WATER QUARTER QUALITY AND MACROINVERTEBRATES COMMUNITY STRUCTURE ALOND A SAHARAN STREAM: THE SAOURA WADI (ALGERIA)

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ABSTRACT

The aim of this study is to gain a better understanding of water quality and the benthic macrofauna of Saharan stream: Saoura wadi. The longitudinal ecological pattern of large river is often strongly influenced by water pollution and flow regulation. The number of sampled taxa was 44 belonging to different groups, where insect were dominant. The distribution of this fauna depends mainly on the environmental factors, and the originality of its composition depends on the water quality. Species of Macroinvertebrates distribution depend essentially on chemical parameters. Thus the physicochemical parameters in Saoura wadi change mainly according to the periods of the year and to anthropogenic impact. The organic pollution effect impoverishes the oxygen in the medium and leads to lands warping and vivid organisms asphyxia. The substrate nature full of calcium and magnesium does not seem to have a negative impact on the fauna. The high contribution of suspended materials takes part certainly in the progressing silting up phenomena of Saoura Wadi bed.

Keywords: Algiers, benthic macro invertebrates**,** dry climate, water quality.

1. INTRODUCTION

The traditional approach, based on the determination of chemical and physical variables, proved less satisfactory, because of the variability of these measures (both in space and time) and because it offers only a partial outline of the problem. Later more sophisticated methods have been developed based not upon the presence of particular species but on the grouping of taxonomic unit bio-indicator of either pure water or, conversely, with varying degrees of water increasing pollution (GENIN *and al*, 2003).
Many authors have studied the application of biotic indices and their adaptations ZAMORA-MUNOS *and al*, (1995); ALBA-TERCEDOR and SANCHEZ ORTEGA**,** (1988); SOLIMINI *and al.*, (2000); BEISEL *and al* (1998) & (2000). BEISEL *and* USSEGLIO- POLATERA,2003.
This work consists in a study of hydro biological water system of the Saoura located in the westernmost part of the northern Sahara. This is an original work, since no research has been done before hydro biological except that of GAUTHIER (1928) on the fauna of the Algerian Sahara. The purpose of this study is to evaluate the water quality of the Saoura wadi by physicochemical methods, and to compare these

methods with those of biological indices (IBGN, BMWP ') to achieve a biological index adapted to our Algerian rivers.

2. STUDY SITE

The Saoura, endoreic wadi, is located in the extreme western part of the northern Sahara (OZENDA, 1977) at 26 ° 30’ North latitude and 1 ° 29' west longitude. It is in a desert area 240 km far from south of Bechar and more than 1000 km away province of Algiers, it is limited in the North by the Ouakda plain, in the East by the Occidental Grand Erg and in the Southern west by the Mountains of Ougarta (fig.1). The climate is that of the North Western Sahara, it is a desert climate, hot and arid. Summer maximum temperatures exceed 40 ° C. Rainfall is rare, in small quantities and of short duration. Winds are frequent and are the agents of desertification, often charged of particles of sand. Very large floods occur in the basin of the Saoura: The Guir and Zusfana waters gathering causes large floods jutting out southward.

2.1 Choice of stations

The selection of sampling stations is mainly based on the presence or absence of pollution sources that may affect the physicochemical and biological quality of the Saoura Wadi. The physical characteristics of sampling stations (substrates; profundity; throughput; aquatic vegetation, Heterogeneity of the facieses …etc) are also important factors to consider in all studies aiming at comparing the stations to each other. Six sampling stations were surveyed on four seasons of the years 2007, 2008, 2009. These stations are spread over a 213km distance upstream (Igli station) to downstream (Kerzaz station) of the Saoura Wadi.

3. MATERIALS AND METHOD

3.1. Physicochemical parameters:

To assess the spatiotemporal evolution of water physicochemical parameters, water samples in different sampling stations of the Saoura Wadi have been collected. The samples are kept in the dark at a temperature of 4° C in coolers. Dissolved oxygen (mg/l), the potential hydrogen, the water temperature (°C), salinity (p/1000), conductivity (µs/cm), and redox potential were measured in situ using a field multi-analyzer of W.T.W MULTI 340/SET type. The other parameters: Nitrites, nitrates, phosphorus, chloride, calcium, magnesium, sulphates, carbonates and suspended matters were dosed at the laboratory.

