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ECOLOGICAL STUDIES OF THREE WEST ALGERIAN RIVERS: THE RIVER CHELIFF AND ITS TRIBUTARY, THE RIVER MINA

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ABSTRACT

This paper is part of a programme of ecological studies of NW Algeria coast. Monthly samples were taken during 1986-1988 at two sites; Relizan on the River Cheliff, the largest river in Algeria, and Mostaganem, on the River Mina. Water temperatures at River Cheliff were slightly lower than at the River Mina, as the former is more shaded by trees. Current velocity, light intensity, pH electrical conductivity, dissolved Oxygen and Biological Oxygen Demand (BOD) were measured. These parameters showed spatical and temporal changes. The tow sites were well oxygenated. The pH ranges from 6-2-8.2. highest current velocity recorded in march, however lowest light intensity coincided with period of high turbidity in January and March. Other ecological parameters including Dissolved Organic Matter (DOM) Suspended Solids (SS), Total Residue (TR). Fixed Total Desidue (FTR), Volatile Matter (VM), chloride content, Inorganic Nitrogen content and Orthophosphate were also considered. Suspended solids negatively correlated with turbidity. Averages TR, FTR and VM were higher at River cheliff than at Riuermina. Correlation coefficients among ecological parameters studied were calculated.

INTRODUCTION

In west Algerian rivers, few physico-chemical or physiographical data have been recorded previously. Physicochemical investigations in water composition are old, incomplete, and rarely comprehensive (Ville, 1857; Coqquand,1868; Beadle, 1943; Charles, 1947; Gornung, 1953; Arrignon, 1962; Blanc & Conrad, 1968). Recent work was done by Al-Shaheen, 2002. who studied on the physico-chemical of drinking water, Al-Nashi, 2002. and Atte, 2004. studied the heavy metals. Samraoui *et. al.*, 1998.

studied the fauna of coastal wetlands in northeast Algeria. The limnology of Tunisia was studied by Zaouali, 1995. and that of Morocco by Chergui *et. al.,* 1999. Ascherson, 1878, 1879. carried out pioneer work in North Africa, studying Libyan waters during 1873 and 1876. Beguinot, 1914. De Toni & Forti (1914a,b, 1916), Nizamuddin, 1982. and others worked on the same area of north Africa, while El-Nayal, 1935. Abdin, 1947. Saad & Abbas (1984, 1985 a, b) and others worked on Egyptian waters.

Investigations of physical, chemical and biological parameters of rivers are important to give baseline data for further work, and to evaluate the water quality for irrigation, fish culture and potable usage.

The present work was carried out as an initial study of the ecology of three main watersheds in Western Algeria, particularly in the arable lowlands near the Mediterranean Sea. The ecology of the other two rivers and the algal population dynamics of the three rivers will be provided in subsequent papers.

STUDY AREA

Western Algeria comprises a plain extending from the Tassala Mountains in the West to the Dhahra Mountains in the East. This area (Figure 1), is around 1.6 million hectares irrigated by three main water sources: The River Cheliff, the Mactaa (Habra) Reservoir and River Tafna (Ayoun, 1985).

The River Cheliff is the largest river in Algeria, with a flow rate of about 2700 m^3s^{-1}. The largest reservoir built on the river is the Algarib of 280 million m^3 capacity. The river is 700 km long, arising from the Amour Mountains and opening into the sea, passing through different wilayas (countries), including Mostaganim, Relizan, Ain-Aldeffla and Cheliff waylays. This river has several tributaries, including the Rehio, and Mina rivers (Figure 1).

Two sampling stations were selected (Figure1), one (station 1) on the River Mina, a tributary of 50 km long near Relizan Wilaya, and another (station 2) on the River Cheliff itself, above the confluence with the tributary at Ain- Tedles Town (Mostaganem Wilaya), about 20 km from the sea.

