

Diatom inventory of Oued Rhiou (tributary of Oued Chelif) and Oued El Malah (tributary of Oued Tafna), north-western Algeria

Bouchra Bezzeghoud, Bouhameur Mansour, Abdelouahb Sidi yakoub

Abstract- The identification of the nature and composition of diatom populations from two Oueds was undertaken to elaborate the diatom database for developing 'diatom indices' and a reliable assessment of the biological quality of these rivers. Two rivers (Oued Rhiou and Oued El Malah), located in north-western Algeria within the two watersheds, respectively Bas Chelif basin and Tafna basin, were studied.

The diatom inventory identified 66 species and varieties from 23 genera including 3 with open nomenclature. The Pennatophycidae are systematically most represented, comprising 64 species, while Centrophycide were represented by only two species. Oued Rhiou sampling location was dominated by the genus *Diatoma* (42.4 %), while the genus *Nitzschia* was frequent (17.5 %). However, the Oued El Malah sampling location was characterised by the predominance of *Nitzschia* (63.9 %) and *Navicula* (18.3 %).

The predominance of *Diatoma* and *Nitzschia* in the studied rivers showed an imbalance in the diatom composition. This is caused by the difference in ecological condition required or preferred by each of the species and variety collected.

Keywords - diatomic inventory; diatom indice; Oued Rhiou; Oued El Malah; north-western Algeria

Résumé-La présente étude a pour objet l'acquisition d'information sur la nature et la composition des peuplements diatomitiques de deux Oueds afin d'élaborer une banque de données des communautés diatomiques, pour développer des indices diatomiques et une évaluation fiable de la qualité biologique de ces cours d'eau.

Les stations analysées sont situées au Nord-Ouest de l'Algérie, plus précisément sur deux Oueds (l'Oued Rhiou et l'Oued El Malah). Ces derniers se situent sur deux bassins versants, respectivement le bassin du Bas Chélif et le bassin de la Tafna.

L'inventaire microfloristique a permis d'inventorier 66 espèces et variétés réparties en 23 genres dont trois en nomenclature ouverte. Les Pennatophycidées sont systématiquement les plus représentées, regroupant 64 espèces tandis que les Centrophycidées ne sont représentés que par deux espèces.

En outre, les stations de l'Oued Rhiou sont prédominées par le genre *Diatoma* (42.4 %) tandis que le genre *Nitzschia* est fréquent (17.5 %). Quand aux stations de l'Oued El Malah, elles se caractérisent par la prédominance du genre *Nitzschia* avec 63.9 % et la fréquence du genre *Navicula* (18.3 %).

La prédominance de ces deux taxons (*Diatoma* et *Nitzschia*) dans la structure spécifique des milieux prospectés, respectivement dans l'Oued Rhiou et l'Oued El Malah par rapport aux autres taxons inventoriés montre un déséquilibre dans la composition diatomique. Ceci est causé par la différence des conditions écologiques exigées par chacune des espèces et variétés.

Mots clés : inventaire diatomique ; indice diatomique ; Oued Rhiou ; Oued El Malah ; Nord-Ouest de l Algérie

1 INTRODUCTION

With the aim of diagnosing the physico-chemical quality of aquatic ecosystems, biological methods (such as diatom-based monitorings among others) can be used to assess the ecological integrity of Algerian waters.

Epilithic diatoms present a large variety of species showing different tolerances to pollution. The epilithic communities of two rivers, Oued Rhiou (tributary of Oued Chélif) and Oued El Malah (tributary of Oued Tafna) were studied with the aim of evaluating river water quality.

This preliminary study of epilithic diatom communities was undertaken to provide a first overview of their systematic structure with the aim of using diatom-based indices in the future to assess ecological integrity of Algerian watercourses.

2 MATERIALS AND METHODS

The study was conducted in two rivers (Oued Rhiou and Oued El Malah). These rivers are located in northwest Algeria (Figure 1). Oued Rhiou is located approximately 180 km east of the city of Oran and Oued El Malah, approximately 65 Km west of the city of Oran.

These rivers (Oued Rhiou and Oued El Malah) belong to two different watersheds, respectively Bas Chelif basin and Tafna basin.

The method used in this study is the one adopted by Cemagref (AFNOR 2000) and Prygiel et al. 2000.