3.2. Biological Study:

Samples of benthic macroinvertebrates were collected using a standard Surber net (mesh size 250 µm, surface sampled 0.20 m2). For the same station, the benthic fauna sampling consists of eight sampling sites in different microbiotopes. Samples were

sorted and fixed using 5% formaldehyde. In the laboratory, all invertebrates were sorted and identified using the identification keys: TACHET and al, (2006), Jacobsen (2008),Vincon and Clergue-Gazeau (1993).

3.3. Assessment of water quality indices by biological methods

To assess the biological quality of the Saoura, we proceed to the use of two indices: the Standardized Global Biological Index (IBGN) and the Biological Monitoring Working Party (BMWP ') scoring System.

3.3.1. Normalized Global Biological Index (IBGN):

The principle is based on the collection of benthic macro fauna at a station, according to a standardized sampling method taking into account different types of habitats. Eight samples taken separately in eight distinct habitats by seeking a maximum representativeness. Stands of macro-invertebrates are identified and provide guidance on environmental quality by the presence or absence of faunal groups indicators. These were selected based on their sensitivity to pollution, both organic and physicochemical as well as any natural or artificial disturbance of the environment (AFNOR, 2004).

3.3.2. Biological Monitoring Working Party (BMWP ') Scoring System

The method of BMWP 'depends on the achievement of eight samples of benthic macrofauna in 8 distinct habitats at the same station, according to a standardized sampling method taking into account different types of habitats. The BMWP is a new approach to the original method (BMWP). These changes included the addition of new families (ALBA TERCEDORE, 2000). This method is a qualitative aspect, it assigns scores between 1 and 10 to families of macroinvertebrates grouped according to tolerances equivalent to pollution, so that the organisms most polluo-tolerant have the lowest score. The total score of a site is obtained by adding scores assigned to different taxa indicators (BEISEL & USSEGLIO-POLATERA, 2003).

4. RESUTTS AND DISCUSSION

4-1-Physical-chemical analysis

Seasonal variations were observed for all physicochemical parameters measured in the waters of the Saoura Wadi.

The temperature of the water increases at month of March, April and February with a maximum of 31°C at the level of the station of Guerzim, this station is subject to the straightforward exposure of the solar radiations. The minimum of 9.9°C is gotten in the morning at the level of the station of Beni Abbes in December (Tab.1).

4-1-1- Parameters related to acidification -alkalinity:

The pH values measured in the sampling stations fluctuate between 8 at station Guerzim and 9, 66 at the station Kerzaz, these values correspond to a moderate to high alkalinity.

4-1-2- Parameters related to mineralization

In the majority of stations can be seen that the mineralization is very high it is related to the nature of limestone and marl land in the watershed. Maximum values were recorded during the month of April in the station Kerzaz (7620us/ cm.).

Salinity values show the existence of an increasing gradient from upstream to downstream they vary between 0,96 p/1000a s minimum values at the station by Guerzim against the highest value was obtained at the station with 4,2 p/1000 live Kerzaz.

4-1 3-Parameters related to oxidizable matter

The dissolved oxygen levels vary depending on various factors including temperature, organic load and biological activity. During the December and February samples of high floods cause an increase in the load of suspended solids on all stations and contribute to their lack of dissolved oxygen. We also note a value of 6, 81 mg /1 in the station of Beni Abbes in March and the value of 6, 3 mg /1 in the resort of El Ouata which are due to low flow rates and effluent from villages of the same name.

4-1 4-Parameters related to particulate matter

The difference in concentration of suspended solids is very marked between the different sampling periods whereas the values do not vary much between stations. The peaks are reached in the months of December 2008, February 2009, in April 2009 with a maximum at the station Igli (1600 mg /1) receiving the floodwaters of the river Guir main tributary of the river Saoura.

4-1 5-Parameters related to Nitrogenous and phosphorus

The maximum recorded nitrate is 2.2 mg /1 in March at the station Kerzaz due to the low water period and the urban waste of the city of the same name. The lowest concentrations were recorded during the summer flood with a minimum of 0.02 mg /1 at Guerzim.