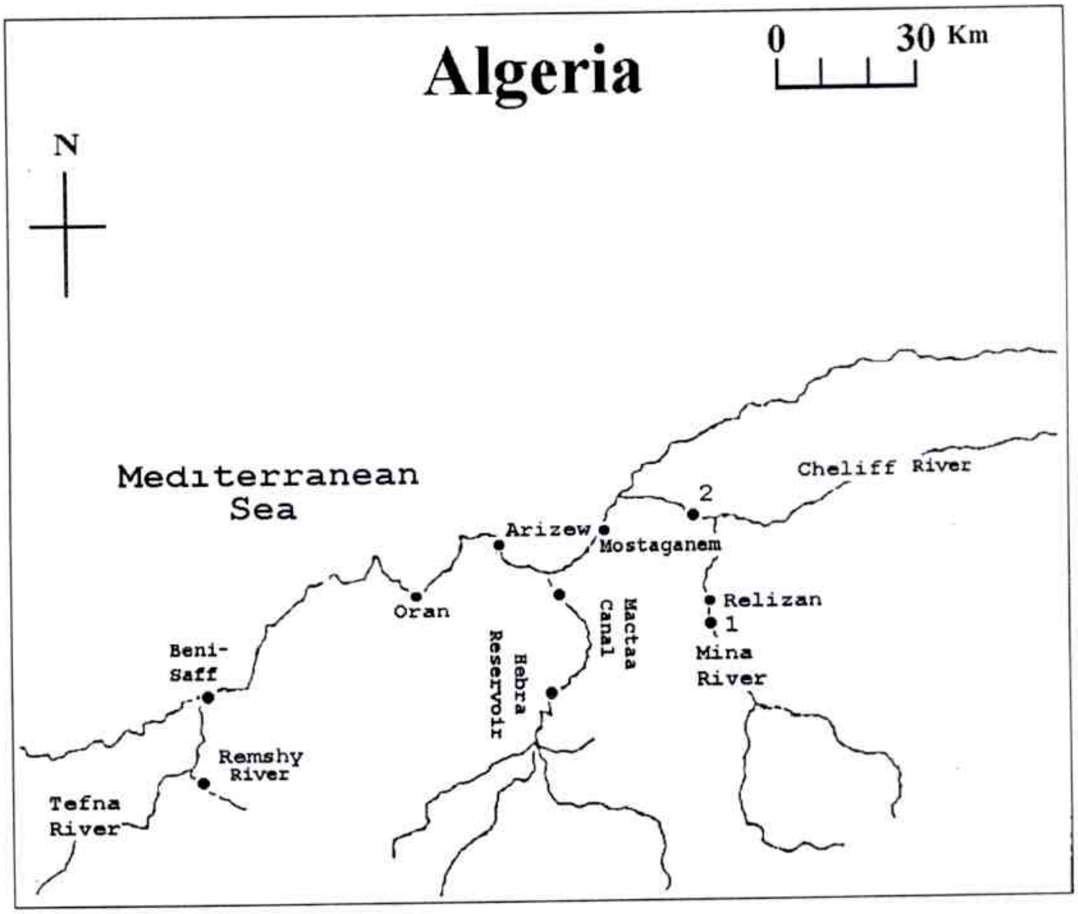

Figure1: Map of the study area on the River Cheliff (2) and its tributary the River Mina (1).

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).

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).

Table (1). Rainfall (mm) Data (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	Temperature	Rainfall	Temperature
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

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.

MATERIALS AND METHODS

Surface water samples were collected at bimonthly intervals, from June 1986 to March 1988. Water collection was carried out at 20cm below the surface to avoid floating matter. Winkler bottles were filled for DO and BOD determinations. Samples for other determinations were kept in well-stoppered polyethylene bottles and immediately treated with 0.5% chloroform, as a preservative (Aberg & Rodhe, 1942), except those for chloride determination.

Air and surface water temperatures were measured *in situ*, using a mercury thermometer, to the nearest 0.1°C. Current velocity was determined with a stop watch by timing a floating cork stopper over a 5-metre distance. Turbidity of water was estimated by the platinum wire method (McLean & Cook, 1946). Light intensity, in full daylight at the water surface, was measured using a SEKONIK model L-418 light meter. EC was determined using a Jenway portable PCMI conductivity-meter and pH was measured using a Pye Unicam PW 9418 pH meter. SS was determined by dry weight estimations and TR, FTR and TM were determined by drying and ignition, according to the APHA (1978).

DO and BOD were estimated according to a modification of the standard Winkler method (APHA, 1971). Percentage saturation of oxygen (OPS) was calculated using the table of Truesdale *et al.* (1955). DOM was determined according to the method described by Golterman & Clymo (1969). Determinations of CO_2 and Bicarbonates were carried out titrimetrically using phenolphthalein and a mixture of methyl red and bromocresol indicators. Alkalinity was measured using methyl orange indicator, according to Golterman & Clymo (1969).

Total, calcium and magnesium Hardness, and chlorides were determined as described in the APHA (1971). Nutrients were determined spectrophotometrically, using the Greiss-Ilosvay method for NO_2-N (Mackereth *et al.*, 1978), sodium azide and phenoldisulphonic acid method for NO_3-N estimation (APHA, 1976), Nessler method for NH_4-N (APHA, 1971), stannous chloride reduction for PO_4-P (APHA, 1971) and SiO_2-Si was determined according to Golterman & Clymo (1969).

RESULTS

Seasonal changes in measured physico-chemical parameters are shown in Figures 2-5.

Water temperatures were closely related to air temperatures. The minimum temperature was recorded (6°C) in January 1987 and maxima (30°C) in July and September 1987. In January 1987, the temperature at station 2 (River Cheliff) was lower than at station 1 (River Mina). Slight differences in temperature occurred between the two stations, with somewhat wider fluctuations at station 2.

Current velocity at station 2 was fluctuated more than at station 1 (peak flows of 42 and 30 cm s^{-1}) in March 1987 and 1988 respectively. River Mina flows was ranged between 13.5 cm s^{-1} in January (1987, 1988) and November 1987 and 17.8 cm s^{-1} in March.

Light intensity varies seasonally at both stations, with minima (2.7w/ m^2) and maxima (48.2 w/ m^2) in March 1987 and October 1986 respectively.

Water turbidity was relatively uniform at station 1 (80-100 mg l^{-1}). At station 2, exceptionally high values were recorded in March 1987 and 1988 (960 and 800 mg l^{-1}, respectively), corresponding to high river flows.
Electrical Conductivity values were generally higher at station 2, the highest values being in June 1986 (4.8 S/cm^2) and May 1987(S/cm^2). The lowest values occurred at Station 1(0.75 S/cm^2) in July and (0.86 S/cm^2) September 1987.

