

## Phytoplankton Population Dynamics in Three West Algerian Rivers: I – The River Cheliff and its Tributary, the River Mina

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### Abstract

Despite the importance of the River Cheliff and its tributary the River Mina as one of the largest natural bodies of fresh water in coastal northwest Algeria, no limnological project has ever been undertaken for the area. This paper is part of a programme of limnological studies of coastal northwest Algeria.

Samples were taken over a period of two years (1986-1988) at two sites, the River Cheliff and its tributary, the River Mina. Seasonal and local variations were reported. From the two sites, a total of 122 species (63 genera) were identified, of which there were 62 species (27 genera) of Bacillariophyta, 9 species (7 genera) of Cyanophyta, 45 species (26 genera) of Chlorophyta, 2 species (1 genus) of Euglenophyta, and 4 species (2 genera) of Conjugatophyta. More species were recorded at the main river site than at the tributary site. Bacillariophyta were more abundant in the tributary than in the main river. The Cheliff River was strongly dominated by Chlorophyta, whereas the tributary Mina River had equal proportions of individuals of both diatoms and green algae. Euglenophyta were detected in the main river but not in its tributary. Conjugatophyta appeared more abundantly at the main river site than at the tributary site.

These results will add useful scientific information to the available literature. Even though the results are for the period between 1986 and 1988, the evaluation of the existing literature with reference to coastal northwest Algeria in general (and specifically the River Cheliff and its tributary the River Mina), as well as personal monitoring with the Mostaganem University and the Institute of Technical Agriculture, Algeria, up until 2003, has shown that no other limnological studies or analyses have been undertaken at all.

Key words: Algerian rivers, tributary, fresh water, species, phylum and phytoplankton.

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### Introduction

**INVESTIGATIONS OF PHYSICAL, CHEMICAL AND BIOLOGICAL** studies of rivers are important to give baseline data for further work, and to evaluate water quality for irrigation, fish culture and potable usage (Al-Asadi, 1991). In Algeria, however, very few studies have been carried out on algal ecology (Gagneur and Kara, 2001). Samraoui, *et al.*, (1998a, b) for example, had done work on plankton in northeast Algeria. Studies have been done elsewhere in North Africa, including Tunisia, Morocco, Egypt and Libya. In Tunisia and Morocco, Zaouali (1995) studied limnology in Tunisia, and Chergui *et al.* (1999) in Morocco; other studies in Morocco included Loudiki (1990); Alaoui Mhamdi *et al.* (1996); and Bouhaddioui (1997), and were focused on the dynamics and the structure of phytoplankton. Several other papers on this topic have been published. In Egypt, El-Nayal (1935) and Saad and Abbas (1985a) investigated the phytoplankton of the Nile system, and in Libya,

Nizamuddin (1982) and Nizamuddin and Gerloff (1982) produced a catalogue of diatoms listing 9 genera, 391 species, 102 varieties and 6 forms.

Other than in the studied area, seasonal differences in phytoplankton composition and development have been intensively analyzed for various large lowland rivers. Bahnwart *et al.* (1999) stated that biotic and chemical factors have rarely been reported to affect phytoplankton composition. Bahhou *et al.* (2000) mentioned that taxonomic composition and physiological cell state are the main factors affecting variability in phytoplankton composition.

The literature showed that no limnological studies have been carried out, either before or after the period of this work and up until 2003, in this northwest Algerian locality. The work carried out in this paper describes the seasonal distribution of phytoplankton in the River Cheliff and its tributary the River Mina, as a part of a phytoplankton survey project of western Algeria at the three main watersheds, the River Cheliff, the Habra Reservoir, and the River Tafna. These watersheds are in the cultivated lowlands near the Mediterranean Sea. Full descriptions will appear in future papers.

## **Study Area**

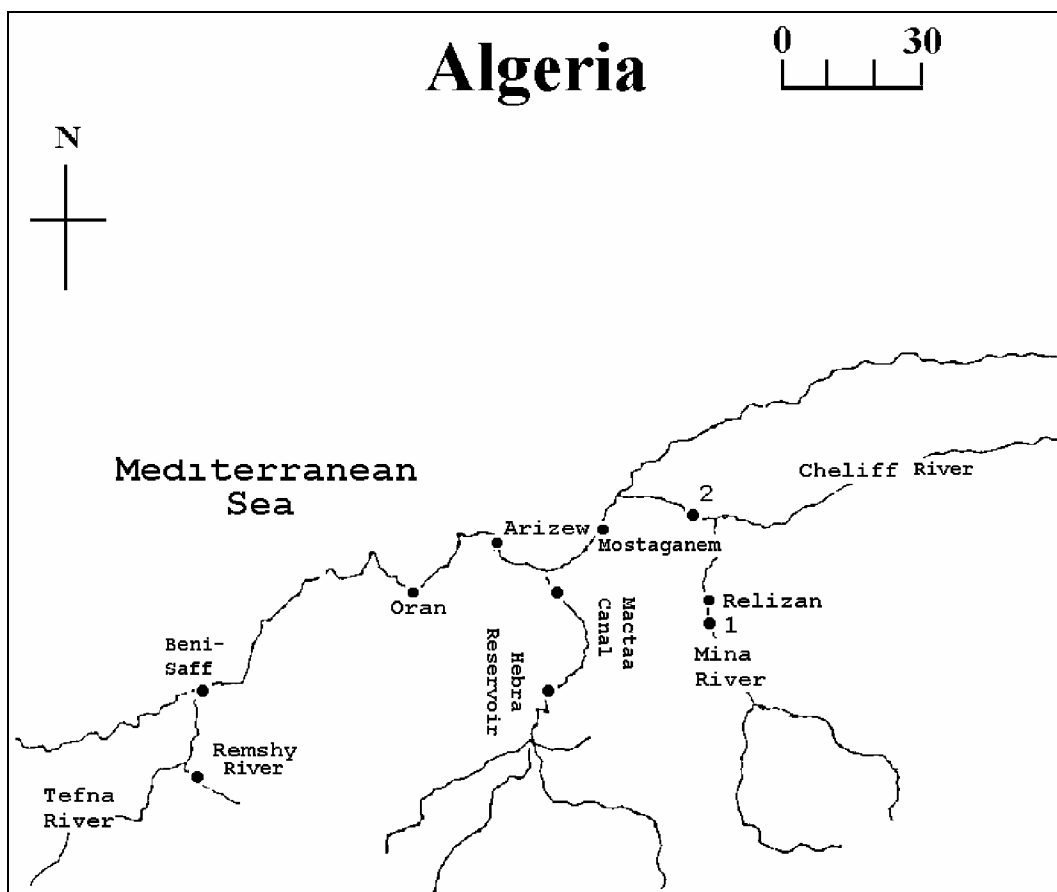
Algeria is the second-largest country in Africa after Sudan and the tenth-largest country in the world. It is located in northwest Africa, having an area of 2,381,745 km<sup>2</sup>. Most of the area consists of desert (Great Western Desert), but the coastal belt of the north (12 %) has a Mediterranean seaboard and is formed of tells and plains. West Algeria is a plain extending from the Tassala Mountains in the west to the Dhahra Mountains in the east. The area is around 1.6 million hectares and is irrigated by three main water sources, the River Cheliff, the Habra Reservoir and the River Tafna (Ayoun, 1985).

The River Cheliff is the largest river in Algeria, with a flow rate of about 2700 m<sup>3</sup> s<sup>-1</sup>. The largest reservoir built on the river is the Algarib with a capacity of 2.8 x 10<sup>8</sup> million m<sup>3</sup>. The river is 700 km long, flowing from the Amour Mountains to the sea. It passes through several different *wilayas* (states) including Mostaganem, Relizan, Ain-Aldeffla and Cheliff, and has several tributaries including the Rehio and Mina Rivers.

Two sampling stations were selected (Figure 1). The first, Station 1, was selected on the River Mina, a 50 km tributary near Relizan Wilaya. The second, Station 2, was selected on the River Cheliff itself, above the confluence with the tributary at Aintedles town (Mostaganem Wilaya), about 30 km from the sea.

## **Climatic Conditions**

Algeria is characterised by hot summers and cool winters (Gagneur & Kara, 2001). The temperature ranges from a minimum of 11.6°C in winter (January) to a maximum of 32.7°C in summer (August). It has a light seasonal rainfall, ranging from 5.8 mm in the wettest season (November and December) to less than 0.1 in the driest season (July and August).



**Figure 1.** Map of the study area on the Cheliff River (2) and its tributary, the river Mina (1).

The winds are usually north-western or south-western (rarely north-eastern or south-eastern), and sometimes a strong westerly wind occurs (Mejrab, 1988). Rainfall and temperature records for the sampling area are shown in Table 1.