For nitrite-significant pollution was recorded in the month of April at the stations: El Ouata, Beni Abbes, Igli respectively 0.124 mg /l, 0.154 mg /1, 0.156 mg /1, and a maximum of 0, 4 mg /1 is recorded at the station at El Ouata in December.

-Note that the majority of stations have low phosphorus levels (<1 mg /l). Noting, however, a unique peak in the month of December with a value of 2.38 mg/1.

4.2. Repartition spatial and temporal of the benthic macro-invertebrates:

The taxonomic richness found in each of our stations during the sampling performed has allowed to identify 44 systematic units that are families, genus and species. Insects with 98% represent the majority of taxa collected. Diptera predominate with 71.19%, followed by Ephemeroptera with 19.79%, and Coleoptera with 5.26%, Trichoptera with 0.92%. The Heteroptera group is poorly represented, with only 0, 67%, and Odonata with 0, 15%.

The Ephemeroptera group is represented by two families: Baetidae, and Caenidae.

Trichoptera are represented by the Hydropsychidae and Phylopotamidae family. The Diptera takes up the greater part of all the insects collected. They are represented by: Chironomidae, Culcidae, Simulidae, Ceratopogonidea, Ephydridae, Ptychopteridae, Stratiomydae, Dolichopodidae, Tipulidae, Dixidae, Chaoboridae, Empididae, Tabanidea.
In the Saoura Wadi, Coleoptera are quite frequent and quite abundant. They are mainly represented by Elmidae, Hydraenidae, Helodidae, Dytiscidae, Haliplidae, and Hyrophilidae families.

4.3-biotic indices

4.3.1-Results obtained from the IBGN

The values obtained for the IBGN for most samples (Tab. 2) show a very poor quality. This is due to the nature of the indicator group that does not exceed the value of 8, represented by the dominance of Chironomidae larvae.
Upstream of the river (station Igli), we see a rise in the value of IBGN (IBGN =11), which describes the water of the river Saoura is of average quality. In fact, this station has a very sharp increase in taxonomic diversity marked by the installation of new faunal groups: Hydropsychidae, Simulidae.

4.3.2. Results obtained from the B.M.W.P ':

The values obtained for the BMWP 'for most samples show a very poor quality of water in most stations, with a rate equivalent to the upstream and downstream. Values typically change between 2 and 49 showing that the quality of water is heavily polluted.
We sometimes see an improvement in water quality mainly in the upper reaches of the river (station Igli) this is due to the appearance of the family Aphelocheridae which has a higher score.

5. DISCUSSION

5-1-Analyse physico-chimique
5-1-Physical-chemical analysis

The physicochemical characteristics of the Saoura waters vary substantially depending on the nature of the geological substrate of human impact and the time of year.
The temperature measurements were taken at various time of day. A daily thermal profile may be superimposed on the longitudinal temperature profile. The water temperature tends to reach equilibrium with the temperature of the environment.
The pH values measured in the sampling stations show a moderate to high alkalinity, which according to (PARINET *et al*, 2000); these values can be attributed to the calcareous nature of the area of study.

The most significant concentrations of dissolved oxygen level of the Saoura river are minimum values that are typically encountered in winter (Low flow with view to the aridity of the region). In December and February heavy floods cause an increase in the load of suspended solids on all stations and contribute to their lack of dissolved oxygen ALHOU (2007).
Salinity shows an increasing gradient from upstream to downstream, according MULHAUSER and MONNIER (1995) the high concentrations of salts are dependent on the geology of the watershed.
Water is extremely mineralized, the levels of Ca^{2+}, Mg^{2+}, sulfates, chlorides are higher than normal, and it is a natural situation in relation to the nature of the substrate surface and leaching during heavy rain RODIER (1996). These high levels do not seem to have an adverse effect on wildlife. The values are generally low nitrite not exceeding 0.5 mg /1. A maximum of 2.2 mg /1 nitrate was recorded in March at the station Kerzaz; this is due to release of the city during the period of low water. According to LIECHTI et al (2004), nitrate concentrations greater than 1 mg /1 explain an intensive agricultural use of soils, fertilizer or excessive intake of major sewage spills. The lowest concentrations were recorded during the summer flood with a minimum of 0.02 mg /1 at Guerzim. For phosphorus we can see that most stations have low phosphorus levels (<1 mg / l).Noting, however, a single peak in December with a value of 2.38 mg /1 which explains the high concentration of phosphorus was rejected by sewage from the city of El Ouata at the station of the same name.