The pH values of the water samples ranged between 6.2 at station 1 in June to 8.2 at station 2 in January 1987 (Figure3).
Generally, the River Cheliff showed greater SS fluctuations, with values up to 702.5 mg l^{-1} in May 1987 whereas, in the River Mina, the maximum value was 24.5 mg l^{-1} in March 1987.

Irregular variations of DO values in the range of 6-12 mg l^{-1} occurred during the study period. In June 1986, a minimum value was recorded at station 1, while a maximum value was recorded at station 2. In general, higher DO values were observed during the cold months and lower ones during the hot months. Oxygen Percentage Saturation showed a trend similar to that of DO, with values mostly close to 100%. BOD values were, in general, very low, between 0.6 and 4.8 mg l^{-1}. The lowest BOD was recorded at station 1 in January 1987, with the highest in May 1987 at station 2. In general, values of BOD were higher at station 2 than at station 1(Figure3).

The values of DOM at station 2 were, generally higher than at Station 1. DOM showed a clear seasonal variation, with the highest values at both Stations (maximum 12 mg l^{-1}) occurring in March1987 and lowest (1mg l^{-1}) in October 1986.

The highest amount of TR was recorded at station 2 (7.3 mg l^{-1}) in March 1987, with the lowest at the same station (1.7 mg l^{-1}) in January 1987. TR values varied relatively little at station 1. A similar pattern is shown at both stations for FTR. Values of VM were generally higher and more variable at station 2 than at station 1. In general, values of TR, FTR and VM were lower at the tributary than at the main river (2.83, 2.33 and 0.6 mg l^{-1} at station 1 and 3.88, 2.63 and 1.26 mg l^{-1} at station 2 for TR, FTR and VM, respectively). In the warm months, values of TR, FTR and VM were higher than in the cold months (Figure4).

The three measures of hardness (total, calcium and magnesium hardness) showed similar patterns, with peal values in March 1987 and 1988 at both stations, these maxima being especially high in the River Mina. Average values of total, calcium and magnesium hardness were greater at station 1 than at station 2 (603, 348 and 275 mg l^{-1} at station 1 and 448, 301 and 146 mg l^{-1} at station 2 respectively).

At both stations, the chloride content ranged between approximately 0.1 and 1gm l^{-1}, with the exception of one value at station 2, of. 2.6gm l^{-1} in May 1987. At station 1, higher values occurred in the months of March and May.

Nitrite-Nitrogen (NO_2-N) values were high in warm months, and average values were similar at both sites (Figure 5).

Ammonia-Nitrogen NH_4-N values were consistently greater at station 2 than at station 1 (average values 5.7 and 0.65 mg l^{-1} respectively).

The minimum values of orthophosphate-phosphorus (PO_4-P) were recorded in October 1986 (0.75 mg l^{-1} and 0.6 mg l^{-1}) at both stations and the maximum (3.8 mg l^{-1}) in July 1987 at station 2 (Figure 5). Average values were higher at station 2 (2.18 mg l^{-1}) than at station 1 (1.72 mg l^{-1}).

Values of Silicate-Silicon (SiO_2-Si) were consistently higher at station 2 (10.5 mg l^{-1}) in March 1987 than at station 1 (2.2 mg l^{-1}) in January 1988. The average values 7.4 and 3.5 mg l^{-1} respectively).

Carbon dioxide and bicarbonate values ranged between 44.8 mg l^{-1} as $CaCO_3$ at station 1 in January and 95.2 mg l^{-1} at station 2 in the same sampling date (January 1987). A maximum value at station 1 was recorded in September 1987, while a minimum value at station 2 was recorded in October 1986. No clear pattern was shown in average values. Total Alkalinity followed the same trend as CO_2 and HCO_3 with maximum values recorded at station 1(River Mina) in March 1987 and minimum in January 1988. The maximum was recorded at station 2 (River Cheliff) in January 1987 and minimum in September 1987 (not shown in Figures).

