interest is the presence of members of the genus Eunotia; *E. fabae* (Fig. 3) and *E. lunaris* (Fig. 2) since these species are inhabitants of acidic environments and rarely occur in neutral habitats

(Round, 1991); whereas here they were recorded in obviously alkaline water.

Fig. 2.1: *Anoemoeneis sphaerophora*

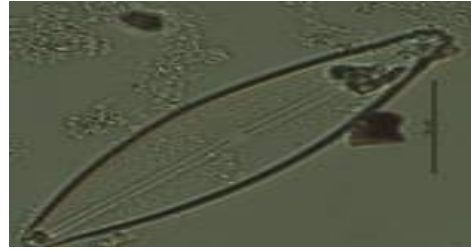


Fig. 2.2: *Eunotia lunaris*



Fig. 2.3: *Amphora holsatica*



Fig. 2.4: *Diatoma elongatum*



Fig. 2.5: *Nitzschia dissipata*

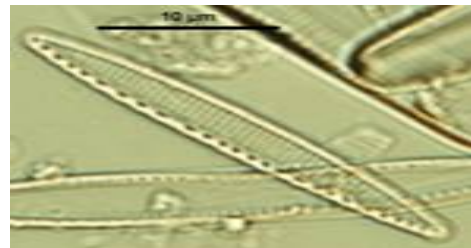


Fig. 2.6: *Navicula slesvisensis*





Fig. 2.7: *Stauroneis anceps*



Fig. 2.8: *Achnanthes longipes*

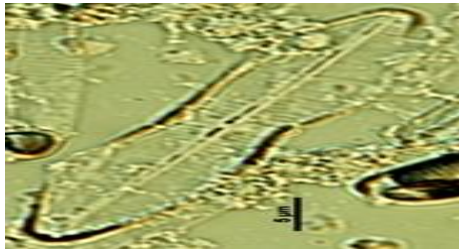


Fig. 2.9: *Navicula viridula*



Fig. 2.10: *Nitzschia palea*



Fig. 2.11: *Navicula rhynchocephala*

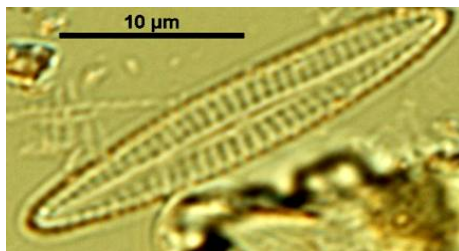


Fig. 2.12: *Nitzschia angustata*

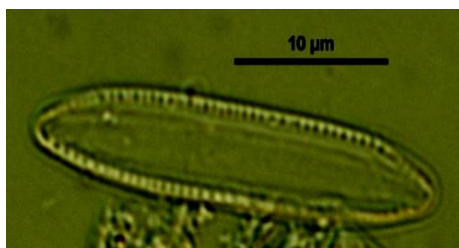


Fig. 2.13: *Nitzschia punctata*

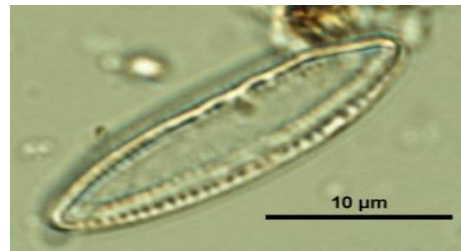


Fig. 2.14: *Navicula radiosa*

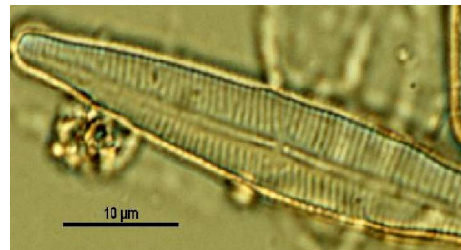


Fig. 2.15: *Navicula reinhardtii*

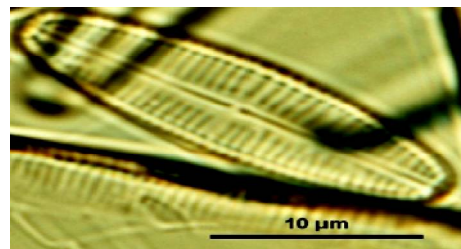
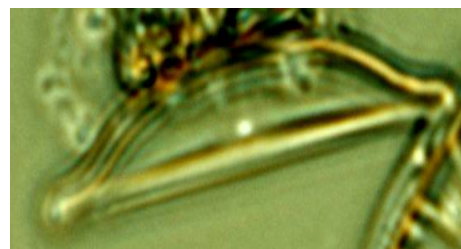


Fig. 2.16



It was noticed from microscopic examination that some species such as *Cymbella minuta*, (Fig. 4) and *Diatoma elongatum* (Fig. 2, 3) were smaller in size than their counterparts in marine environments, as reported in the used keys, and may be explained as a consequence of the increased salinity of the water; such an observation was also made by Round in reference to hypersaline environments (1991).