Air temperature at Relizan ranged between 9.9°C in January and 27.9°C in July, while rainfall ranged between 1.0 mm in both July and August and averaged 48.0 mm in December. At Mostaganem, temperatures varied from 10.41°C in January to 24.06°C in August, while rainfall ranged from 1.37 mm in July to 74.59 mm in December. According to Mejrab (1988), higher evaporation rates are recorded during June to October and lower rates during November to April. The total evaporation and transpiration at the study area ranged between 800 and 900 mm per annum.

**Table 1. Rainfall data (mm), (1914-1938) and temperature data (°C) for the sampling area, at Relizan, near the River Cheliff (range in the period 1918-1939) and Mostaganem, near the River Mina (Mejrab, 1988).**

Month	Mostaganem (R. Mina)		Relizan (R.Cheliff)	
	Rainfall (mm)	Temperature (°C)	Rainfall (mm)	Temperature (°C)
January	44.39	10.41-	47.0	9.90-
February	45.22	11.12	35.0	11.30
March	30.40	12.45	37.0	13.45
April	33.48	14.34	30.0	16.25
May	31.11	16.85	32.0	20.05
June	04.98	21.11	07.0	23.60
July	01.37-	23.74	01.0-	27.90+
August	02.75	24.06+	01.0-	26.70
September	13.60	22.22	13.0	15.05
October	44.39	18.14	29.0	19.60
November	52.80	14.11	45.0	14.50
December	74.59+	12.36	48.0+	10.80

+: maximum, - : minimum

## Materials and Methods

Quantitative and qualitative estimations of phytoplankton were carried out according to Hellawell (1978), with ten samples collected at each station during the study period (June 1986- March 1988) as described by Al-Asadi (1991). Preparation of algal material for counting was carried out by sedimentation of a known volume of samples, according to Round (1981), a modification of Utermohl's technique using Lugol's iodine solution (Vollenweider, 1971) as a preservative. Wet mount slides were prepared to determine algae other than diatoms, while permanent slides were prepared of the latter. Counting of phytoplankton was carried out according to Furet (1979).

Algal taxa were identified using a light microscope. The diatoms were mainly identified according to Hustedt (1930a, b; 1959; 1962), Patrick and Reimer (1966; 1975) and Germain (1981). Other algal taxa were identified according to Bourrelly (1966, 1970), Pascher (1914; 1915; 1925) and Prescott (1954; 1962). The nomenclature of algal taxa was mostly checked according to Whitton *et al.* (1978). Names of the diatoms were checked through Hartley's checklist (1986) and from the Algae Base web site (Guiry and Guiry 2006; 2007).

## Results

### Seasonal distribution of phyla:

**Cyanophyta:** The maximum of blue-green algae at Station 1 was recorded in June 1986, and the minimum in January 1988. At Station 2, the maximum of blue-green algae was recorded in May 1987, and the minimum in January 1988 (Figure 2).

**Euglenophyta:** *Euglena* species were found only at Station 2 (River Cheliff), in five out of ten occasions during the sampling period. A maximum was recorded in July

1987 (Table 2). *Euglena* species were not found on any occasion during the sampling period at Station 1 (River Mina).

**Bacillariophyta:** Figure 2 shows that the maximum number of diatoms was recorded in July 1987 at both stations. The minimum number of diatoms was recorded in January 1987 at Station 1 and in March 1988 at Station 2.

**Chlorophyta:** More green algae were recorded at Station 2 (River Cheliff) than at Station 1 (River Mina), 41 and 18 species respectively. Figure 2 shows the same pattern as that for the blue-green algae and diatoms. In May 1987, the maximum number of green algae was recorded at both stations. The minimum number was recorded in March 1988 at Station 1 and in January 1988 at Station 2.

**Conjugatophyta:** On two of 10 occasions, low numbers of Conjugatophyta were found at Station 1 during the sampling period. This phylum was found in five of 10 occasions at Station 2. A maximum was recorded in November 1987 and a minimum in January 1987 (Figure 2).

### **Seasonal distribution of species:**

The number of species and their distribution during the sampling period are illustrated in Figure 2. Fig. 2 shows a definite seasonal distribution at both stations. The River Cheliff (Station 2) had more species than did the River Mina (Station 1). The maximum number of species was recorded in May 1987 at both stations (79 and 64 species respectively). The minimum number of species occurred in January 1987 and January 1988 (24 and 21 species respectively).

### **Frequency of Species:**

#### **At Sampling Station 1 (the River Mina):**

Table 1 shows that Bacillariophyta was the most frequent phylum and of those species the pennate form was predominant with 47 out of 51 representatives. The Chlorophyta were represented by 18 species, 13 of which belonged to the Chlorococcales and two to the Volvocales; the remaining three were filamentous forms. The Conjugatophyta was represented by only one species.

#### **At Sampling Station 2 (the River Cheliff):**

Table 2 shows that the numbers of the Bacillariophyta were slightly more frequent than those of the Chlorophyta, but both predominated over any other phyla. With regard to the Bacillariophyta, most were again pinnate forms. Most species of the Chlorophyta belonged to the Chlorococcales; only two were filamentous forms and 6 belonged to the Volvocales. The Cyanophyta were not very frequent being represented by only 6 species.

The Euglenophyta were represented by two species, which were not found at Station 1. The Conjugatophyta were represented by 3 species.

### **Frequency of species categories:**

Four different groups (categories) of species were identified from the occasions of sampling at the two stations, according to the following definitions:

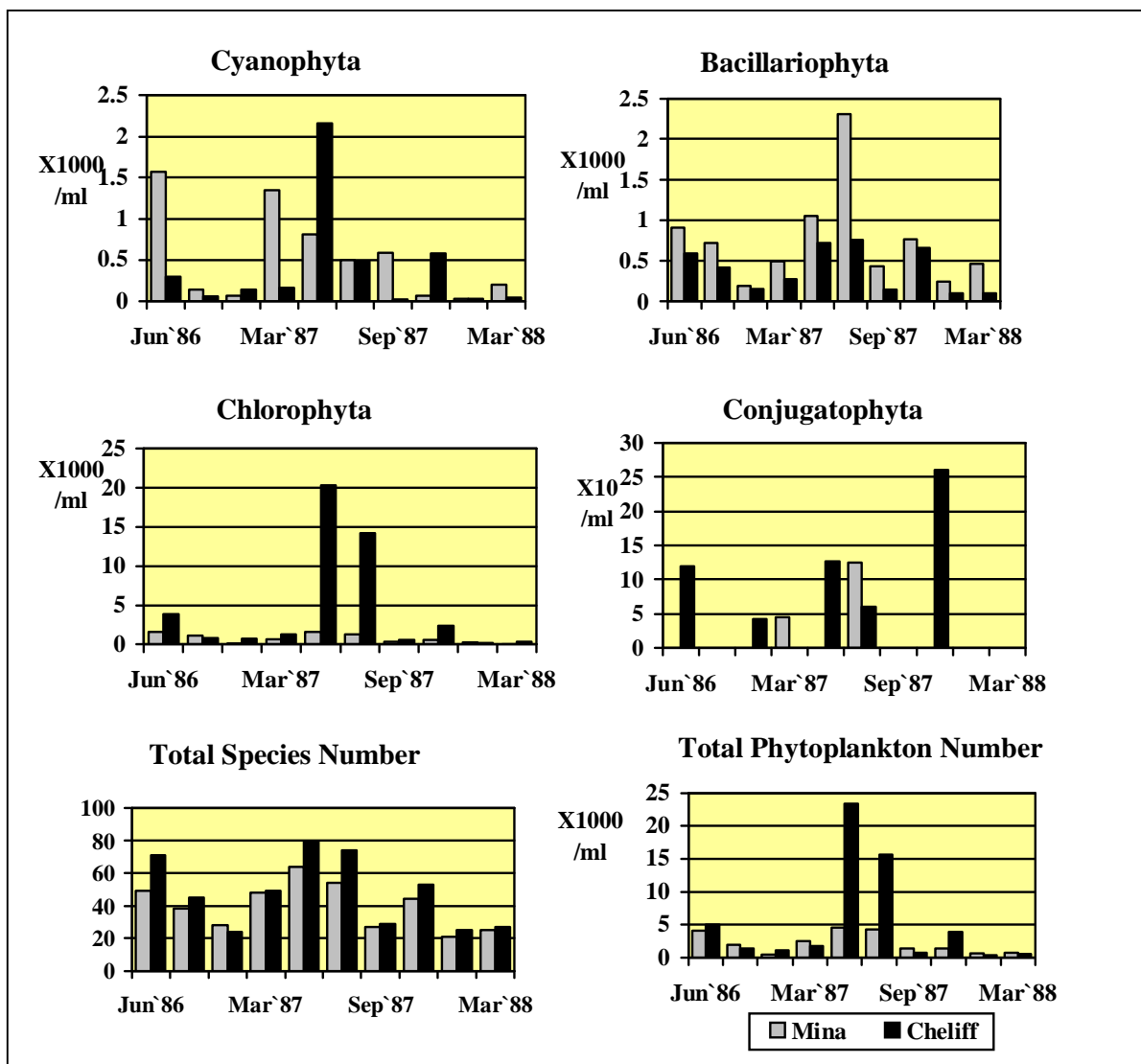
**Common Species:** Species present at all sampling periods or absent on not more than two occasions.