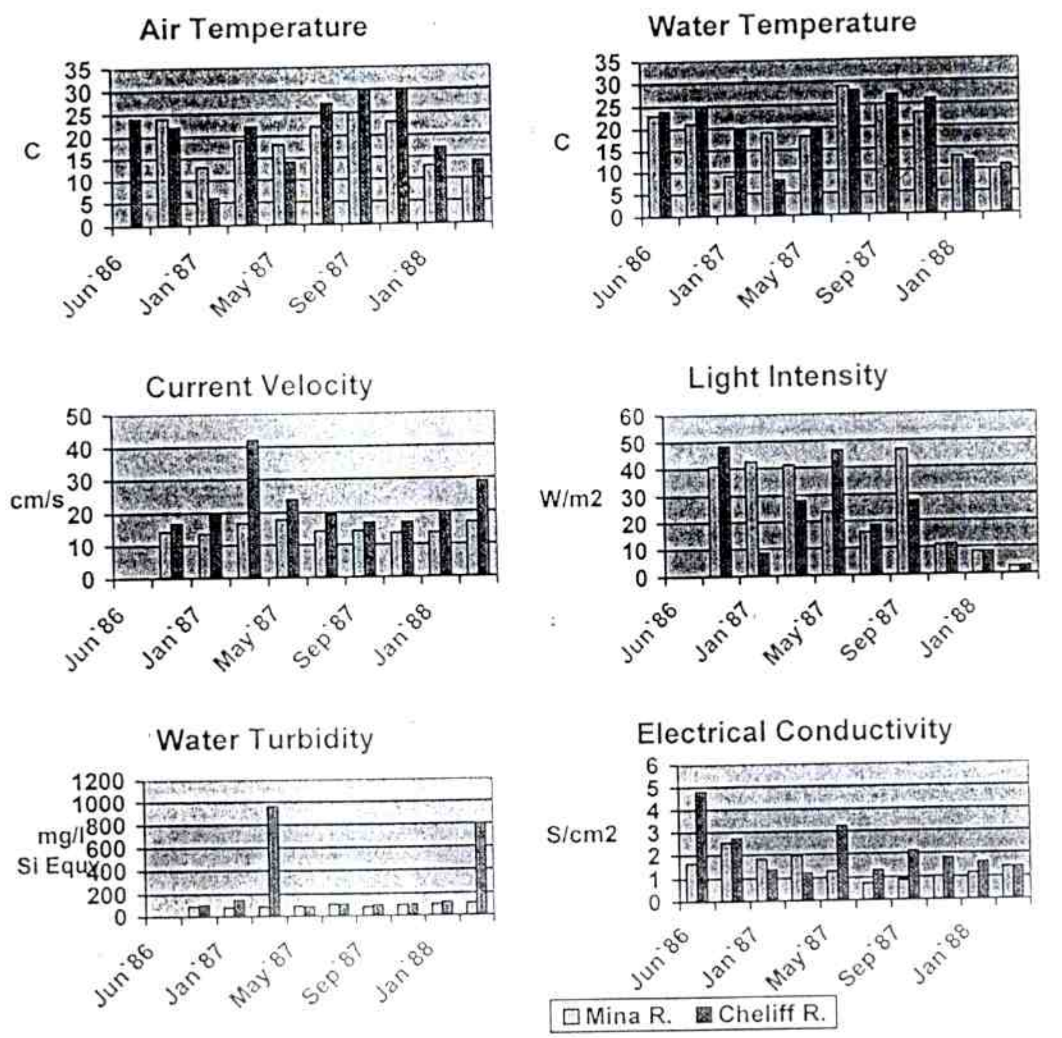

Figure 2: Seasonal variations of physical variables, in the River Cheliff and its Tributary Mina, during the sampling period (1986-1988).