The choice of stations was particularly very difficult, because most Oueds in Algeria do not have permanent flow throughout the year. However the oueds (Oued Rhiou and

Oued El Malah) are characterized by permanent flow

throughout the year.

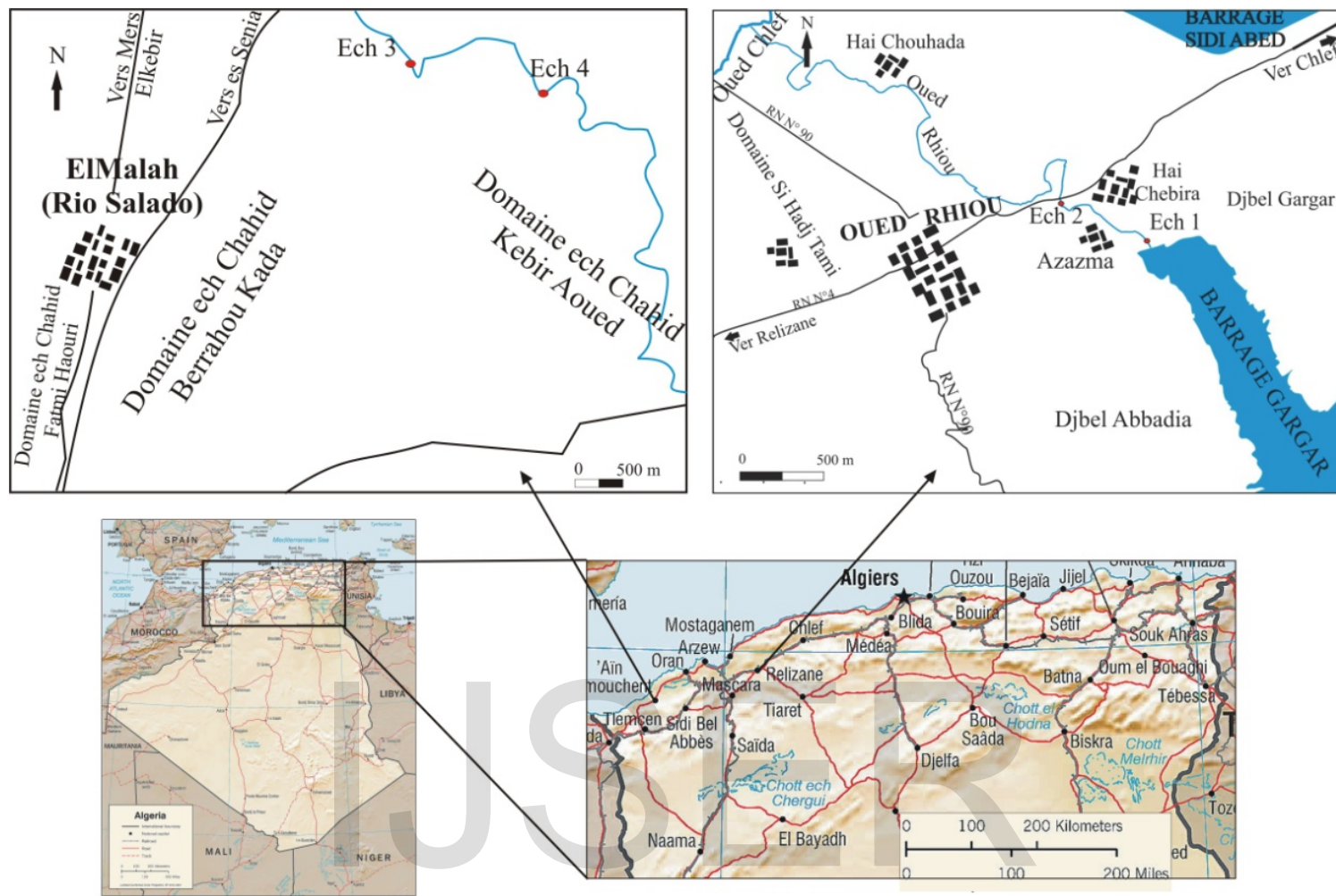


Figure. 1. Map showing the location of study area (Oued Rhiou and Oued El Malah).

2.1 Sampling

Two periods of sampling were retained, November, 2013 in Oued El Malah and May, 2014 in Oued Rhiou.

A total of four stations were sampled. The European standard methodology was respected for the harvest and the treatment of samples as well as for the preparation of slides and in the counts.

