

## **OBSERVATIONS ON THE DISTRIBUTION OF PHYTOPLANKTON IN FOUL BAY, RED SEA**

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### **ABSTRACT**

Standing crop and species composition of phytoplankton were investigated in the Foul Bay, Red Sea. The results showed that the major groups of phytoplankton were diatoms (58.9%), dinoflagellates (40.6%) and blue-greens (0.5%). During this survey, 111 species of phytoplankton were identified of which 63 diatoms, 42 dinoflagellates and 6 blue-green algae. Three peaks of phytoplankton were recorded in summer, autumn and winter. The summer peak was due to dominance of *Rhizosolenia alata* f. *gracillima*, while in autumn, *Nitzschia longissima* was the leading species. The winter peak was found only at Marsa Shab due to the vigorous bloom of *Chaetoceros* spp. In general, summer was the most productive season although the highest crop occurred in winter.

### **INTRODUCTION**

The value of phytoplankton in a body of water forming the basic link in the food chain of fishes has been well recognized. There is no available data dealing with phytoplankton and productivity of the Foul Bay, Red Sea. Moreover, not much work has been reported on phytoplankton of the Red Sea. The knowledge of Red Sea phytoplankton is mainly derived from Cleve (1900 and 1903), Schroder (1906) and Karsten (1907) for the main basin. On the other hand, Ghazzawi (1936) studied the phytoplankton community in Suez Canal waters. The observations of the earlier authors are based on the examinations of a limited number of net or net and pump samples. These observations have been reviewed by Halim (1969).

### **MATERIALS AND METHODS**

#### **Study Area**

Foul Bay of the Red Sea lies at the extreme end of the Egyptian borders with Sudan (Fig. 1). It extends from Ras Benas in the north (24°N) to Ras Abu-Dara in the south (22°40'N). Six sampling sectors were selected, namely Ras Benas, Berenice, Marsa Hemira, Shalatein, Marsa Shab and Ras Abu-

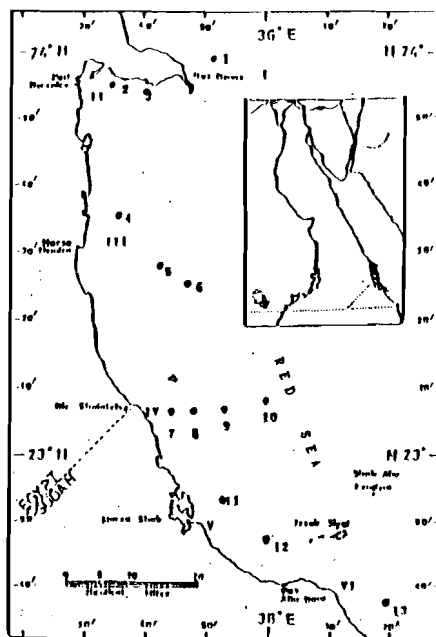


Fig. (1)  
Map of Foul Bay showing the location of sampling sectors.

Dare. The sectors are numbered in Roman Numerals from I to VI and include 13 sampling stations which are numbered in Arabic Numerals (Fig. 1).

During this investigation an ordinary fishing vessel was used. Four main cruises were carried out during spring, summer, autumn and winter 1986.

Integrated sample of 5 liters was collected from different depths at each station by using standard plastic Nansen bottles, usually at intervals of 10 m. The samples were preserved immediately in 4% formalin. In the laboratory, the samples were poured in glass cylinders and Luogol's iodine solution was added to make a 1% solution (colour of weak tea). The samples were left five days for sedimentation. Siphonation procedure was carried out to reduce the volume of each sample to 100 ml. The reduced volume samples were well shaken and 5 ml aliquot were withdrawn by means of Plunger Pipette and introduced into sedimentation chamber of the inverted microscope. After 48 hours, the phytoplankton population was identified and enumerated at high magnification. The exact enumeration of phytoplankton standing crop (number of cells/m<sup>3</sup>) and species composition were recorded by direct observation of the preserved cells.