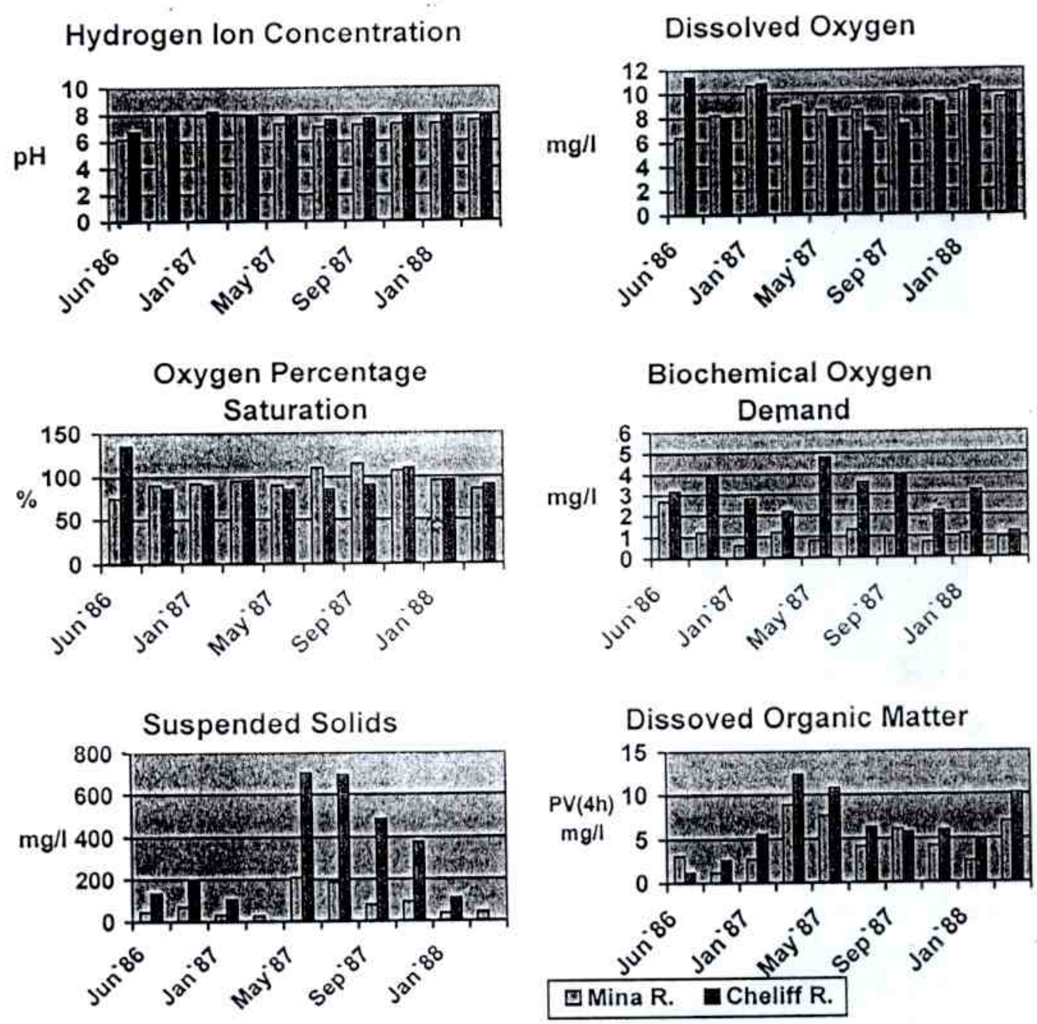

Figure 3: Seasonal variations of physico-chemical variables, in the River Cheliff and its Tributary Mina, during the sampling period (1986-1988).

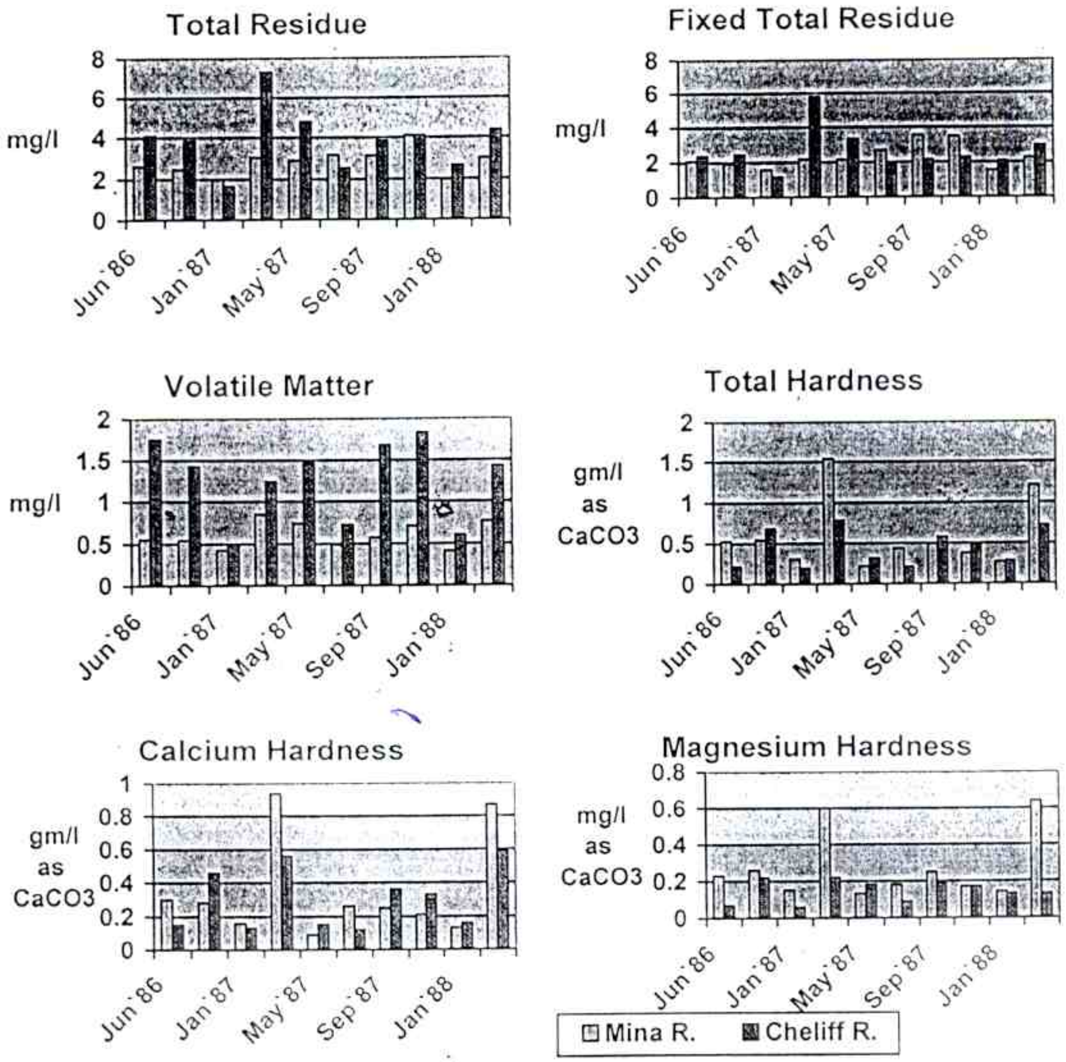

Figure 4: Seasonal variations of chemical variables, in the River Cheliff and its Tributary Mina, during the sampling period (1986-1988).