**Abundant Species:** Species present in more than six samples over the whole sampling period.

**Seasonal Species:** Species present at one season of the year more than in the others, and being in at least four samples over the whole sampling period.

**Rare or Ephemeral Species:** Species present in three or fewer samples over the whole sampling period.

Some common and rare algae collected throughout the sampling period are described in Figures 3, 4, 5 and 6.



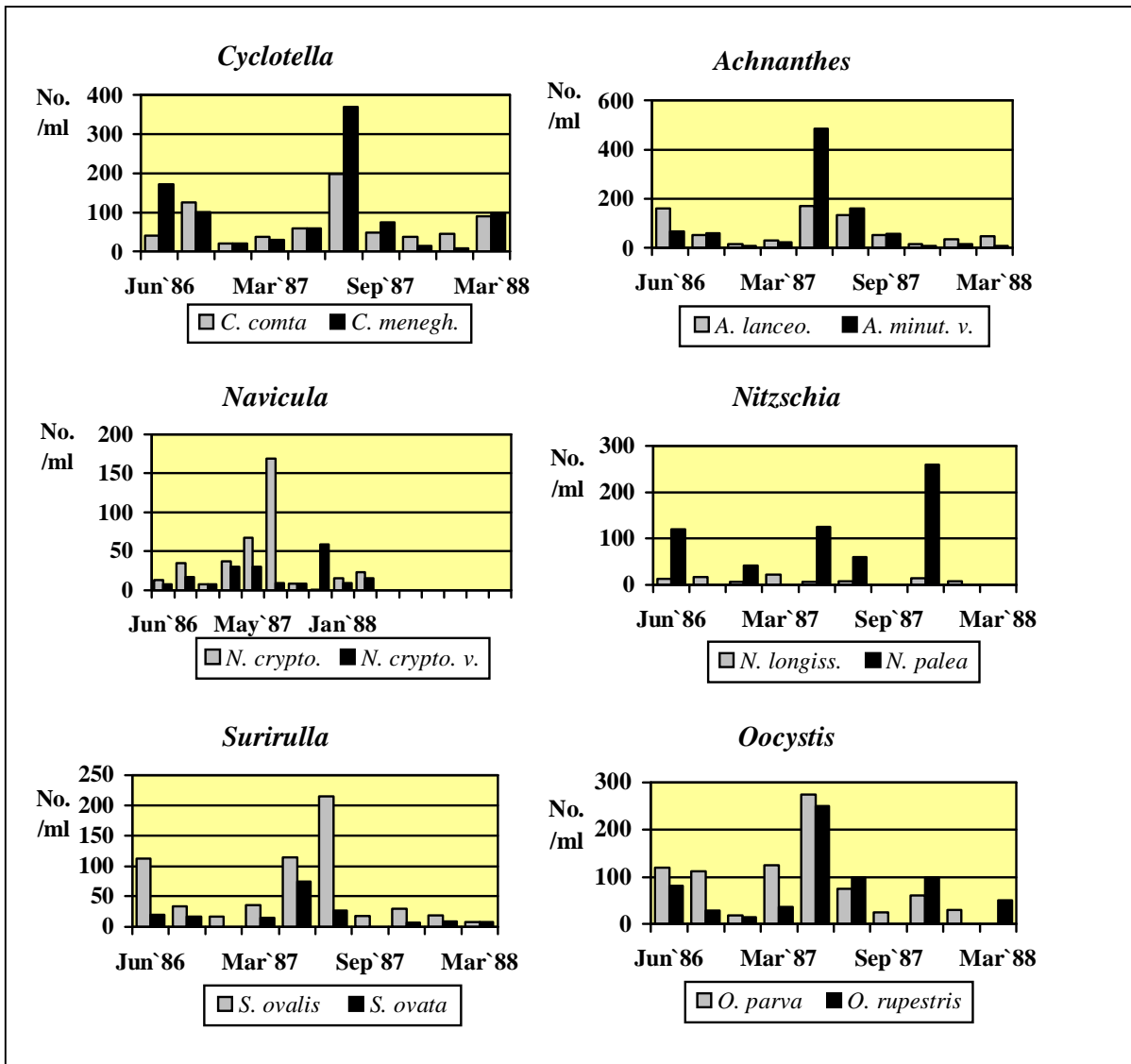
**Figure 2.** Seasonal distribution of four phyla as species and phytoplankton numbers during the study period (1986-1988).

**List of the Common and Rare Algae during the Study Period:**

**Common Algae at Station 1 (River Mina):**

**Cyanophyta:** *Microcystis aeruginosa* Kützing

**Bacillariophyta:** *Cyclotella comta* Kützing; *Cyclotella meneghiniana* Kützing; *Achnanthes lanceolata* (Brébisson ex Kütz) Grun.; *Achnanthes minutissima* var. *cryptocephala* Grunow.; *Gomphonema parvulum* Kützing; *Gyrosigma acuminatum* (Kützing) Rabenhorst; *Navicula cryptocephala* Kützing.; *Navicula cryptocephala* var. *veneta* (Kützing) Rabenhorst; *Nitzschia acicularis* (Kützing) W. Smith; *Nitzschia longissima* (Bréb. In Kütz.) Ralfs; *Nitzschia palea* (Kützing) W. Smith; *Nitzschia tryblionella* var. *debilis* (Arnott) Hustedt; *Rhopalodia gibberula* (Ehrenb.) O. Müller; *Surirulla ovalis* Bréb.; *Surirulla ovata* Kützing; *Synedra acus* Kützing.



**Figure 3.** Seasonal distribution of some of the common species of the River Mina (Station 1) during the study period (1986 – 1988).

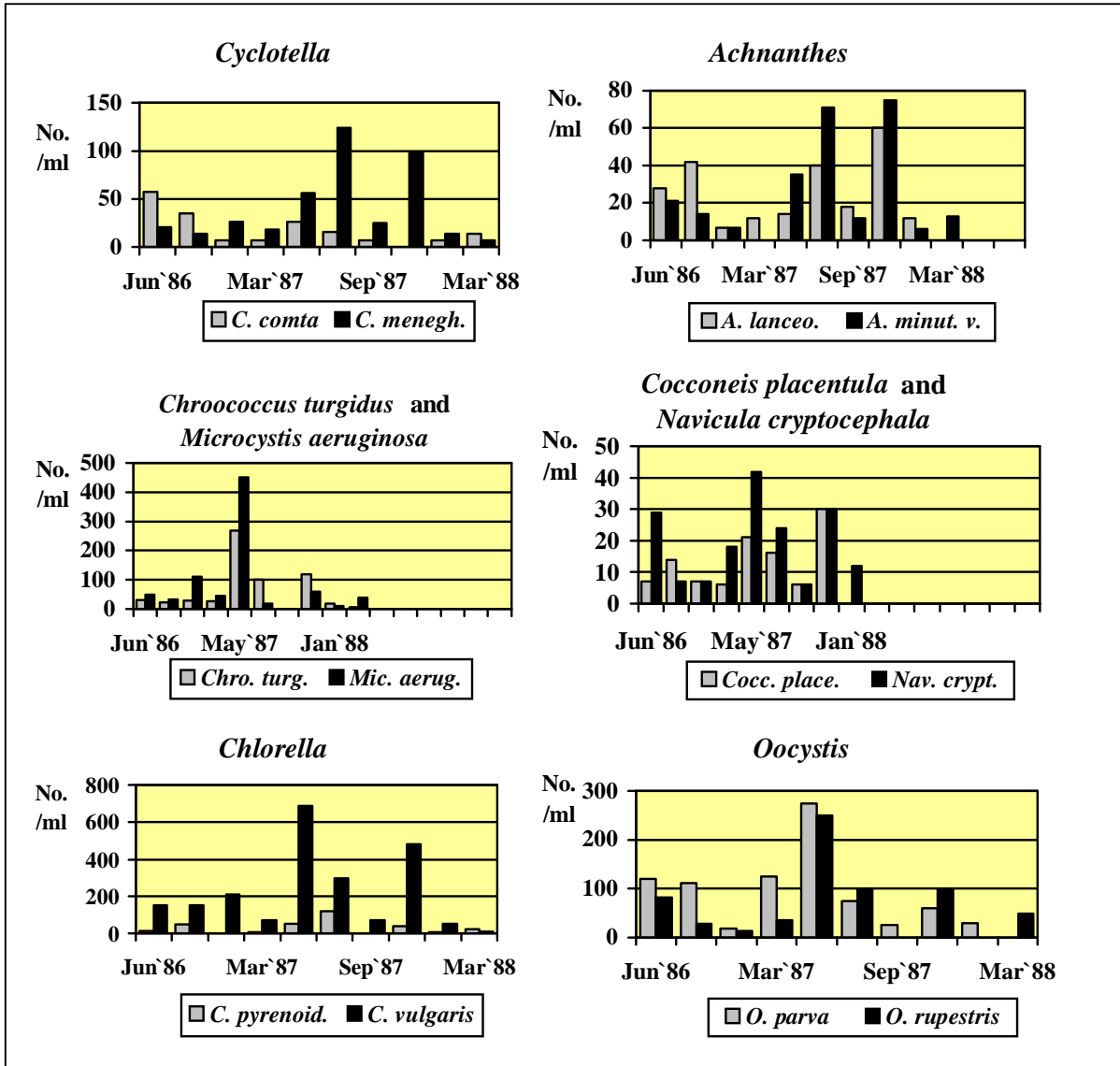
**Chlorophyta:** *Chlorella vulgaris* Beijerinck; *Oocystis parva* W. West & G. S. West; *Oocystis rupestris* Kirchner; *Tetraedron quadratum* (Reinsch) Hansgirg.