2.2 Choice of the site

The upper surface of one or several stones immersed in a fast current was brushed with a nylon toothbrush over a surface of about 200 cm². The residue was collected in a 250 ml flask.

2.3 Physico-chemical parameters

The parameters as temperature, pH and conductivity were measured in situ.

2.4 Preservation of the sample

The diatom samples were preserved on site using 10 % formalin, in the laboratory.

2.5 Analysis in the laboratory

Sample were treated with hydrogen peroxide (H₂O₂) and with hydrochloric acid (HCl) for the elimination of the organic matter and the carbonates;

The determination and the counting of 400 Diatoms in the microscope the most recent works of Süßwasserflora (Krammer and Lange-Bertalot 1986, 1988, 1991a, 1991b) and (Lange- Bertalot et al. 2004) were used;

The results and systematic are adopted from the one proposed by (Round et al. 1990) and (Rimet et al. 2007).

3 RESULTS AND DISCUSSION

The diatom inventory identified 66 species and varieties from 23 genera including three in open nomenclature (Table 1).

The Pennatophycidae are systematically most represented, comprising 64 species, while Centrophycidae were represented by only two species.

The stations of Oued Rhiou had dominated by the genus *Diatoma* (42.4 %), while the genus *Nitzschia* was frequent (17.5 %). However, the stations of the Oued El Malah were characterised by the predominance *Nitzschia* (63.9 %) and the frequency of the genera *Navicula* (18.3 %).

The diatom population of Oued Rhiou had characterised by species more tolerant to pollution such as: *Navicula veneta* (3.1 %), *Nitzschia communis* (2.3 %), *Nitzschia umbonata* (0.2 %) and *Ulnaria ulna* (0.8 %), while the species more sensible were frequents as: *Achnantheidium minutissimum* (1.5 %), *Cymbella prostrata* (2.5 %) and *Nitzschia linearis* (1.9 %). However the composition of the diatom community of Oued El Malah was dominated by the most sensitive species to pollution as: *Nitzschia fonticola* (34.4 %) and *Gomphonema augur* (3.8 %), while the species more tolerant to pollution such as: *Mayamea permitis* (6.9 %), *Nitzschia palea* (6.3 %), *Nitzschia umbonata* (4.4 %), *Nitzschia capitellata* (1.9 %), *Navicula veneta* (0.1 %), and *Amphora veneta* (0.1 %), were frequent. The presence of species more tolerant to pollution in the two rivers (Oued Rhiou and Oued El Malah) showed that the water is characterized by the pollution organic. This pollution is caused by anthropogenic factors like agricultural activities and livestock grazing.

The results of diatom inventory (with OMNIDIA codes) were compared with those of European indices (Lecointe et al. 1993) and (Van dam et al. 1994): the diversity Index (Shannon and Weaver), the Specific Pollution Index (IPS) and the Biological Diatom Index (IBD).

The analyses indicate an important diversity (1.78 and 3.9) at stations of Oued Rhiou (station 1 and station 2) and (2.53 and 3) at stations of Oued El Malah (station 3 and station 4). The number of the species was (16 and 29) at stations of Oued Rhiou and (8 and 14) at stations of Oued El Malah. The number of genera was (11 and 14) at stations of Oued Rhiou and (4 and 8) at Oued El Malah.

IBD values showed that the stations of Oued Rhiou (12.9 and 11.9) and Oued El Malah (9.7 and 11.3) are characterised by an intermediate water quality.

The analyses of the physico-chemical data of the Oued Rhiou and Oued El Malah are given. The main characteristics can be summarized as follows:

The water temperature values ranged between (27 °C and 26.7 °C) at stations of Oued Rhiou (station 1 and station 2) and (25.2 °C and 26.8 °C) at stations of Oued El Malah (station 3 and station 4). Highly coincided with the surrounding air temperature variation in water temperature related to many environmental factors as water flow, water depth, bottom material, temperature of inlet water and exposure to direction light and degree of shading.

The highest conductivity values were observed at Oued Rhiou, (6360 $\mu\text{S cm}^{-1}$) at (Station 1) and (5350 $\mu\text{S cm}^{-1}$) at (Station 2). The conductivity was minimal at Oued El Malah, (4600 $\mu\text{S cm}^{-1}$) at (Station 3) and (4560 $\mu\text{S cm}^{-1}$) at (Station 4). Those values are Highly coincided with the water temperature.