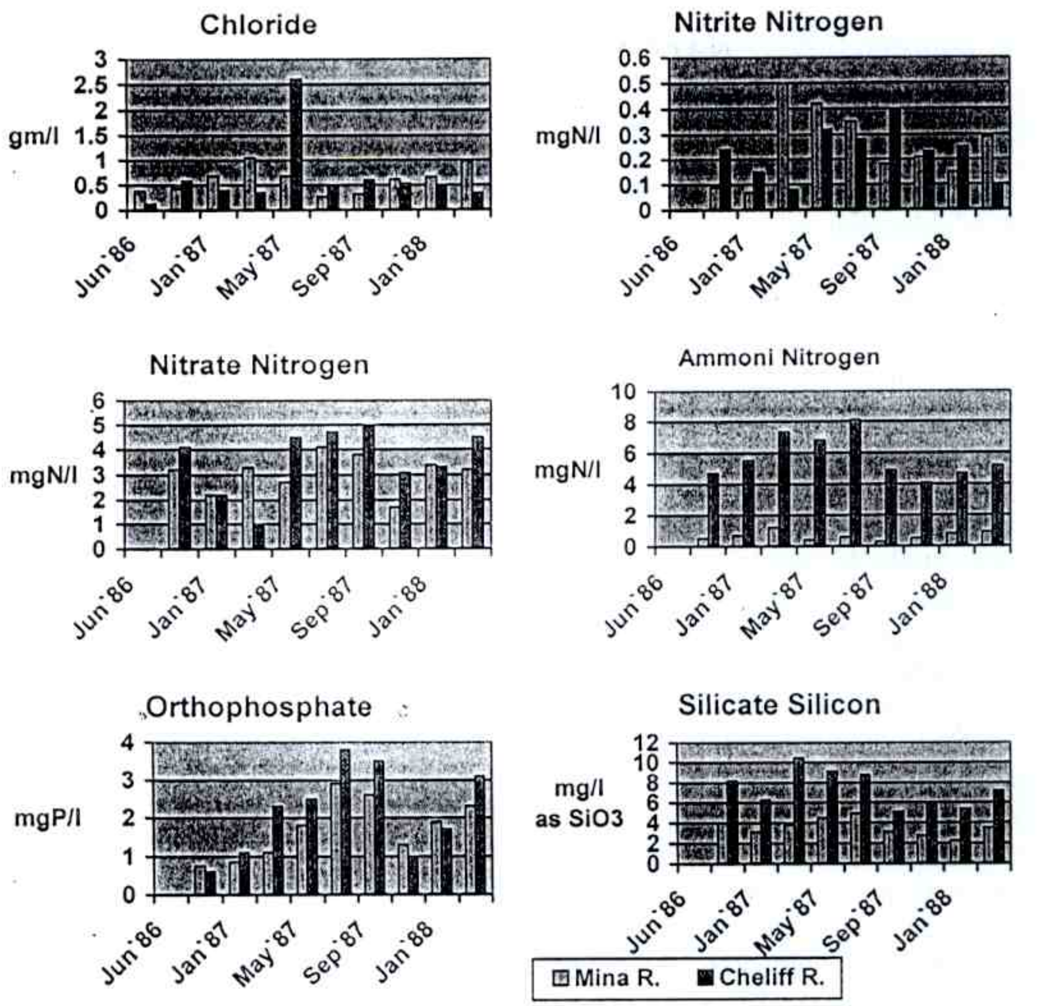

Figure 5: Seasonal variations of chemical variables, in the River Cheliff and its Tributary Mina, during the sampling period (1986-1988).

DISCUSSION

At station 2, Temperature was lower than at station 1, this may have been due to the shaded nature of this station. Such effects are similar to the work of Edington (1966) and El-Sawy (1988) in the UK. Both observed that the waters in the shaded locations were always warmer in winter than the air temperature and cooler in summer, than at the exposed stations on their rivers. A wider fluctuation in temperature at station 2, may have been due to the greater width and depth of the River Cheliff and faster flows. Ravinchandran and Ramaniban (1988) had described such a relationship in their work on the Buckingham canal in India.

In March (1987), the water temperature at the River Cheliff was higher than at the River Mina, possibly due to the higher turbidity, which occurred at that time. The same observations were found with the Mactaa Canal and the Habra Reservoir (Al-Asadi *et al*. 2006) but not with the River Tafna and its Tributary Remshy, northern west Algeria (Al-Asadi, 1991). In this respect, Hussainy (1967), Timms (1970), Antoine and Benson-Evans (1988) and others had suggested that turbid waters are warmer than clearer ones under the same circumstances. The same observation was not found in March 1988 during this study.

The greater fluctuations of velocity and turbidity at the River Cheliff, the largest in Algeria, may be due to variable rainfall in the mountains where this river arises.

Regarding light intensity, there was no clear trend during the first year of investigation, Antoine (1984) and Antoine and Benson-Evans (1988) worked on the River Wye, Wales, U.K. and found that low light intensity occurred in autumn and winter, and high intensities in spring and summer. At Station 2, there is an inverse relationship between the previous parameters (air and water temperatures, water velocity, water turbidity and light intensity) with dissolved oxygen.

In general, the EC at the downstream station on the River Cheliff was greater than in the River Mina. The increase in EC downstream at the river is due to the larger and more varied areas of land that drain into the water (Odum, 1971), and as a result of rock weathering (Kimbadi *et al.* 1999). Conductivity values were higher in hot weather and lower in cold weather, similar to the observations of Ibanez (1998).

During the investigation period, Values for pH were found to be mainly slightly alkaline (within the range 6.2-8.2), which would be expected for natural inland waters and would support a normal flora (Sarker *et. al.*, 1980; Antoine and Al-Saadi, 1982; Esho 1983). There was no clear seasonal trend, and little variation, during the sampling period. This might be due to the fact that the two stations were in low-lying agricultural land. Sreenivasan (1974) explained the pH as a reflection of many chemical and biological processes occurring in natural waters.