**Common Algae at Station 2 (River Cheliff):**

**Cyanophyta:** *Chroococcus turgidus* Nägeli; *Microcystis aeruginosa* Kützing.

**Bacillariophyta:** *Cyclotella comta* Kützing; *Cyclotella meneghiniana* Kützing; *Achnanthes lanceolata* (Bréb. ex Kütz) Grun.; *Achnanthes minutissima* var. *cryptocephala* Grun.; *Cocconeis pediculus* Ehrenberg; *Cocconeis placentula* Ehrenb.; *Navicula cryptocephala* Kützing; *Nitzschia linearis* W. Smith; *Surirulla ovata* Kützing.

**Chlorophyta:** *Pandorina morum* (Müller) Bory de Saint-Vincent; *Chlorella pyrenoidosa* Chick; *Chlorella vulgaris* Beijerinck; *Chlorococcum humicolum* (Nägeli) Rabenhorst; *Oocystis parva* W. West & G. S. West; *Oocystis rupestris* Kirchner.



**Figure 4.** Seasonal distribution of some of the common species of the River Cheliff (Station 2) during the study period (1986-1988).

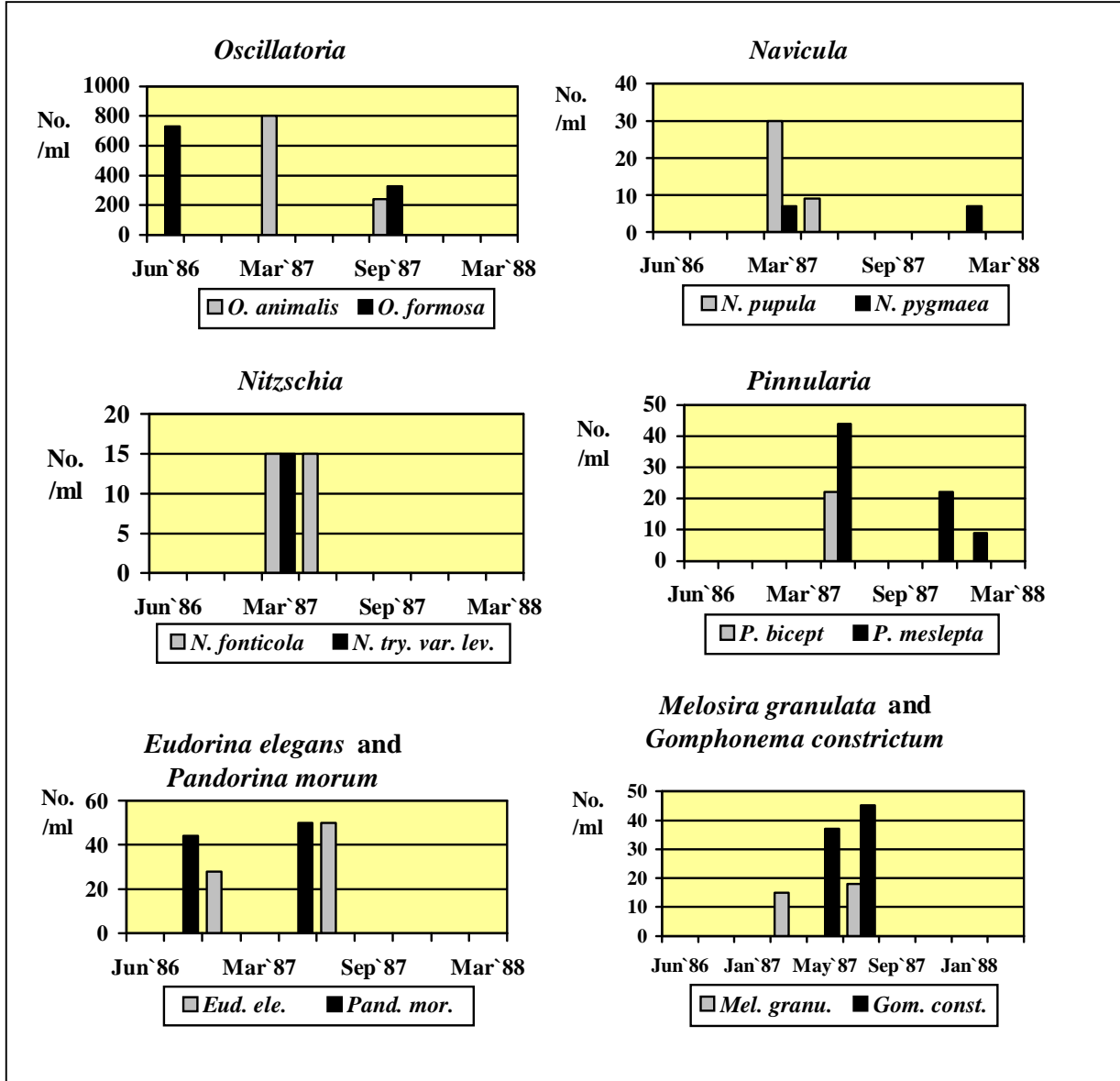
**Rare Algae at Station 1 (River Mina):**

**Cyanophyta:** *Oscillatoria animalis* Agardh; *Oscillatoria formosa* (Bory de Saint-Vincent) Gomont.

**Bacillariophyta:** *Melosira dickiei* (Thwaites) Kützing; *Gomphonema constrictum* var. *capitatum* f. *curta* Grun.; *Navicula pupula* Kützing; *Navicula pygmaea* Kützing;