5.2. Benthic macroinvertebrates:

Disturbances in the composition of fauna are important. Many low-resistance groups tend to disappear while other indices that are heavily loaded with organic matter (polluoresistants) grow strongly. In Saoura the substrate is quite varied along the longitudinal profile but very little diversity within a station.
The upper river is characterized by a medium to fast flow, a dense riparian forest and a varied substrate. These features allow the installation of different faunal groups such as Trichoptera, Diptera Simulidae and the Ephemeroptera (WAGNER *and al*, 2000). Going towards the downstream part of the substrate becomes increasingly homogeneous as a result of heavy flooding where the variation of flow is of great intensity on the specific richness of the different stations. A high proportion of Chironomidae taxa considered tolerant to disturbances (BARBOUR *et al*, 1999), is usually a sign of ill health of a stream. The Chironomidae colonizing the upstream and downstream of the rivers of the Saoura, the species that are found in sewage Igli, Beni Abbes, El Ouata, Guerzim are different from those that colonize Kerzaz stations and Beni Ikhlef, NEVEU (1974) reported that species of Chironomidae change depending on the environment. Upstream, are found in cold-water species, very rheophilic, whereas downstream, are found in warmer and quiet water species.
A low diversity can be achieved during periods of flooding at all stations because there disappearance of benthic macrofauna (BADRI *and al.*, 1987 ; GAYRAUD, 2001). After the flood are the stations Guerzim, Beni Ikhlef and Kerzaz that have the highest taxonomic richness this is due to the training of species by the current to the lower river.

5.3.3. Sensitivity of two-indices

The evolution of the BMWP 'and IBGN along the longitudinal profile of the Saoura river, estimated from the same results fauna is very similar. Generally the two indices move in the same way in a station, the highest degradation index values correspond to low and vice versa. Generally the two indices change with the variety of different sampling stations. The BMWP runs parallel with IBGN, the exception of high index values, it seems that the BMWP' is more sensitive than IBGN; This is related to the fact that the BMWP ', by its principle of calculation, followclosely the evolution of taxonomic richness when the IBGN neglected the number of species (family Aphelocheridae), besides it neglects the presence of some families strongly represented in the Saoura as Simulidae and larvae of Another family of Diptera. The adaptation of these indices to other Algerian regions so as to arrive at the creation of a standardized index allow better characterize the state of degradation of a stream. Therefore we can conclude that the BMWP' is better suited to the watercourse of the Saoura and the index of IBGN but with some adaptation in their principle of this is calculated by adding a number of family well represented in our Algerian waterways

Illustrations:

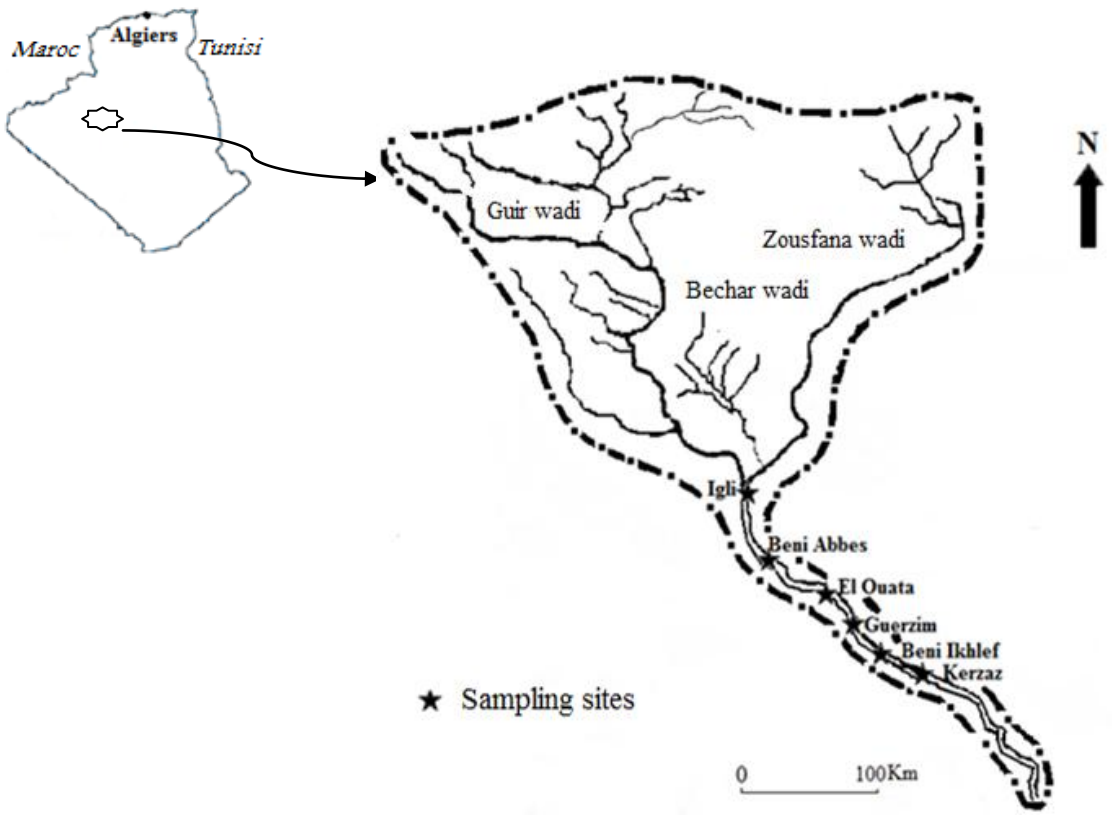

Fig.1. location of the sampling sites along the Saoura wadi basin

Table.2. Spatiotemporal evolution of water physicochemical parameters of Saoura wadi. T : water temperature, pH : Potential hydrogen, O2 : dissolved oxygen, SM: suspended matters, V : current velocity, Ca^{2+}: calcium, Mg^{2+} : Magnesium, Cl^{-2} : Chloride, HCO3-: Carbonates, $SO4^{-2}$: Sulfates, $NO3^{-}$: Nitrates, NO2-: Nitrites, $PO4^{-3}$: phosphorus, IG : Igli, BA : Beni Abbes, EO : El Ouata, G : Guérzim, BI : Béni Ikhlef, K : Kerzaz.