References used for the identification of the species were: Hustedt, (1927-32), Lebour (1930), Hendey (1964), Miles (1933-35), Geitler (1925), Kofoid (1907,1911) and Kofoid and Swezy (1921).

## RESULTS AND DISCUSSION

The phytoplankton of the Foul Bay is comprised mainly of Bacillariophyceae, Dinophyceae and Cyanophyceae (Table 1 and Fig.2). Members of Cyanophyceae (Cyanobacteria) were less represented contributing not more than 2.8 % of the total phytoplankton population.

The seasonal fluctuations of different phytoplankton classes in the Foul Bay can be indicated as follows:

### Spring Season

The standing crop of phytoplankton increased southward from Ras Benas ( $474 \times 10^3$  cells/  $m^3$ ) reaching its maximum value in Mersa Shab ( $1042 \times 10^3$  cells/ $m^3$ ). Dinoflagellates were always found to be the dominant group in all sampling sections. They constituted from 54.4 to 88.6% of the total phytoplankton population. The predominant dinoflagellates during this season were *Peridinium* spp., *Phalacroma* spp., *Prorocentrum micans*, *Oxytoxum* spp. and *Gymnodinium* spp.

TABLE 1  
Seasonal variation of phytoplankton standing crop at  
different sampling sectors of the Foul Bay.

(No. of Cells  $\times 10^3/m^3$ )

| Season | Sampling Sectors | Ras Benas | Berenica | Mersa Memira | Shalaten | Mersa Shab | Ras Abu-Dara |
|--------|------------------|-----------|----------|--------------|----------|------------|--------------|
| Spring | Bacill.          | 54        | 300      | 122          | 229      | 387        | 308          |
|        | Cyano.           | --        | 2        | ---          | 2        | 19         | 4            |
|        | Dino.            | 420       | 471      | 503          | 619      | 636        | 458          |
| Summer | Bacill.          | 72        | 475      | 4343         | 4961     | 574        | 616          |
|        | Cyano.           | 6         | 5        | 3            | 52       | 25         | 2            |
|        | Dino.            | 304       | 608      | 423          | 528      | 725        | 441          |
| Autumn | Bacill.          | 150       | 2059     | 1360         | 2454     | 3804       | 1638         |
|        | Cyano.           | -         | ---      | ---          | ---      | ---        | ---          |
|        | Dino.            | 274       | 58       | 227          | 395      | 142        | 286          |
| Winter | Bacill.          | 72        | 60       | 39           | 75       | 8872       | 36           |
|        | Cyano.           | --        | 3        | --           | --       | --         | --           |
|        | Dino.            | 46        | 26       | 53           | 18       | 331        | 24           |