The pH value became more alkaline from the Oued Rhiou. Its mean values ranged between 6.9 in (station 1) and 8.1 in (station 2). However, the Oued El Malah were characterised by alkaline value, ranged between 7.62 in (station 3) and 7.77 in (station 4). The alkaline value at the rivers (Oued Rhiou and Oued El Malah) shows the evaporation of the water and the high temperature.

Oued Rhiou was characterized by slight salinity and alkaline content and was occupied by species like: *Achnantheidium minutissimum* (1.5 %), *Cyclotella memeghiniana* (0.8 %), *Cymbella prostrata* (2.5 %), *Diploneis oblongella* (0.1 %), *Diatoma tenuis* (41.9 %), *Melosira varians* (0.1 %), *Navicula veneta* (3.1 %), *Nitzschia communis* (2.3 %), *Nitzschia constricta* (1.7 %), *Nitzschia lineas* (1.9 %), *Nitzschia aff. nana* (3.1 %), *Nitzschia pura* (0.3 %), *Nitzschia pusilla* (0.4 %), *Nitzschia umbonata* (0.1 %), *Surirella ovalis* (1.5 %), *Tryblionella hungarica* (0.1 %) and *Ulnaria ulna* (0.8 %).

However Oued El Malah was also characterized by slight salinity and alkaline content and was represented by species like: *Amphora veneta* (0.1 %), *Gomphonema augur* (3.8 %), *Gomphonema lateripunctatum* (0.6 %), *Mayamea permitis* (6.9 %), *Navicula veneta* (0.1 %), *Nitzschia angustata* (1.5 %), *Nitzschia brunoi* (3.8 %), *Nitzschia capitallata* (1.9 %), *Nitzschia constricta* (5.3 %), *Nitzschia fonticola* (34.4 %), *Nitzschia palea* (6.3 %), *Nitzschia umbonata* (4.4 %) and *Surirella ovalis* (0.4 %).

Most species recorded at river (Oued Rhiou and Oued El Malah) streams are known to be cosmopolitan, being common in European with a slight salinity and alkaline content in European rivers, as remarked by (Baudrimont 1970, 1971, 1974) and (Chaïb et al. 2011) in their study of taxa from arid and semi-arid areas of Algeria.

These rivers (Oued Rhiou and Oued El Malah) were impacted by intermittent physical and chemical disturbances, which were caused by the anthropogenic activities (use of detergents in laundering, perturbation of the stream bed). However, chemical and physical analyzes and the distribution of diatoms in rivers (Oued Rhiou and Oued El Malah) prove these results.

DENOMINATION COMPLETE	Oued Rhiooue		Oued El Malah	
	Ech 1	Ech 2	Ech 3	Ech 4
<i>Achnantheidium affine</i> (Grunow) Czarnecki		14,25		
<i>Achnantheidium druarttu</i> Rimer & Couste in Rimet & al.				7,5
<i>Achnantheidium minutissimum</i> (Kützing) Czarnecki fo. teratogene	3			
<i>Achnanthes minutissima</i> var. scotida		6,75		
<i>Amphora veneta</i> Kützing				0,25
<i>Craticula accomoda</i> (Husted) Mann				0,5
<i>Cocconeis pediculus</i> Ehrenberg		1,5		
<i>Cyclotella memeghiniana</i> Kützing		0,25		
<i>Cymbella excisa</i> var. procerata Krammer		2,5		
<i>Cymbella helvetica</i> Kützing		1		
<i>Cymbella parva</i> (W. Smith) Kirchner in Cohn	0,75			
<i>Cymbella prostrata</i> (Berkeley) Cleve		5		
<i>Delicata</i> sp.				2,75
<i>Diploneis oblongella</i> (Naegeli) Cleve-Euler	0,25			
<i>Diatoma moniliformis</i> Kützing		0,75		
<i>Diatoma tenuis</i> Agardh	68,75	15		
<i>Diatoma tenuis</i> var. elongatum Lyngbye		0,25		
<i>Fragilaria crotonensis</i> Kitton		0,25		
<i>Fragilaria construens</i> var. venter (Ehrenberg) Grunow et VanHeurck		1,25		
<i>Fragilaria ulna</i> (Nitzsch.) Lange-Bertalot				
<i>Fragilaria</i> sp.		0,5		
<i>Gomphonema augur</i> Ehrenberg			7,5	
<i>Gomphonema clevei</i> Fricke	3,75			
<i>Gomphonema designatum</i> E. Reichardt	5			
<i>Gomphonema lateripunctatum</i> Reichard & Lange-Bertalot				1,25
<i>Gomphonema olivaceum</i> (Hornemann) Brébisson		1,75		
<i>Gomphonema vidalii</i> Beltrami & Ector in Beltrami et al.	2,5			
<i>Gyrosigma attenuatum</i> (Kützing) Rabenhorst		0,25		
<i>Gyrosigma kuetzingii</i> (Grunow) Cleve	0,25			
<i>Mayamea permitis</i> (Husted) Bruders & Mealin				13,75
<i>Melosira varians</i> Agardh	0,25			
<i>Navicula cataracta</i> Rheni Lange -Bertalot		0,5		10
<i>Navicula cryptotenelloides</i> Lange-Bertalot		0,25		
<i>Navicula gregaria</i> Donkin		1,5		
<i>Navicula radiosa</i> Kützing	1,75	5,25	22,5	3,75
<i>Navicula simulata</i> Manguin	0,75			
<i>Navicula tripunctata</i> (O.F.Muller) Bory	0,25	1,25		
<i>Navicula veneta</i> Kützing		6,25		0,25
<i>Nitzschia angustata</i> (W. Smith) Grunow in Clever et Grunow				5