Fig. 3.1: *Navicula lanceolata*

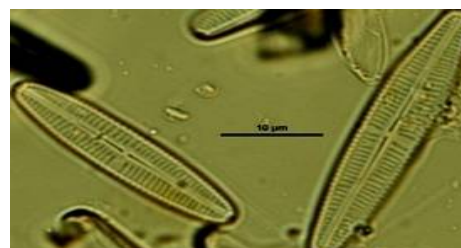


Fig. 3.2: *Rhopalodia gibba*

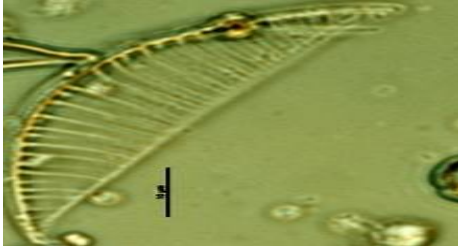


Fig. 3.8: *Nitzschia bilobata*



Fig. 3.3: *Diatoma elongatum*  
(valve view)

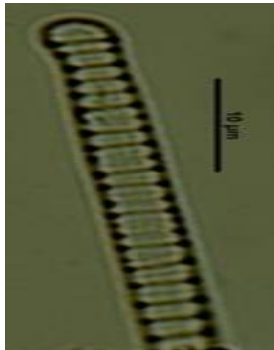


Fig. 3.4: *Eunotia fabae*

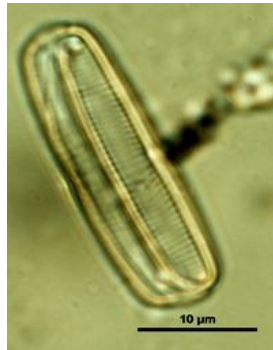


Fig. (4): Scanning electron micrographs of the recorded diatoms.  
(Scale is 1cm on page equals 1μ in fact).

Fig. 4.1: *Nitzschia dissipata*

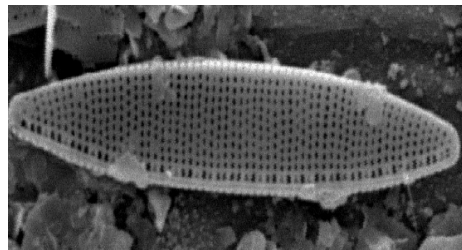


Fig. 3.5: *Cymbella naviculiformis*

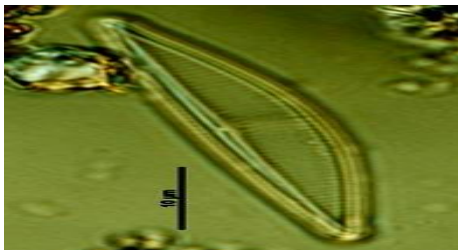


Fig. 4.2: *Nitzschia obtusa*

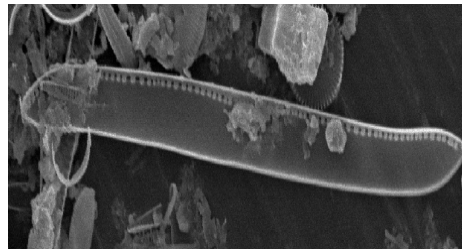


Fig. 3.6: *Fragilaria intermedia*

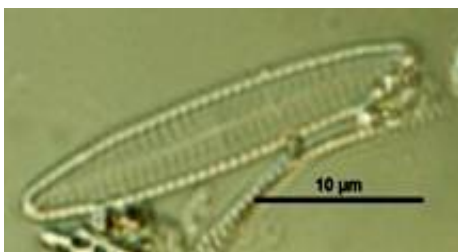


Fig. 4.3: *Cymbella minuta*

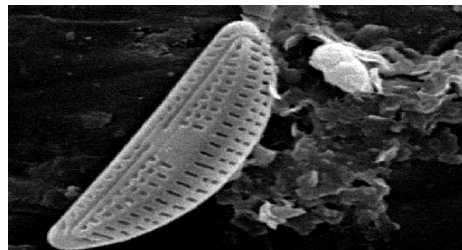


Fig. 3.7: *Gomphonema olivaceum*

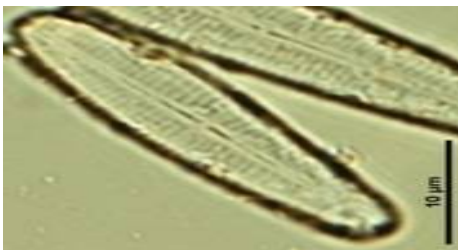
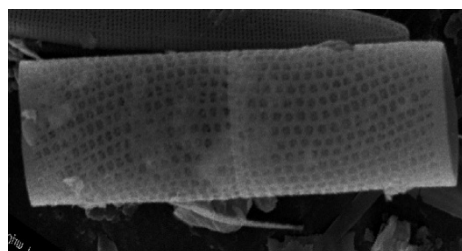


Fig. 4.4: *Aulacoseira italica*



In conclusion, the community of diatoms in Lake Gaber Oun was mainly composed of halophilic species, although there were also a number of non endemic species recorded. Future studies should concentrate more on detecting the whole algal flora in order to better understand the functioning of this distinctive ecosystem.