Bacill. = Bacillariophy., Cyano. = Cyanophyceae and Dino. = Dinophyceae

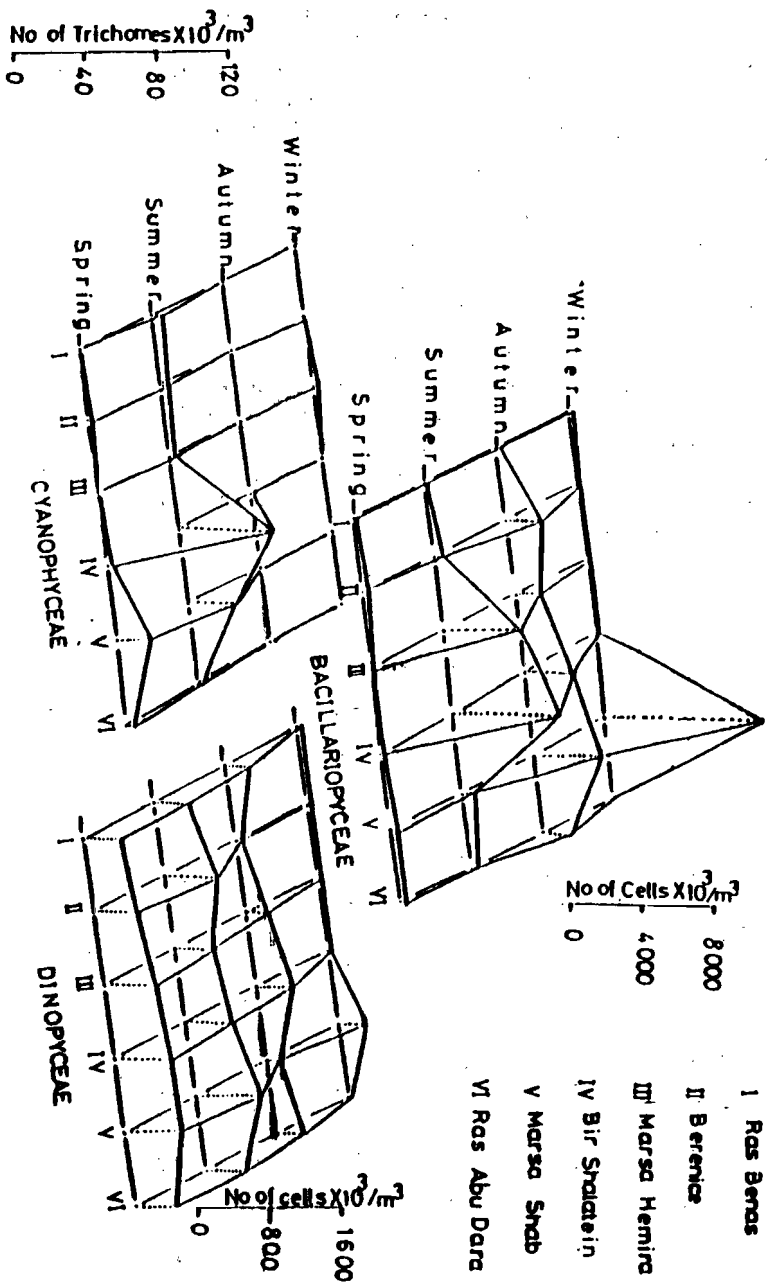


Fig. (2)  
 Seasonal variations in the standing crop of various phytoplankton groups in the Foul Bay, Red Sea.

Members of bacillariales constituted from 11.4 to 46.1% of the total phytoplankton crop. They were chiefly represented by *Hemiaulus* spp., *Nitzschia* spp., *Rhizosolenia* spp. and *Thalassiothrix* spp.

The blue-green algae were less represented and formed from 0.3 to 1.9% of the total phytoplankton crop. The maximum density of the blue-greens (average  $19 \times 10^3$  Units/m<sup>3</sup>) was found in section V (Marsa Shab). They were represented by *Lyngbya* spp. and *Oscillatoria margaritifera*.

#### Summer Season

During this season. The standing crop of phytoplankton reached the maximum value at all the Foul Bay sampling sites.

Bacillariales dominated at Marsa Hemira (Section III), Shalaten (sec. IV), and Ras Abu-Dara (Sec. VI) and formed from 91.1 to 58.2% of the total phytoplankton population. The highest crop of bacillariales (average  $4961 \times 10^3$  cells/m<sup>3</sup>) was found in Shalaten (sec. IV), while the minimum (average  $72 \times 10^3$  cells/m<sup>3</sup>) was recorded in Ras Benas (sec. I). The predominant diatoms were *Rhizosolenia alata* f. *gracillima*, *Nitzschia longissima* and *Nitzschia closterium*.