<i>Nitzschia aurariae</i> Cholnoky		2		
<i>Nitzschia brunoi</i> Lange - Bertalot			7,5	
<i>Nitzschia capitellata</i> Husted in A. Schmidt & al,				3,75
<i>Nitzschia communis</i> Rabenhorst		4,5		
<i>Nitzschia constricta</i> (Kützing) Grunow		3,25	10,5	
<i>Nitzschia dissipata</i> (Kützing) Grunow		0,75		
<i>Nitzschia fonticola</i> Grunow in Cleve & Moller			36,25	32,5
<i>Nitzschia frustulum</i> (Kuting) Grunow in Cleve & Grunow				11
<i>Nitzschia gracilis</i> Hantzsch	0,5			
<i>Nitzschia linearis</i> (Agardh) W. Smith		3,75		
<i>Nitzschia</i> aff. <i>Nana</i> Grunow in van Heurck	6,25			
<i>Nitzschia sigma</i> (Kützing) W.M.Smith		1,5		
<i>Nitzschia palea</i> (Kützing) W.Smith			6,25	6,25
<i>Nitzschia palea</i> var. <i>devilis</i> (Kützing) Grunow in Cleve et Grunow		8,75		
<i>Nitzschia paleaformis</i> Hustedt		1,75		
<i>Nitzschia pura</i> Hustedt	0,5			
<i>Nitzschia pusilla</i> (Kützing) Grunow	0,75			
<i>Nitzschia umbonata</i> (Ehrenberg) Lange-Bertalot		0,25	8,75	
<i>Nitzschia</i> sp.		0,5		
<i>Rhopalodia operculata</i> (Agardh) Hakansson	0,75	0,25		
<i>Surirella brebissonii</i> Krammer & Lange-Bertalot var. <i>brebissonii</i>		2,75		
<i>Surirella ovalis</i> Brebisson		3	0,75	
<i>Synedra acus</i> Kützing		0,5		
<i>Tabularia fasciculata</i> (Agardh) Williams et Round	2,5			
<i>Tryblionella angustata</i> Wm Smith		0,25		
<i>Tryblionella hungarica</i> (Grunow) D.G. Mann				1,5
<i>Ulnaria ulna</i> (Kützing) Compère	1,5			

Table 1. List of diatom taxa recorded from the 4 stations sampled in the two watercourses
(Oued El Malah et Oued Rhiou).

4 CONCLUSION

The predominance of *Diatoma* and *Nitzschia* in the specific structure of the stations studied, respectively Oued Rhiou and Oued El Malah shows an imbalance in the diatom composition. This imbalance in the diatom composition is caused by the difference in ecological condition required or preferred by each of the species and variety collected.

The values of the IBD allowed us to estimate the quality of streams. These analyses indicate that the stations of Oued Rhiou and Oued El Malah are characterised by an intermediate water quality.

Results show that the nature and the composition of diatom population in Oued Rhiou and Oued El Malah is influenced by geological, chemical, physical and anthropogenic factors like agricultural activities and livestock grazing.

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