Fig. 4.5: *Cyclotella meneghiniana*

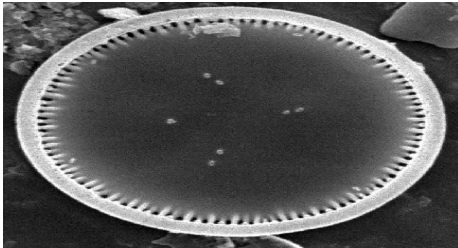
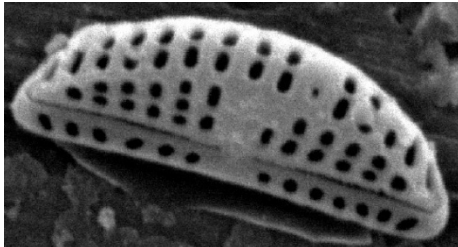


Fig. 4.6: *Amphora ovalis*



## References

- 1) Bold, C.H. and Wynne, J.M. (1978). *Introduction to the algae*. Prentice Hall Inc. New Jersey. 706 pp.
- 2) Boney, A.D. (1989). *Phytoplankton*. Edward Arnold Pub., London, New York, Melbourne, Auckland. 118 pp.
- 3) Compere, P. (1986). Algues recoltees par J. Leonard dans le desert de Libye. *Bull. Jard. Bot. Nat. Belg.*, 56: 9- 50.
- 4) Elnaghy, M.A., Elshahed A., Fathy, A. and Gharib, G. (2005). Ecological studies on algae of Elkharga Oasis. *Assiut. Univ. J. of Botany*, 34: 77- 93.
- 5) Elshahed, A. (2006). Preliminary study on the diatom flora of coastal periphytic assemblages of the Red Sea and Suez Gulf, Egypt. *Egy. J. Phycol.*, 7: 185- 196.
- 6) Krammer, K. and Lange-Bertalot, H. (1986). Bacillariophyceae 1. Teil: Naviculaceae In: *Süßwasserflora von Mitteleuropa 2/1*, VEB Gustav Fischer Verlag Jena 876 pp.
- 7) Krammer, K. and Lange-Bertalot, H. (1988). Bacillariophyceae 2. Teil: Bacillariaceae, Epithemiaceae, Surirellaceae In: *Süßwasserflora von Mitteleuropa 2/2*. VEB Gustav Fischer Verlag Jena, 596 pp.
- 8) Kramer, K. and Lange-Bertalot, H. (1991a). *Süßwasser-flora von Mitteleuropa, Band 2/3, Teil 3: Centrales, Frailariaceae, Eunotiaceae*. Gustav Fischer Verlag, Stuttgart Jena 575 pp.
- 9) Kramer, K. and Lange-Bertalot, H. (1991b). *Süßwasser-flora von Mitteleuropa, Band 2/4, Teil 4: Achanataceae, Kritische Ergänzungen zu Navicula (Lineolatae) und Gomphonema Gesmatliteraturzeichnis Teil 1-4*. Gustav Fischer Verlag, Stuttgart Jena: 437 pp.
- 10) Leonard, J. (1969). Expedition scientifique belge dans le desert de Libye. Jebel Uweinat 1968- 1969. *African- Tervuren*, 15: 101- 136.
- 11) Pajak, J. (1986). Zywica Eljaszewska-staly osroder zamykajacy preparaty okrzemkowe. *Wszech Swiat*. 87 (10): 245-246.
- 12) Round, F.E. (1991). Diatoms in river water-monitoring studies. *J. Appl. Phycol.* 3: 129- 145.
- 13) Van den Heuk, C., Mann, D.J. and Jahns, H.M. (1997). *Algae, an introduction to phycology*. Cambridge Univ. Press, Edinburgh, New York, Melbourne. 627 pp
- 14) Witkowski, A., Lange-Bertalot H. and Metzeltin, D. (2000). Diatom flora of marine coasts I. Gantner Verlag Pub. Kongenstein. 925 pp.
- 15) Wojtal, A. and Sobczyk, K. (2006). Composition and structure of epilithic diatom assemblages on stones of different size in a small calcareous stream (S. Poland). *Arch. Hydrobiol. suppl. 162 Algological studies*: 105- 119.