Date	Sites	T (°c)	pH	O2 (mg/l)	SM (mg/l)	V m/s	Ca+2 (mg/)	Mg+2 (mg/l)	Cl-2 (mg/l)	HCO3- (mg/l)	SO4-- (mg/l)	NO3- (mg/l)	NO2- (mg/l)	PO4--- (mg/l)
March 2007	**IG**	24	8.1	8.1	0.022	1	199.3	230.1	340.8	0.052	0.18	0.421	0.095	0,89
	BA	26.1	8.22	6.87	0.014	0.5	160.3	241.3	347.9	0.71	0.31	0.15	0.107	0.71
	EO	25	8.1	8.8	0.012	0.5	240.4	125.6	348	0.69	0.31	1.123	0.068	0.69
	G	19.1	8.1	9.18	0.002	0.15	130.2	121.2	347.9	0.015	0.79	0.374	0.058	0.68
	B I	18	9.05	11.4	0.002	0.3	248.1	332.9	347	0.015	0.06	0.3	0.057	0.54
	K 1	18	9.05	11.9	0.012	0.3	242.3	351.5	347	0.015	0.05	2.24	0.098	0.65
January 2008	**IG**	15	8.5	6.5	0.79	1	208.41	229.39	656.7	0.27	0.35	0.11	0.09	0.87
	BA	17.6	8.5	7.3	0.82	0.5	296.6	236.19	568	0.18	0.10	0.059	0.13	0.45
	EO	15.3	8.6	6.3	0.8	0.5	265.3	238.5	445	0.21	0.25	0.12	0.1	0.41
	G	15	8.5	7	0.8	0.5	376.52	195.37	497	0.21	0.28	0.059	0.091	0.34
	BI	13.3	8.4	7.1	0.79	0.35	200.4	260.01	497	0.18	0.1	0.09	0.092	0.23
	K2	10.5	8.4	7.6	0.8	0.32	232.42	201.69	585	0.108	0.11	0.08	0.091	0.65
June 2008	**IG**	**Dry**												
	BA													
	EO													
	G													
	BI													
	K3													
October 2008	**IG**	**Flood**												
	BA													
	EO													
	G													
	BI													
	K4													
December 2008	**IG**	12,9	8.91	8.2	1.6	2.8	105.81	126.36	710	0.093	0.73	0.274	0.025	0.28
	BA	9.9	8.7	9.5	1.08	1.5	100.2	142.39	837.8	0.127	0.61	0.262	0.027	0.048
	EO	16.3	8.55	8.2	0.62	2	115.2	165.24	972.7	0.09	0.79	0.257	0.43	2.38
	G	19.3	7.73	8.3	0.77	2.5	134.66	185.16	1050	0.07	0.8	0.265	0.063	0.048
	BI	21	8.5	8.1	0.97	2.1	140.5	175.8	1050	0.065	0.67	/	0.04	0.027
	K5	19.5	8.6	7.8	1.21	1.7	168.33	191.97	1136	0.096	0.71	0.342	0.009	0.048
February 2009	**IG**	20	8.86	7.24	1.2	3	113.82	175.78	560.9	0.05	0.34	0.604	0.006	0.99
	BA	18	8.95	8.38	0.74	1.3	110.62	121.5	532.5	0.04	0.58	0.401	0.022	0.421
	EO	16.5	8.8	8.7	1.28	1.6	105.81	204.12	646	0.03	0.395	0.473	0.005	0.62
	G	15.2	8.84	8.99	0.81	1.8	102.6	176.41	561	0.033	0.36	0.36	0.005	0.287
	BI	14.2	9.26	8.29	0.512	2.4	115.43	191	560.9	0.031	0.613	0.339	0.009	0.215
	K6	13.6	8.81	8.37	0.75	2.2	117.83	164.75	561	0.072	0.32	0.359	0.02	0.83
April 2009	**IG**	28,2	8.82	5.99	0.9	1.5	216.4	330.4	1377.4	0.03	1.13	0.165	0.156	0.334
	BA	27.5	8.75	6.81	1.04	1.8	188.3	341.17	1562	0.03	0.959	0.137	0.154	0.334
	EO	30	8.78	7.7	1.01	1.8	240.4	325.6	1668.5	0.33	1.08	0.099	0.124	0.26
	G	31	9.37	8.81	0.89	1	120.2	121.5	2016.4	0.022	0.62	0.023	0.056	0.175
	BI	27	8.74	8	0.85	2.4	308.6	349.92	2016	0.37	1.36	0.099	0.091	0.175
	K7	23.6	8.7	7.04	0.9	1.5	242.4	381.51	1810.5	0.357	0.49	0.071	0.079	0.045

Tableau 2: Variation of the indices BMWP'& IBGN according to the sampling stations and the Saoura river. Sampling 1: March 2007, Sampling 2: January 2008, Sampling 3 : December 2008, Sampling 4: February 2009, Sampling 5: April 2009.

Stations	Samplings	BMWP'	IBGN
Igli	Sampling 1	5	5
	Sampling 2	39	11
	Sampling 3	3	2
	Sampling 4	22	7
	Sampling 5	44	13
Beni Abbes	Sampling 1	18	6
	Sampling 2	24	8
	Sampling 3	0	1
	Sampling 4	12	5
	Sampling 5	12	4
El ouata	Sampling 1	23	8
	Sampling 2	0	5
	Sampling 3	0	0
	Sampling 4	22	7
	Sampling 5	25	7
Guerzim	Sampling 1	8	3
	Sampling 2	19	7
	Sampling 3	0	0
	Sampling 4	50	14
	Sampling 5	9	3
Beni Ikhlef	Sampling 1	16	5
	Sampling 2	25	9
	Sampling 3	0	0
	Sampling 4	30	9
	Sampling 5	26	7
Kerzaz	Sampling 1	27	8
	Sampling 2	30	8
	Sampling 3	12	3
	Sampling 4	37	9
	Sampling 5	16	5

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