Both stations were well oxygenated, with highest DO readings recorded during the winter and lowest during the spring, summer and autumn. Similar observations were found with the River Tafna and its tributary the River Remshy (Al-Asadi, 1991). The highest DO values coincided with periods of high CV and flow. Similar observations were made by Saad & Antoine (1978, 1983); Saad & Abbas (1985a); Esho & Baenson-Evans (1984) in the rivers, Tigris (Iraq), Rossetta branch of the Nile (Egypt) and Ely (Wales), respectively.

High values of BOD, in general, were observed in the warm months and low ones during the cold months, same observation was found at Habra Reservoir and Mactaa Canal northern west Algeria (Al-Asadi *et al.*2006). Gocke & Rhemeimer (1988) worked on the Elbe and Trave Rivers of northern Germany and found the same seasonal variations in BOD. At the River Cheliff site the average values of BOD were higher than at the River Mina, may be due to agricultural activity in the area. This was not the case for the River Tafna and its Tributary the River Remshy (Al-Asadi, 1991).

Clear seasonal fluctuations of DOM were observed at both Stations. Local factors such as changes in phytoplankton abundance, surface runoff, wind action and pollution, may also produce local variations (Saad & Aantoine, 1980, 1983). The maximum values could have been due to allochthonous (Liaw and MacCrimmon, 1977), autochthonous organisms (Fogg, 1958; Nalewajko, 1962) or even due to autolytic processes, especially in March. In this respect, Brehm (1967). and Weinmann (1970) stated that low molecular weight organic substances such as amino acids, monomeric sugars and organic acids can enter directly into the water e.g. as excretion from plankton. Hoppe (1986) considered that an important role is probably played by the enzymatic hydrolysis of high molecular organic compounds by means of heterotrophic microorganisms.

The Average values of DOM at the River Cheliff were higher than at the River Mina. The same was found in the River Tafna and its Tributary the River Remshy, while at the Mactaa Canal, higher values were found than at the Habra Reservoir (Al-Asadi, 1991).

Fluctuations of SS may be due to local conditions such as wind action, and rainfall, as observed by several workers (Antoine 1977; Esho 1983; Saad & Abbas, 1985a) in other rivers. Higher values were recorded at the River Cheliff, which may have been due to a greater range of velocities at this Station. SS values were high in warm months at the two Stations, and this may have been due to the increase in biomass in contrast to results of

Hynes (1970), who stated that most streams and rivers are normally clear at low water. They become turbid during floods when suspended matter may be carried in. Meybeck *et. al.* (1999) worked on the Seine Basin and found no significant trend in total suspended solids (TSS) at the river mouth from 1971-1997. Comparison with a previous daily survey from 1863-1866 showed a marked decrease of average TSS and TSS annual range attributed mostly to locks.

There was a seasonal trend of TR, FTR and VM at the two stations, increasing in values during the warm months and decreasing during the cold months. Antoine (1977), Saad & Abbas (1984) found similar results in the Tigris River, Iraq, and the Rosetta branch of the Nile, Egypt. Higher average values were recorded at the River Cheliff than in the River Mina. Saad (1976) stated that TR and FTR represent mainly the total amounts of suspended matter and dissolved solids, while VM represents the organic matter lost due to the partial decompositions of solids, water of hydration and probably burning of carbonaceous matter (Cushing, 1964). The average values of TR, FTR and VM were greater at The River Chileff than at the River Mina. The same observations were found in the River Tafna and its Tributary the River Remshy (Al-Asadi, 1991) but were not clear with the Habra Reservoir and the Mactaa Canal, (Al-Asadi *et al.* 2006). This may due to the fact that Habra is a reservoir.

Higher values of total, calcium and magnesium hardness were recorded at station 1 (River Mina) than at station 2 (River Cheliff). This contrasted with Antoine & Benson-Evans (1988), who showed a marked downstream increase in total hardness during their studies on the River Wye, Wales, UK. They attributed this to accumulation of calcium and magnesium carbonate from the catchments area. In the present study, most hardness may be due to calcium harness especially at station 2 and this may have been due to the geology of the land. In this respect, Antoine & Al-Saadi (1982) stated that CO_2 which has resulted from the breakdown of organic matter, (both in the water column and the bottom sediments), reacts with both calcium and magnesium carbonate. Munawar (1970) observed that CO_2 reacts more readily with calcium than with magnesium salts and therefore larger quantities of calcium than magnesium are converted into soluble bicarbonate. The average of calcium hardness values was more than those of magnesium hardness values.

In general the chloride content at the two stations was similar. Sharp fluctuations had been observed at Station 1 during January-March-May and at station 2 during March-May-July.

Generally, the inorganic nitrogen values were found to be more at station 2 (the River Cheliff) than at station 1 (the River Mina). There was no decline in amounts of nitrogen sources during the study period. Stanacke *et. al.* (1999) worked on the Gulf of Riga, for a 6-year research programme and showed that the river played a crucial role in the total input of nutrients of the Gulf. It exceeded the contributions from atmosphere, the combined emissions from cities and industries, and nitrogen fixation by organisms. Also, Antoine & Benson-Evans, (1985.a, b, 1988) reported similar temporal fluctuations. In contrast, Park *et. al.* (1970), Hannan *et. al.* (1973), Egborge (1974), Casey & Farr (1982) and others had noted that uptake of nitrate by phytoplankton may lead to its decrease.