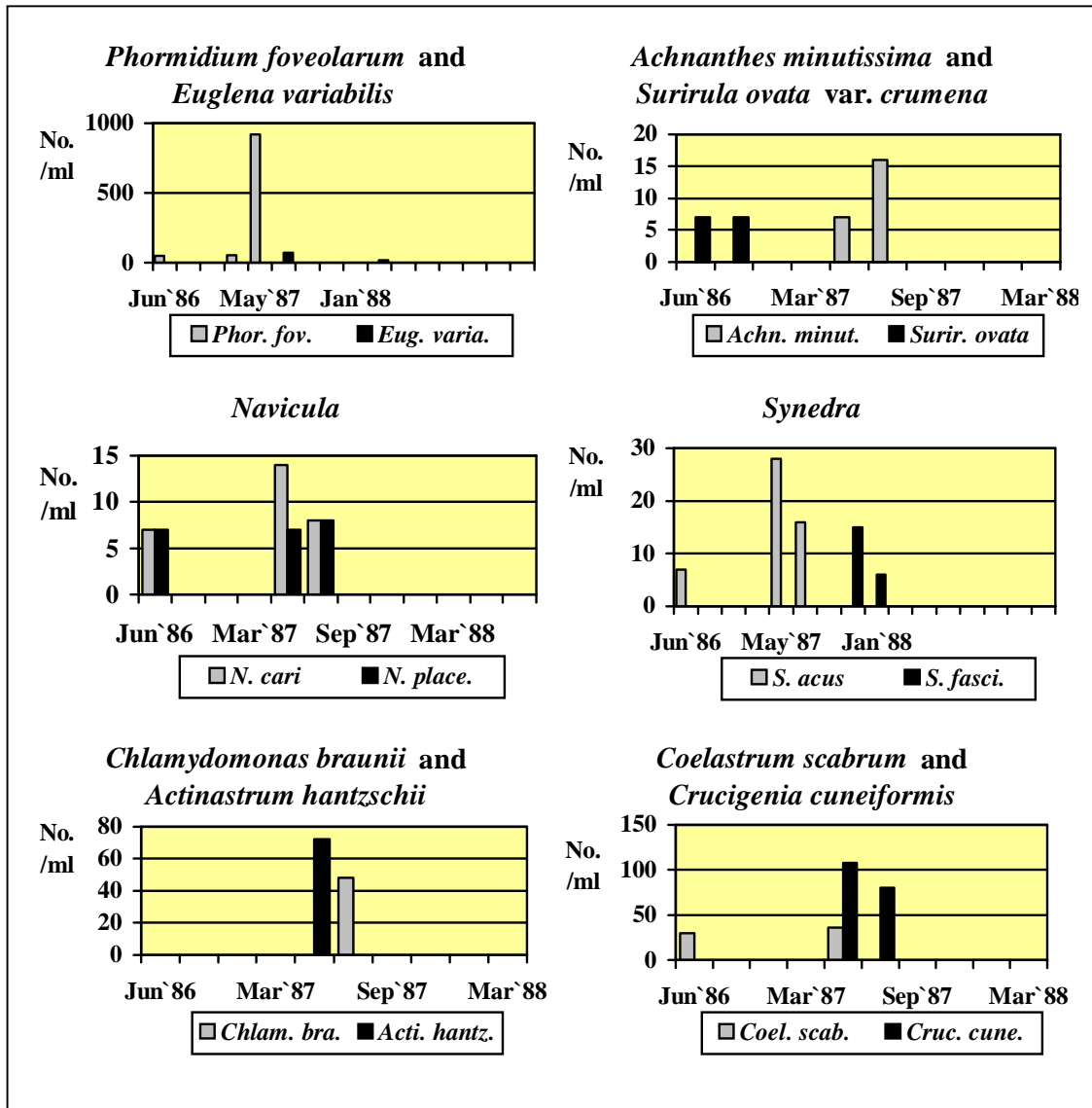


*Navicula rhyncocephala* Kützing; *Neidium binod* (Ehrenb.) Hust.; *Nitzschia fonticola* (Grun.) Grun.; *Nitzschia tryblionella* Hantzsch in Rabenh.; *Nitzschia tryblionella* var. *levidensis* (W. Sm.) Grun.; *Pinnularia biceps* W. Gregory; *Pinnularia mesolepta* (Ehrenb.) W. Sm.; *Pinnularia viridis* (Nitzsch) Ehrenb.; *Synedra fasciculata* (Agardh) Kützing.



**Figure 5.** Seasonal distribution of some of the rare species of the River Mina (Station 1) during the study period (1986-1988).

**Chlorophyta:** *Eudorina elegans* Ehrenb.; *Pandorina morum* (Müller) Bory de Saint-Vincent; *Scenedesmus quadricauda* (Turpin) Bréb.; *Selenastrum gracile* Reinsch.  
**Conjugatophyta:** *Cosmarium affine* Raciborski.



**Figure 6.** Seasonal distribution of some of the rare species at the River Cheliff (Station 2) during the study period (1986-1988).

**Rare Algae at Station 2 (River Cheliff):**

**Cyanophyta:** *Phormidium foveolarum* Gomont.

**Euglenophyta:** *Euglena variabilis* Klebs.

**Bacillariophyta:** *Cyclotella striata* Grun.; *Achnanthes minutissima* Kützing; *Amphora coffeaformis* (C. Agardh) Kützing; *Navicula cincta* (Ehrenberg) Ralfs; *Navicula placentula* f. *rostrata* (A. Mayer) Hust.; *Navicula pupula* Kützing; *Navicula rhyncocephala* Kützing; *Surirulla ovata* var. *crumena* (Bréb. ex. Kütz.) Hust.; *Synedra acus* Kützing; *Synedra fasciculata* (Agardh) Kützing.

**Chlorophyta:** *Chlamydomonas braunii* Goroschankin; *Golenkinia radiata* Chodat emed. Korshikov; *Actinastrum hantzschii* Lagerheim; *Characium debaryanum* (Reinsch) De Toni; *Chodatella ciliata* (Lagerheim) Lemmermann; *Coelastrum cambricum* W. Archer; *Coelastrum scabrum* Reinsch; *Crucigenia cuneiformis* (Schmidle) Brunnth.; *Dictyosphaerium pulchellum* Wood; *Eremosphaera viridis* de

Bary; *Pediastrum duplex* Meyen; *Scenedesmus bijugatus* var. *alternas* (Reinsch) Hansg.; *Scenedesmus incrassatulus* var. *mononae* G. M. Smith; *Scenedesmus opoliensis* P. G. Richter; *Tetrastrum tetracanthum* (G. S. West) Brunnthaler; *Microspora pachyderma* (Wille) Lager.

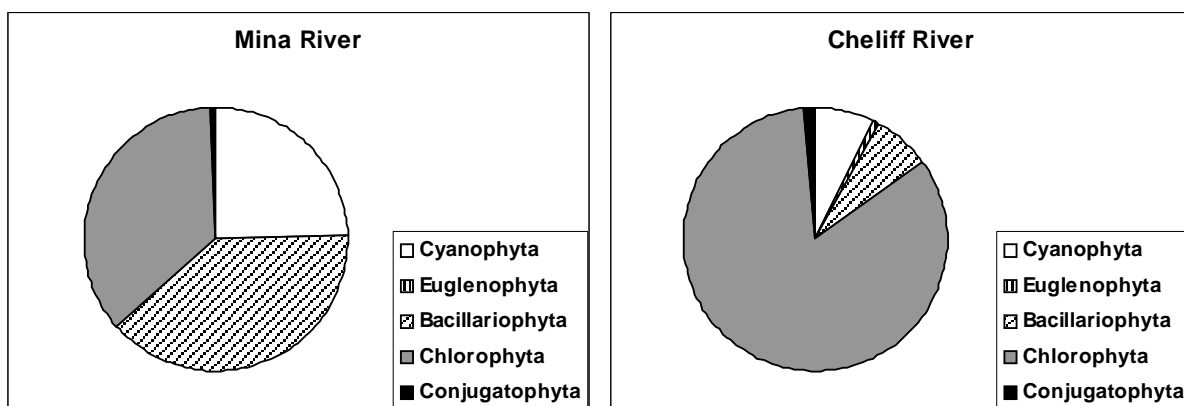
**Conjugatophyta:** *Closterium lanceolatum* Kützing.

### **Phytoplankton:**

Isolated phytoplankton species from Station 1 (River Mina) were classified and listed in Table 2. 76 species were collected. These were mostly Bacillariophyta, of which 51 species (4 centric) were present. These samples also included 6 species of Cyanophyta, 18 species of Chlorophyta and one species of Conjugatophyta. At Station 2 (River Cheliff), 96 species were collected (Table 3). Forty-four species of Bacillariophyta (3 centric), 6 species of Cyanophyta, 41 species of Chlorophyta, 2 species of Euglenophyta and 3 species of Conjugatophyta were recorded at this station (Table 3).

### **The abundance groups of phyla of the stations:**

Figure 7 shows clearly that the relative abundance of Cyanophyta and Bacillariophyta was greater in the tributary (the River Mina) than in the River Cheliff, while the Chlorophyta were found to be more dominant in the River Cheliff than in the tributary River Mina. The abundance of Conjugatophyta was similar at the two stations and the Euglenophyta were absent from the tributary. The latter had more equal proportions of individuals of both diatoms and green algae.



**Figure 7.** Relative abundance of algal phyla at the Cheliff River and its tributary the Mina River during the study period (1986-1988).

Table 2. Distribution of phytoplankton at Station 1 (The River Mina) during the period of study (June 1986 - March 1988).

Species Names	Jun	Oct	Jan	Mar	May	Jul	Sep	Nov	Jan	Mar
	1986		1987						1988	
<b>CYANOPHYTA</b>										
001- <i>Chroococcus giganteus</i> West	304	0	14	108	200	75	0	0	0	0
002- <i>C. turgidus</i> Nägeli	146	0	0	90	250	50	0	20	30	0
003- <i>Microcystis aeruginosa</i> Kützing	305	135	42	346	365	223	27	0	0	200
004- <i>Oscillatoria animalis</i> Agardh	0	0	0	800	0	0	240	0	0	0
005- <i>O. formosa</i> (Bory de Saint-Vicent) Gomont	728	0	0	0	0	0	325	0	0	0
006- <i>Spirulina subsalsa</i> Oersted	84	0	17	94	0	150	0	47	0	0
Sub-total Numbers	1567	135	73	1348	815	498	592	67	30	200
<b>BACILLARIOPHYTA – CENTRALES</b>										
007- <i>Cyclotella comta</i> Kützing	40	126	21	37	59	198	50	37	45	90
008- <i>C. meneghiniana</i> Kützing	172	101	21	30	59	369	75	15	9	100
009- <i>C. striata</i> Grunow	13	8	0	15	44	27	0	7	0	0
010- <i>Melosira dickiei</i> (Thwaites) Kützing	0	0	0	15	0	18	0	0	0	0
Sub-total Numbers	225	235	42	97	162	612	125	59	54	190
<b>BACILLARIOPHYTA – PENNALES</b>										
011- <i>Achnanthes lanceolata</i> (Bréb. Ex Kütz.) Grun.	160	50	14	30	170	133	50	15	34	46
012- <i>A. minutissima</i> var. <i>cryptocephala</i> Crun.	66	59	7	22	485	160	58	7	17	8
013- <i>Amphora coffeaeformis</i> (C. Agardh) Kützing	8	8	0	7	15	27	0	15	0	0
014- <i>Caloneis amphisbaena</i> var. <i>fenzlii</i> Cleve	20	17	0	0	37	18	8	15	0	0
015- <i>Cocconeis pediculus</i> Ehrenb.	0	0	0	7	30	89	0	22	0	0
016- <i>C. placentula</i> Ehrenb.	0	33	0	0	52	89	0	15	0	0
017- <i>Cylindrotheca gracilis</i> Grun.	7	0	0	22	15	27	0	0	0	8
018- <i>Cymbella prostrata</i> Grun.	20	17	0	7	22	18	0	0	0	15
019- <i>Denticula tenuis</i> Kützing	7	0	0	7	15	9	0	15	0	0
020- <i>Eunotia curvata</i> (Kützing) Lagerstedt	14	7	0	6	14	0	6	0	0	0
021- <i>E. exigua</i> Rabenhorst	13	8	0	7	30	9	0	22	0	15
022- <i>Fragilaria capucina</i> var. <i>lanceolata</i> Grun.	7	8	0	0	22	18	17	7	0	0
023- <i>Gomphoneis olivaceum</i> (Hornemann) P. Dawson ex R. Ross & Sims	0	0	7	15	50	35	0	0	0	0
024- <i>Gomphonema constrictum</i> var. <i>capitatum</i> f. <i>curta</i> Grun.	0	0	0	0	37	45	0	0	0	0