Dinoflagellates predominated over the other phytoplankton classes in Ras Benas (sec. I), Bernice (sec. II), and Marsa Shab (sec. V). They constituted from 83.1 to 54.7% of the total phytoplankton density. The maximum crop of dinoflagellates (average  $725 \times 10^3$  cell/m<sup>3</sup>) was observed in Marsa Shab (sec. V), whereas the minimum (average  $384 \times 10^3$  cells/m<sup>3</sup>) occurred in Ras Benas (sec. I). The leading species of dinoflagellates were *Preidinium* spp., *Ceratium* spp., *Oxytoxum* spp. and *Prorocentrum* spp.

The blue green reached their maximum density (average  $52 \times 10^3$  cells/m<sup>3</sup>) in Shalaten (sec. IV), while the minimum (average  $2 \times 10^3$  cells/m<sup>3</sup>) was found in Ras Abu Dara (sec. VI). They constituted from 0.1 to 2% of the total phytoplankton density. Cyanobacteria were represented by *Lyngbya* spp. *Trichodesmus* (*Oscillatoria*) *erythraeum*, *Oscillatoria margaritifera* and *Phormidium penicillatum*.

#### Autumn Season

Bacillariales were the most predominant group among the phytoplankton groups in all sampling sections except in Ras Benas (sec. I) where the dinoflagellates predominated. The maximum standing crop of bacillariales (average  $3804 \times 10^3$  cells/ m<sup>3</sup>) occurred in Marsa Shab (sec.V), whereas the minimum (average  $150 \times 10^3$  cells/m<sup>3</sup>) was found in Ras Benas (sec.I). The predominant diatoms were *Nitzschia longissima*, *Nitzschia closterium* and *Rhizosolenia* spp.

Dinoflagellates constituted from 2.7 to 64.6% of the total phytoplankton

### **Oxytoxum spp., Ceratium spp. and Peridinium spp.**

The blue-greens were not recorded during this season.

### **Winter Season**

The values of phytoplankton standing crop were in the minimum level in all section, except in Marsa Shab (sec.V) where the maximum density of phytoplankton (average  $8872 \times 10^3$  cells/m<sup>3</sup>) occurred.

Bacillariales were in the minimum stage in all sampling sections except in Mersa Shab (sec.V) where they reached the highest density (average  $8872 \times 10^3$  cells/m<sup>3</sup>) owing to the vigorous development of *Chaetoceros* spp. They constituted from 42.4 to 96.4% of the total phytoplankton crop. The leading species of bacillariales were *Chaetoceros* spp., *Nitzschia* spp. and *Rhizosolenia* spp.

Dinoflagellates occupied the second predominance place at all sampling sections except in Marsa Shab where they dominated over bacillariales. The maximum density of dinoflagellates (average  $331 \times 10^6$  cells/m<sup>3</sup>) occurred in Marsa Shab (sec. V) , while the minimum (average  $18 \times 10^3$  cells/m<sup>3</sup>) recorded in Shalaten (sec. IV). They formed 3.6 to 57.6% of the total phytoplankton density. Dinoflagellates were chiefly represented by *Oxytoxum* spp., *Peridinium* spp. and *Ceratium* spp.

The blue-green algae were observed only in Berenice (sec. II). Their standing crop was  $3 \times 10^3$  unit/m<sup>3</sup> and constituted 2.8% of the total phytoplankton density. The leading species of Cyanobacteria were *Trichodesmus (Oscillatoria) erythraeum* and *Lyngbya* spp.

During this investigation 111 species and 45 genera of phytoplankton were identified. These were distributed among the phytoplankton groups as follows:

| Class                | Genera | Species |
|----------------------|--------|---------|
| 1. Bacillariophyceae | 31     | 63      |
| 2. Dinophyceae       | 11     | 42      |
| 3. Cyanobacteria     | 3      | 6       |
| Total                | 45     | 111     |

The complete list of genera and species of phytoplankton recorded in

The systematic position of the 63 species of diatoms was carried out according to the system of Hendey (1964).