There is a marked downstream increase of PO_4-P values in the River Cheliff as illustrated by the values recorded at Station 2 compared with Station 1, which is upstream in the River Mina. This may be the result of input from land drainage and urban runoff. The same results were observed regarding the River Tafna and its tributary, River Remshy, (Al-Asadi, 1991). Several others (Antoine & Benson-Evans, 1988; Antoine, 1987 and Hadi, 1981) reported similar observations in other rivers. Higher values of PO_4-P were recorded in warm months during the study period.

High values of $Si0_2$-Si were recorded in warm months and low in cold months. Higher averages were recorded at the River Cheliff, (7.4 mg 1^{-1}) than at the River Mina, (3.53 mg 1^{-1}). A downstream increase was noted in most rivers in other countries. Antoine & Benson-Evans (1988) showed downstream increases in the silica content of the River Wye, Wales, U.K. They attributed this to the differences in geology of the area, and also to sediments replenishing a part of the silica content of the water as well, together with dissolution of diatom frustules.

Trends in CO_2, HCO_3^- and total älkalinity, were strongly correlated. Average values of CO_2 on the main river (Cheliff) were higher than in the tributary (Mina). The River Cheliff had greater fluctuations in physical factors than did the River Mina and this could explain the differences in CO_2 values as well, since e.g. Norris *et. al.* (1980) reported that free CO_2 is normally controlled by physical factors. They observed a significant temporal variation in free CO2 concentrations during their studies on the south Esk River in Australia. Sarker *et. al.* (1980) and Antoine & Al-Saadi (1982) came to similar conclusions.

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دراسات بيئية لثلاث انهار غرب الجزائر (نهر شلف وروافده ونهر مينا)

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الخلاصة

هذه الدراسة هي جزء من برنامج دراسي بيئي لساحل شمال غرب الجزائر (شمال افريقيا). جمعت عينات شهرية خلال سنتين (1986-1987) حيث تم تعيين محطتين في منطقة شلف. الاولى لنهر شلف الذي يبلغ طوله اكثر من 120 كيلومتر حيث يصب بالبحر الابيض المتوسط والمنطقة المختارة هي قريب من مدينة مستغانم اما المحطة الثانية فهي من احدى الروافد التي ترفد هذا النهر وهو رافد او نهر مينا والمحطة المختارة قريب المصب بعشرين كيلومتر على مقربه من مدينة غليزان. درجات حرارة الجو كانت الصغرى في شهر كانون الثاني والعظمى خلال اشهر تموز- ايلول وحتى تصل الى تشرين الثاني. درجة حرارة نهر شلف اقل من درجة حرارة نهر مينا وذلك لكون الاولى تظللها الاشجار. سرعة جريان الماء في نهر شلف اعلى منه في نهر مينا مع تغيرات متلاحقة خلال شهر مارس وحتى انتهاء موسم الامطار. أقل شدة اضاءة سجلت خلال شهري كانون الثاني ومارس ومتزامنه مع ارتفاع عكرة المياة وزيادة الاجسام العالقة. درجة الاس الهايدروجيني خلال الدراسة يتراوح بين 6.2-8.2 مع ظهور الحد الاعلى سائداً خلال الدراسة. امادرجة التوصيل الكهربائي فهي تتراوح بين($\mu S\ cm^{-2}$) 750- 4800 ولوحظ ان درجة التوصيل الكهربائي في نهر شلف اعلى منه في نهر مينا وذلك لتأثر الاول بالمد والجزر. بالنسبة للاوكسجين الذائب وجد بان المحطتين تتمتعان بدرجة جيدة من الاوكسجين. أقل قيمة لمتطلب الاوكسجين الحيوي المسجلة في شهر كانون الثاني واعلى قيمة في شهري حزيران وتموز. اما قيم المواد العضوية الذائبة فتتراوح بين 1.18 في شهر تشرين الاول و 12.35 في شهر مارس. المواد الصلبة العالقة تكون عالية خلال اشهر الحر وواطئة خلال اشهر البرد ولها علاقة عكسية مع درجة العكورة . بينما معدلات المواد المتطايرة والثابته والكلية في نهر شلف اكثر منه في نهر مينا. تغيرات قوية في محتوى أيون الكلور لكلا النهرين في اوقات مختلفة. محتوى النتروجين اللاعضوي عالي خلال اشهر الصيف وواطئ خلال اشهر الشتاء مع ارتفاع معدلاتها في نهر شلف عنه في نهر مينا. الفوسفات تزداد في اشهر الصيف. شدة الاضاءة لها علاقة عكسية مع كل من التوصيل الكهربائي والاوكسجين المذاب وطلب الاوكسجين الحيوي والمادة العضوية المطلوبة وسرعة الماء. كما سجلت علاقة عكسية للعسرة الكلية وعسرة الكالسيوم والمغنيزيوم مع كل من الكلورين والنتروجين والفوسفات والسيلكات. كما سجلت نفس العلاقة بين الثلاثة الاولى وبين المواد الطيارة والثابته والكلية.