Table 2 (continued). Distribution of phytoplankton at Station 1 (The River Mina) during the period of study (June 1986 - March 1988).

Species Names	Jun	Oct	Jan	Mar	May	Jul	Sep	Nov	Jan	Mar
	1986		1987						1988	
025- <i>G. exiguum</i> Kützing	0	0	14	0	22	27	0	15	0	8
026- <i>G. parvulum</i> Kützing	40	0	14	7	22	18	50	29	9	23
027- <i>Gyrosigma acuminatum</i> (Kützing) Rabenhorst	13	8	0	15	15	27	8	7	0	8
028- <i>Navicula capitata</i> var. <i>hungarica</i> (Grun.) Ross	0	17	7	0	15	18	0	29	0	30
029- <i>N. cryptocephala</i> Kützing	13	35	7	37	67	169	8	51	15	23
030- <i>N. cryptocephala</i> var. <i>veneta</i> (Kützing) Rabenhorst	7	17	7	30	30	9	8	59	9	15
031- <i>N. cuspidate</i> (Kützing) Kützing	13	8	0	0	22	35	0	22	0	0
032- <i>N. cuspidate</i> var. <i>ambigua</i> (Ehrenb) Cleve	0	25	0	15	15	0	0	22	9	0
033- <i>N. pupula</i> Kützing	0	0	0	30	9	0	0	0	0	0
034- <i>N. pygmaea</i> Kützing	0	0	0	7	0	0	0	0	7	0
035- <i>N. radiosa</i> Kützing	7	0	0	7	14	52	0	0	0	0
036- <i>N. rhyncocephala</i> Kützing	0	0	0	15	22	0	0	0	0	0
037- <i>Neidium binod</i> (Ehrenb.) Hustedt	0	0	0	0	15	18	0	0	0	0
038- <i>Nitzschia acicularis</i> (Kützing) W. Smith	13	17	7	7	22	27	0	29	9	0
039- <i>N. amphibian</i> Grun.	13	0	0	0	22	0	0	7	0	8
040- <i>N. fonticola</i> (Grun) Grun.	0	0	0	15	15	0	0	0	0	0
041- <i>N. linearis</i> W. Smith	7	33	0	0	37	27	0	22	0	15
042- <i>N. longissima</i> (Bréb. in Kütz.) Ralfs	13	17	7	22	7	9	0	15	9	0
043- <i>N. palea</i> (Kützing.) W. Smith	26	8	7	22	22	53	8	105	0	0
044- <i>N. tryblionella</i> Hantzsch in Rabenh.	0	0	17	22	30	0	0	0	0	0
045- <i>N. tryblionella</i> var. <i>debilis</i> (Arnott) Hust.	20	17	0	7	60	107	33	7	17	0
046- <i>N. tryblionella</i> var. <i>levidensis</i> (W. Sm.) Grun.	0	0	0	15	0	0	0	0	0	0
047- <i>Opephora schwartzii</i> (Grun.) Petit ex Pelletan	7	0	7	0	7	9	0	0	0	8
048- <i>Pinnularia biceps</i> W. Greg.	0	0	0	0	22	0	0	0	0	0
049- <i>P. mesolepta</i> (Ehrenb.) W. Sm.	0	0	0	0	44	0	0	22	9	0
050- <i>P. viridis</i> (Nitzsch) Ehrenb.	0	0	0	0	29	105	0	22	0	0
051- <i>Rhoicosphenia abbreviate</i> (C. Agardh) Lange-Bertalot	20	0	0	0	22	18	0	7	0	0
052- <i>Rhopalodia gibberula</i> (Ehrenb.) O. Müll.	7	8	0	7	15	18	8	15	0	8
053- <i>Surirulla ovalis</i> Bréb.	113	34	17	35	115	215	18	30	19	8
054- <i>S. ovata</i> Kützing	20	17	0	15	75	27	0	7	9	8

Table 2 (continued). Distribution of phytoplankton at Station 1 (The River Mina) during the period of study (June 1986 - March 1988).

Species Names	Jun	Oct	Jan	Mar	May	Jul	Sep	Nov	Jan	Mar
	1986		1987						1988	
055- <i>Synedra acus</i> Kützing	13	8	0	30	81	27	17	29	9	8
056-S. <i>fasciculate</i> (Agardh) Kützing	0	0	0	0	15	0	0	15	0	0
057-S. <i>pulchella</i> Ralfs ex Kützing	0	8	7	0	15	0	8	7	0	8
Sub-total Numbers	687	484	146	390	1897	1692	305	708	182	270
<b>CHLOROPHYTA - VOLVOCALES AND TETRASPORALES</b>										
058- <i>Eudorina elegans</i> Ehrenb.	0	0	28	0	0	50	0	0	0	0
059- <i>Pandorina morum</i> (Müller) Bory de Saint-Vincent	0	44	0	0	50	0	0	0	0	0
Sub-total Numbers	0	44	28	0	50	50	0	0	0	0
<b>CHLOROPHYTA - CHLOROCOCCALES</b>										
060- <i>Ankistrodesmus falcatus</i> (Corda) Ralfs	82	136	14	0	0	125	100	0	0	0
061- A. <i>falcatus</i> var. <i>acicularis</i> G. S. West	0	0	0	0	100	250	0	140	60	0
062- <i>Chlorella pyrenoidosa</i> Chick	64	56	0	72	0	200	0	120	0	0
063- C. <i>vulgaris</i> Beijerinck	56	396	54	188	150	150	50	80	0	0
064- <i>Chlorococcum humicolum</i> (Nägeli) Rabenhorst	204	0	14	0	0	125	50	0	180	8
065- <i>Coelastrum cambricum</i> W. Archer	96	0	0	0	25	0	0	40	0	0
066- <i>Kichneriella contorta</i> (Schmidle) Bohlin	240	0	18	0	100	0	0	0	0	0
067- <i>Oocystis parva</i> W. West & G. S. West	120	112	18	125	275	75	25	60	30	0
068- O. <i>rupestris</i> Kirchner	82	29	14	36	250	100	0	100	0	50
069- <i>Scenedesmus quadricauda</i> (Turp.) Bréb.	0	124	0	0	100	0	0	0	0	0
070- <i>Selenastrum gracile</i> Reinsch	152	0	0	72	175	0	0	0	0	0
071- <i>Tetraedron minimum</i> (A. Braun) Hansg.	0	84	14	0	75	0	50	0	0	0
072- T. <i>quadratum</i> (Reinsch) Hansg.	88	0	0	108	50	75	75	20	60	20
Sub-total Numbers	1184	937	146	601	1300	1100	350	560	330	78
<b>CHLOROPHYTA - CHAETOPHORALES, OEDOGONALES AND ULOTRICHALES</b>										
073- <i>Hormidium flaccidum</i> A. Braun	82	0	0	18	150	0	25	0	0	0
074- <i>Stichococcus bacillaris</i> Nägeli	264	0	0	54	0	125	0	40	0	0
075- <i>Ulothrix subtilissima</i> Rabenhorst	100	86	0	0	150	50	0	0	0	0
Sub-total Numbers	446	86	0	72	300	175	25	40	0	0
<b>CONJUGATOPHYTA</b>										
076- <i>Cosmarium affine</i> Racib.	0	0	0	54	0	125	0	0	0	0
Sub-total Numbers	0	0	0	54	0	125	0	0	0	0
<b>Total Phytoplankton Numbers</b>	<b>4109</b>	<b>1921</b>	<b>435</b>	<b>2552</b>	<b>4544</b>	<b>4252</b>	<b>1397</b>	<b>1432</b>	<b>595</b>	<b>738</b>

Table 3. Distribution of Phytoplankton at Station 2 (The River Cheliff) during the period of study (June 1986 – March 1988).