Division : **Chrysophyta**  
Class : **Bacillariophyceae**  
Order : **Bacillariales**

Suborder : **Coscinodiscineae**

1- Family : **Coscinodiscaceae**  
Genus : **Coscinodiscus** (Ehrenberg)  
Species : **lineatus**

**excentricus**  
**radiatus**

Genus : **Coscosira** (Gran)  
Species : **Østrupii**

Genus : **Thalassiosira** (Cleve)  
Species : **monile**  
**suptilis**

Genus : **Planktoniella** (Schutt)  
Species : **sol**

2- Family : **Hemidiscaceae**  
Genus : **Hemidiscus** (Wallich)  
Species : **cuneiformis**

3- Family : **Actinodiscaceae**  
Genus : **Asteromphalus** (Ehrenberg)  
Species : **flabellatus**

Suborder : **Biddulphineae**

4- Family : **Biddulphiaceae**  
Genus : **Biddulpha** (Gray)  
Species : **sinensis**

Genus : **Lithodesmium** (Ehrenberg)  
Species : **undulata**

Genus : **Cerataulina** (Peragallo)  
Species : **compacta**  
**bergonii**

Genus : **Streptotheca** (Shrubsole)  
Species : **indica**  
**thamesis**

Genus : **Hemiaulus** (Ehrenberg)  
Species : **heibergi**

Genus : **Climocodium** (Gran)  
Species : **biconcavum**

Genus : **Eucampia** (Ehrenberg)  
Species : **cornuta**  
**hemialoides**

- 5- Family : **Chaetoceraceae**  
Genus : **Chaetoceros** (Ehrenberg)  
Species : **compressum**  
**decipiens**  
**denticulatum**  
**distans**  
**diversum**  
**contortum**  
**anastomosans**  
**rostratus**

Suborder : **Rhizosoleniineae**

- 6- Family : **Bacteriastreae**  
Genus : **Bacteriastrea** (Shadbolt)  
Species : **delicatulum**  
**varians**

- 7- Family : **Leptocylindraceae**  
Genus : **Leptocylindrus** (Cleve)  
Species : **danicus**

Genus : **Dactyliosolen** (Castracane)  
Species : **antarcticus**  
**hyalinus**  
**mediterraneus**

Genus : **Guinardia** (Peragallo)  
Species : **flaccida**

Genus : **Laudaria** (Cleve)  
Species : **annulata**

- 8- Family : **Corethronaceae**  
Genus : **Corethron** (Castracane)  
Species : **cryophilum**

- 9- Family : **Rhizosoleniaceae**  
Genus : **Rhizosolenia** (Brightwell)  
Species : **imbricata**  
**shrubsolii**  
**robusta**  
**alata f. gracillima**



**alata f. indica**  
**calcar avis**  
**semispina**  
**setigera**  
**styliformis**  
**hyalina**  
**sp.**

**Suborder : Fragilariineae**  
**10- Family : Fragillariaceae**  
**Genus : Asterionella (Hassall)**  
**Species : notata**

**Genus : Striatella (Agardh)**  
**Species : delicatula**

**Genus : Licmophora (Agardh)**  
**Species : flabellata**

**Genus : Synedra (Ehrenberg)**  
**Species : crystallina**

**Genus : Thallasiothrix (Cleve)**  
**Species : fraunfeldii**  
**longissima**

**Genus : Thalassionema (Grunow) Hustedt**  
**Species : nitzchoides**

**Suborder : Naviculineae**

**11- Family : Naviculaceae**  
**Genus : Navicula (Bory)**  
**Species : membranaceae**

**Genus : Pleurosigma (Wm. Smith)**  
**Species : angulatum**

**Genus : Amphipora (Ehrenberg)**  
**Species : paludosa**

**12- Family : Bacillariaceae**  
**Genus : Bacillaria (Gemelin)**  
**Species : paradoxa**

**Genus : Nitzschia (Hassall)**  
**Species : sigma**  
**closterium**  
**longissima**  
**seriata**  
**atlantica**

The classification adopted here for the recorded species of dinoflagellates is chiefly that of Kofoid and Swezy (1921).

Class : **Dinophyceae**  
Order : **Adiniferidea**

1- Family : **Prorocentridae**  
Genus : **Prorocentrum** (Ehrenberg)  
Species : **gibbosum**  
**micans**  
**gracile**

Order : **Diniferidae**  
2- Family : **Gymnodiniidae**  
Genus : **Gymnoginium**  
Species : **galeaeformis**

Genus : **Pyrocystis** (Murray)  
Species : **lunula**  
**ellipsoides**  
**fusiformis**  
**hamulus**  
**pseudoclituca**

3- Family : **Dinophysidae**  
Genus : **Dinophysis** (Ehrenberg)  
Species : **miles**  
**caudata**

Genus : **Phalocroma** (Stein)  
Species : **argus**  
**operculatus**  
**rapa**  
**porodictyum**  
**doryphorum**

4- Family : **Peridiniidae**  
Genus : **Goniaulax**  
Species : **turbynei**  
**minima**

Genus : **Peridinium**  
Species : **africanoides**  
**carassipes**  
**conicum**  
**depressum**  
**diabolus**  
**divergens**  
**globulus**  
**inflatum**

stenii  
obtusum  
ovatum  
spheroides  
nipponicum  
orientale

Genus : *Peridiopsis* (Lemmermann)  
Species : *asymmetrica*

Genus : *Oxytoxum* (Stein)  
Species : *constrictum*  
*gladiolus*  
*scolopax*  
*sphaeroides*

Genus : *Podolampas* (Stein)  
Species : *bipes*  
*pallipes*

Genus : *Ceratium* (Schrank)  
Species : *egyptiacum*  
*breve*  
*fusus*

The blue-greens recorded in the Foul Bay were classified according to the system proposed by Prescott (1962).

Division : *Cyanophyta*  
Class : *Myxophyceae*  
Order : *Hormogonales*  
Family : *Oscillatoriaceae*  
Genus : *Oscillatoria*  
Species : *erythraeum*  
*thiebautii*  
*margritifera*

Genus : *Lyngbya* (Agardh)  
Species : *majuscula*  
*conferoides*

Genus : *Phormidium* (Kütz.)  
Species : *penicellatum*

#### DISCUSSION

During this study, a total of three species of phytoplankton was found, of which 63 diatoms, 42 dinoflagellates and 6 blue-greens. The phytoplankton pictures of the Foul Bay were quite distinct in different sampling sectors

and in different seasons. The standing crop in Ras Banas was always lower than in the other sectors.

Two peaks of phytoplankton were recorded in the central sectors (Berenice, Marsa Hemira, Shalatein and Marsa Shab) during summer and autumn. The summer peak was due to the abundance of *Rhizosolenia alata* f. *gracillima*. While in autumn, *Nitzschia closteium* and *Nitzschia longissima* were the most important species. On the other hand, there was a third peak of phytoplankton occurred in Marsa Shab in winter due to the flourishing of the marine diatoms *Chaetoceros* spp.

Taking the Foul Bay as a whole, on an annual average basis the diatoms were the dominant group (58.9) followed by dinoflagellates (40.6%) and blue-green algae (0.5%). The composition of phytoplankton in different sectors in the same season was heterogeneous in nature. While diatoms were comparatively poor in the northern and southern sectors (Ras Banas and Ras Abu Dara), they were rich in the central sectors.

The results indicated that summer is the most productive season although the maximum phytoplankton crop (average  $9203 \times 10^3$  cells/m<sup>3</sup>) was observed in Marsa Shab during winter. This reveals that Foul Bay phytoplankton does not depend on the conditions created by winter monsoon which increase the productivity of the Red Sea. (Halim, 1969).

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