Species Names	Jun	Oct	Jan	Mar	May	Jul	Sep	Nov	Jan	Mar
	1986		1987						1988	
<b>CYANOPHYTA</b>										
001- <i>Chroococcus turgidus</i> Nägeli	30	24	28	27	270	100	0	120	20	6
002- <i>Gloeocapsa alpine</i> Brand	30	0	0	0	324	310	0	360	0	0
003- <i>Merismopedia punctata</i> Meyen	90	0	0	45	180	0	18	0	0	0
004- <i>Microcystis aeruginosa</i> Kützing	50	32	112	45	450	20	0	60	10	38
005- <i>Phormidium foveolarum</i> Gomont	50	0	0	54	918	0	0	0	0	0
006- <i>Spirulina subsalsa</i> Oersted	45	0	0	0	18	50	0	40	0	0
Subtotal Numbers	295	56	140	171	2160	70	18	580	30	44
<b>EUGLENOPHYTA</b>										
007- <i>Euglena proxima</i> Dangeard	60	48	0	0	0	50	0	40	0	18
008- <i>E. variabilis</i> Klebs	0	0	0	0	0	70	0	0	0	18
Sub-total Numbers	60	48	0	0	0	120	0	40	0	36
<b>BACILLARIOPHYTA – CENTRALES</b>										
009- <i>Cyclotella comta</i> Kützing	57	35	7	6	26	16	6	0	6	13
010- <i>C. meneghiniana</i> Kützing	21	14	26	18	56	124	25	98	12	6
011- <i>C. striata</i> Grun.	7	0	0	6	0	8	0	0	0	0
Sub-total Numbers	85	49	33	30	92	148	31	98	18	19
<b>BACILLARIOPHYTA – PENNALES</b>										
012- <i>Achnanthes lanceolata</i> (Bréb. Ex Kütz.) Grun.	28	42	7	12	14	40	18	60	12	0
013- <i>A. minutissima</i> Kützing	0	0	0	0	7	16	0	0	0	0
014- <i>A. Minutissima</i> var. <i>cryptocephala</i> Grun.	21	14	7	0	35	71	12	75	6	13
015- <i>Amphora coffeaeformis</i> (C. Agardh) Kützing	0	21	0	0	56	16	0	0	0	0
016- <i>A. ovalis</i> Kützing	14	0	7	6	14	0	6	0	0	0
017- <i>Caloneis amphisbaena</i> var. <i>fenzlii</i> Cleve	29	0	7	0	21	16	0	8	0	0
018- <i>Cocconeis pediculus</i> Ehrenb.	0	0	0	6	0	0	12	0	6	19
019- <i>C. placentula</i> Ehrenb.	7	14	7	6	21	16	6	30	0	0
020- <i>Diploneis didyma</i> (Ehrenb.) Cleve	29	0	0	12	14	0	0	7	0	13
021- <i>D. ovalis</i> Cleve.	14	21	0	6	14	24	0	15	0	6
022- <i>Eunotia curvata</i> (Kützing) Lagerst.	14	7	0	6	14	0	6	0	0	0
023- <i>E. exigua</i> Rabenhorst	14	0	0	21	14	0	0	7	6	0
024- <i>Gomphonema parvulum</i> Kützing	14	0	7	12	14	0	0	0	0	0

Table 3 (continued). Distribution of Phytoplankton at Station 2 (The River Cheliff) during the period of study (June 1986 – March 1988).

Species Names	Jun	Oct	Jan	Mar	May	Jul	Sep	Nov	Jan	Mar
	1986		1987						1988	
025- <i>Gyrosigma acuminatum</i> (Kützing) Rabenhorst	29	56	0	0	14	39	0	22	6	0
026- <i>Navicula capitata</i> var. <i>hungarica</i> (Grun.) Ross	4	7	0	0	14	16	0	7	0	0
027- <i>N. cincta</i> (Ehrenberg) Ralfs	7	0	0	0	14	8	0	0	0	0
028- <i>N. cryptocephala</i> Kützing	29	7	7	18	42	24	6	30	12	0
029- <i>N. cryptocephala</i> var. <i>veneta</i> (Kützing) Rabenhorst	7	7	0	24	7	8	0	7	0	6
030- <i>N. placentula</i> f. <i>rostrata</i> (A. Mayer) Hust.	7	0	0	0	7	8	0	0	0	0
031- <i>N. pupula</i> Kützing	0	7	7	12	0	0	6	0	0	0
032- <i>N. radiosa</i> Kützing	14	0	0	0	14	8	0	0	0	6
033- <i>N. rhyncocephala</i> Kützing	7	0	0	6	0	8	0	0	0	0
034- <i>Nitzschia acicularis</i> (Kützing) W. Smith.	14	14	0	6	14	0	0	15	6	0
035- <i>N. amphibia</i> Grun.	7	0	0	6	14	8	6	0	0	0
036- <i>N. fonticola</i> (Grun.) Grun.	21	14	7	0	7	8	6	0	0	0
037- <i>N. linearis</i> W. Smith	50	35	7	18	21	31	6	38	6	13
038- <i>N. longissima</i> (Bréb. Ex Kütz.) Grun.	7	0	7	12	14	16	0	15	0	13
039- <i>N. palea</i> (Kützing) W. Smith	21	7	14	12	28	39	0	0	0	0
040- <i>N. tryblionella</i> Hanzsch in Rabenh.	7	0	0	12	21	24	0	53	0	0
041- <i>N. umbonata</i> (Ehrenb.) Lange-Bertalot	14	0	0	0	14	16	6	0	0	0
042- <i>Pinnularia viridis</i> (nitzsch) Ehrenb.	14	0	0	0	14	24	0	15	6	13
043- <i>Pleurosigma elongatum</i> W. Smith	7	21	0	12	21	31	0	30	6	0
044- <i>Rhoicosphenia abbreviata</i> (C. Agardh) Lange-Bertalot	0	0	0	6	14	16	6	0	0	0
045- <i>Rhopalodia gibberula</i> (Ehrenb.) O. Müll.	7	7	0	0	7	8	0	0	0	0
046- <i>Stauroneis phoenicenteron</i> Ehrenb.	7	28	7	0	7	16	0	45	0	0
047- <i>S. (Navicula) spicula</i> Hickie	0	0	0	0	14	24	6	15	6	0
048- <i>Surirulla ovata</i> Kützing.	21	14	7	6	14	24	6	22	6	0
049- <i>S. ovata</i> var. <i>crumena</i> (Bréb.ex.Kütz.) Hust.	7	7	0	0	0	0	0	0	0	0
050- <i>Synedra acus</i> Kützing	7	0	0	0	28	16	0	0	0	0
051- <i>S. fasciculata</i> (Agardh) Kützing	0	0	0	0	0	0	0	15	6	0
052- <i>S. ulna</i> (Nitzsch) Ehrenb.	0	7	7	6	0	0	0	7	0	0
Sub-total Numbers	506	371	119	243	623	611	108	563	84	77



Table 3 (continued). Distribution of Phytoplankton at Station 2 (The River Cheliff) during the period of study (June 1986 – March 1988).

Species Names	Jun	Oct	Jan	Mar	May	Jul	Sep	Nov	Jan	Mar
	1986		1987						1988	
<b>CHLOROPHYTA - VOLVOCALES AND TETRASPORALES</b>										
053- <i>Chlamydomonas braunii</i> Goroschankin	0	0	0	0	0	48	0	0	0	0
054- <i>C. globosa</i> Snow	159	0	0	27	0	450	0	40	0	0
055- <i>C. mucicola</i> Schmidle	300	48	0	0	270	0	0	40	0	12
056- <i>Eudorina elegans</i> Ehrenb.	30	0	0	9	54	110	0	0	0	0
057- <i>Golenkinia radiata</i> Chodat emed. Korshikov	0	0	0	9	0	10	0	40	0	0
058- <i>Pandorina morum</i> (Müller) Bory de Saint-Vincent	15	16	0	9	36	40	18	0	10	12
Sub-total Numbers	504	64	0	54	360	658	18	120	10	24
<b>CHLOROPHYTA – CHLOROCOCCALES</b>										
059- <i>Actinastrum hantzschii</i> Lagerheim	0	0	0	0	72	0	0	0	0	0
060- <i>Ankistrodesmus falcatus</i> var. <i>acicularis</i> G. S. West	0	96	0	45	360	170	0	120	0	0
061- <i>A. falcatus</i> var. <i>tunii</i>	150	50	0	450	14760	70	54	0	0	0
062- <i>A. nitzchioides</i> West	540	112	0	0	36	180	126	200	0	0
063- <i>Characium acuminatum</i> A. Braun	0	0	28	18	54	30	0	0	0	0
064- <i>C. debaryanum</i> (Reinsch) De Toni	80	0	0	0	0	0	18	0	0	12
065- <i>Chlorella pyrenoidosa</i> Chick	15	48	0	9	54	120	0	40	10	24
066- <i>C. vulgaris</i> Beijerinck	150	152	210	72	684	300	72	480	50	12
067- <i>Chlorococcum humicolum</i> (Nägeli) Rabenhorst	390	48	168	18	270	200	90	180	40	84
068- <i>Chodatella ciliata</i> (Lagerheim) Lemm.	60	0	0	0	18	20	0	0	0	0
069- <i>Coelastrum cambricum</i> W. Archer	90	0	0	0	72	0	0	29	0	0
070- <i>C. scabrum</i> Reinsch	30	0	0	0	36	0	0	0	0	0
071- <i>Crucigenia cuneiformis</i> (Schmidle) Brunnth.	0	0	0	0	108	80	0	0	0	0
072- <i>C. quadrata</i> Morren	270	0	0	36	432	320	0	120	0	12
073- <i>Crucigeniella rectangularis</i> (Nägeli) Komàrek	0	80	0	108	0	0	36	80	0	0
074- <i>Dictyosphaerium pulchellum</i> Wood	0	0	0	18	0	100	0	0	0	0
075- <i>Eremosphaera viridis</i> de Bary	60	0	0	18	18	0	0	0	0	0
076- <i>Kichneriella contorta</i> (Schmidle) Bohlin	135	0	0	108	612	9100	0	0	0	18
077- <i>Oocystis parva</i> W. West & G. S. West	120	32	84	27	324	100	54	20	40	12
078- <i>O. rupestris</i> Kirchner	30	18	42	9	90	190	18	180	10	30
079- <i>Pediastrum duplex</i> Meyen	0	0	0	0	36	0	0	80	0	6
080- <i>Scenedesmus bijugatus</i> var. <i>alternas</i> (Reinsch) Hansg.	180	0	0	0	114	40	0	0	0	0
081- <i>S. incrassatulus</i> Bohlin	0	0	0	0	36	120	18	0	20	0

Table 3 (continued). Distribution of Phytoplankton at Station 2 (The River Cheliff) during the period of study (June 1986 – March 1988).

Species Names	Jun	Oct	Jan	Mar	May	Jul	Sep	Nov	Jan	Mar
	1986		1987						1988	
082- <i>S. incrassatulus</i> var. <i>mononae</i> G. M. Smith	60	0	0	0	0	40	0	40	0	0
083- <i>S. opoliensis</i> P. G. Richter	60	0	0	0	144	80	0	0	0	0
084- <i>S. opoliensis</i> var. <i>carinatus</i> Lemm.	0	16	0	0	144	40	0	80	0	0
085- <i>S. quadricauda</i> (Turp.) Bréb.	0	24	112	0	567	200	36	80	0	0
086- <i>Schroederia setigera</i> (Schr.) Lemm.	0	0	42	0	90	300	0	240	0	0
087- <i>Selenastrum gracile</i> Reinsch	120	24	0	27	180	160	0	40	0	0
088- <i>Tetraedron minimum</i> (A. Braun) Hansg	90	8	0	0	144	60	0	200	0	0
089- <i>T. quadratum</i> (Reinsch) Hansg.	525	24	0	18	144	170	0	240	0	12
090- <i>T. quadratum</i> var. <i>minor acutum</i> Reinsch	0	24	0	0	90	20	0	0	10	0
091- <i>Tetrastrum tetracanthum</i> (G. S. West) Brunthaler	225	0	0	0	0	1000	0	0	0	0
Sub-total Numbers	3380	756	686	981	19689	13110	522	2249	180	222
<b>CHLOROPHYTA – CHAETOPHORALES + OEDOGONIALES</b>										
092- <i>Hormidium flaccidum</i> A. Braun	0	24	84	0	270	100	36	0	10	0
093- <i>Microspora pachyderma</i> (Wille) Lager.	0	0	0	270	0	350	0	0	0	120
Sub-total Numbers	0	24	84	270	270	450	36	0	10	120
<b>CONJUGATOPHYTA</b>										
094- <i>Closterium lanceolatum</i> Kützing	60	0	0	0	108	0	0	200	0	0
095- <i>Cosmarium affine</i> Racib.	60	0	0	0	90	20	0	20	0	0
096- <i>C. microsphinctum</i> Nordst.	0	0	42	0	36	40	0	40	0	0
Sub-total Numbers	120	0	42	0	234	60	0	260	0	0
<b>Total Phytoplankton Numbers</b>	<b>4943</b>	<b>1354</b>	<b>1097</b>	<b>1749</b>	<b>23397</b>	<b>15745</b>	<b>739</b>	<b>4085</b>	<b>338</b>	<b>567</b>

## Discussion

Very little has been written on aquatic and riverine flora (Gagneur and Kara, 2001); however, the works of Gauthier-Lievre (1931) and Bensettiti (1995) deserve to be mentioned. Relatively abundant literature is available on the taxonomy and distribution of several aquatic groups in Algeria. Reference to older works is often made, e.g., Seurat (1930); Beadle (1943); Vaillant (1955). These early works were typical taxonomic accounts, focusing on species distribution and occurrence, and were mostly limited to fish (Pellegrin, 1921; Bertin, 1951). The main, if not only, aim of the field trips of early explorers of these poorly known North African regions was to establish or complete faunal lists. In contrast, new approaches aim to study systems as a whole from an ecological view. By the early 1970`s, approaches to studying aquatic ecosystems had changed. Even if taxonomy continued to progress, it was no longer the first aim. Subsequently some watercourses were studied in Algeria. Examples include Aissi Wadi (Lounaci, 1987), El-Harrach Wadi (Zouakh, 1995), Inaouene Wadi (Afkir, 1985), Mouzaia and Cheffa Wadies (Arab, 1989), Rhumel Wadi (Afri and Pauwels, 1983), Sebaou Wadi (Lounaci *et al.* 2000), and Tafna Wadi (Gagneur, 1983, 1994; Belaidi-Aliane, 1992; Vaillant and Gagneur, 1998; Gagneur and Thomas, 2001).

The current study presented in this paper identified a total of 122 species of phytoplankton algae from the River Cheliff and its tributary, the River Mina. As the primary study for this area the results provide an invaluable record and form a baseline checklist for future work (Tables 2 and 3). In the River Cheliff it was found that Bacillariophyta showed less dominance than in the River Mina. This means that the downstream portion of the study area had fewer diatoms. This finding was supported by the view of Darley (1982) that motility is an advantage in this habitat and that diatoms are common. Saad and Antoine (1982), worked on the phytoplankton of some outlet canals of the Shatt al-Arab Estuary at Basrah, Iraq and reported that Bacillariophyta were predominant in the genera and species, followed by Chlorophyta and then Cyanophyta. It was found that the River Mina had a greater degree of species evenness, whereas nearly half the individuals at the River Cheliff belong to the two most common species.

In Morocco, Chergui *et al.* (1999) listed the aquatic flora as Cyanophyta, 21 species; Euglenophyta, 13 species; Pyrrophyta, 6 species; Bacillariophyta, 69 species; Chlorophyta, 51 species; Conjugatophyta, 11 species; Cryptophyta, 7 species and Xanthophyta, 1 species. In Tunisia, Solhobji (1992) demonstrated the presence of phytoplankton, which are abundant in number but reduced in species (20 phytoplankton species). During summer, there is an increase in phytoplankton abundance accompanied by a severe reduction in species diversity (6 species). Zaouali (1995) mentioned that in winter, the effects of inflow of river water could be seen from the development of cyanobacteria such as *Oscillatoria* and *Lynghya*.

In Libya, Nuzamuddin (1982) published a list of algae that have been isolated from different water bodies (9 genera, 391 species of Bacillariophyta; 21 genera, 35 species of Chlorophyta; 3 genera, 7 species of Xanthophyta; 2 genera of Pyrrophyta; 20 genera, 26 species of Cyanophyta; and one of each genera and species of Rhodophyta). Most of these algae were also found in our study area. In Egypt, Saad and Abbas (1985b) worked

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on the Nile River and identified 54 genera, of which 7 were Cyanophyta, 16 were Chlorophyta, 33 were Bacillariophyta and 2 were Pyrrophyta. Most of the algae recorded in their research also occurred in our study area.

The abundance of the phyla in our study showed that the Cyanophyta and Chlorophyta were more abundant in the tributary (the River Mina) than in the main river (the River Cheliff) and that Bacillariophyta were more abundant in the river than in the tributary. At the Tafna Watershed (Al-Asadi *et al.* 2005c) found that the Chlorophyta abundance was higher in the River Tafna than in its tributary, the Remshy River, while the Cyanophyta and Bacillariophyta were found to be slightly more dominant in the tributary Remshy River than in the Tafna River. Other investigation on the Habra Watershed (Al-Asadi *et al.* 2005b) found that the Cyanophyta abundance was higher at the Mactaa Canal (the branch canal of Habra Reservoir) than in the Habra Reservoir, while Chlorophyta were more abundant in the reservoir than in the canal.

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