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Description of the Macrobenthic Population in the Gulf of Arzew in Northwestern Algeria

Youcef Amar, AbdelKrim Kandouci, Sara Lebid, Benyounes Djahed, Touria Zahzeh and Macho Anani
Laboratoire d'hydrobiologie et de pollution, Faculté des Sciences,
Université Djillali Liabes de Sidi Bel Abbès, BP 89. Sidi Bel Abbès, Algeria

Abstract: This present research is dealing with the study of the benthic community in the Arzew gulf and permits to give an overview on the MacroBenthos encountered in this area, which seems to be more or less threatened by the Arzew's industrial area pollution. The samples were picked up in 46 several stations with deeps going from 16-96 m, using the Aberdeen Benne, where two hits were needed each station. A sediment undersample was used in the granulometric study. The species identification and the faunistical analysis show, in one hand, the main pollution indicator characteristic species and in another hand the principal dominant ecological stocks. Concerning the data processing, the TWINSPAN (Two Way INdicator SPecies of ANalysis) and the AFC (Analyse Factorielle des Correspondances) based upon the abundance of every species give the same results offering the stations and the species gatherings and this according to their existing affinities and their ecological preferences related to the gulf seabed sedimentary cover.

Key words: MacroBenthos, pollution, granulometry, ecological preference

INTRODUCTION

The Arzew gulf is one of the most important Algerian gulfs. In its western part, it receives the urban and industrial rejections associated to the agglomerations implanted along the gulf, after a partial and incomplete purification of the most important North African industrial area. The augmentation of the pollution flows, bonded to the last years urban development and also the very growing economical activities, lead in time, to disturbances on the benthic community, in both either qualitative and quantitative domains. The observations and the obtained results, concerning the Oil pollution in certain zones in the Arzew's gulf are very mater of worry (Sebbih, 1990). In the western coast in particular, very few works have been made.

At the same time, this problem is not confined in the Arzew's gulf but concern the Algiers area also, where the pollution by important organic mater incomings, offers worrying data (Bakalem and Romano, 1981). Instead, the MacroBenthos in the Toulon's bay in France presents a middle state which needs more studies (Bourcier, 1976) and this show greatly that this problem concerns also, as well, the whole of the Mediterranean sea. Diaz-Castaneda and Safran in (1988) show a new colonisation by the Polychets Annelids of the sediments ruined by the pollution and this under experimental shapes in this Toulon's bay.

Nevertheless, Present study was conducted with absolutely no comparative study in the literature. Cause of the security problems facing Algeria, in the last decade, no foreigner was able to come and investigate our area, so as no study; absolutely no study was made concerning the macrobenthic population of the Arzew's gulf.

Hence, this present research presenting a double interest, was made to evaluate the degree of pollution effects in this area. For this purpose, the sedimentary texture was studied in order to create a biosedimentary map and also the Polychets Annelid population inventory.

MATERIALS AND METHODS

The Arzew's gulf is located near 40 kms east of the well known town of Oran, north-western Algeria. It is delimited west by the Carbon Cape and east by the Salamander end (Fig. 1). This gulf presents a much reduced continental plateau going from the Orous mountain base (nearby the Carbon Cape) and then the plateau's slope becomes more and more soft from Marsat Hadjadj town to the Cheliff river mouths.

Particularly, between the 50 m and the 100 m isobaths, the bottoms come down in very soft inclinations (Caulet, 1972).

The sedimentation is at a muddy dominance in the centre of the gulf. In contrast, all around, the bottoms are

Corresponding Author: M.M. Anani, Département des Sciences de l'environnement, Laboratoire d'hydrobiologie et de pollution, Faculté des Sciences, Université Djillali Liabes de Sidi Bel Abbès, BP 89. 22000, Sidi Bel Abbès, Algérie Tél: + 213 72 45 78 03

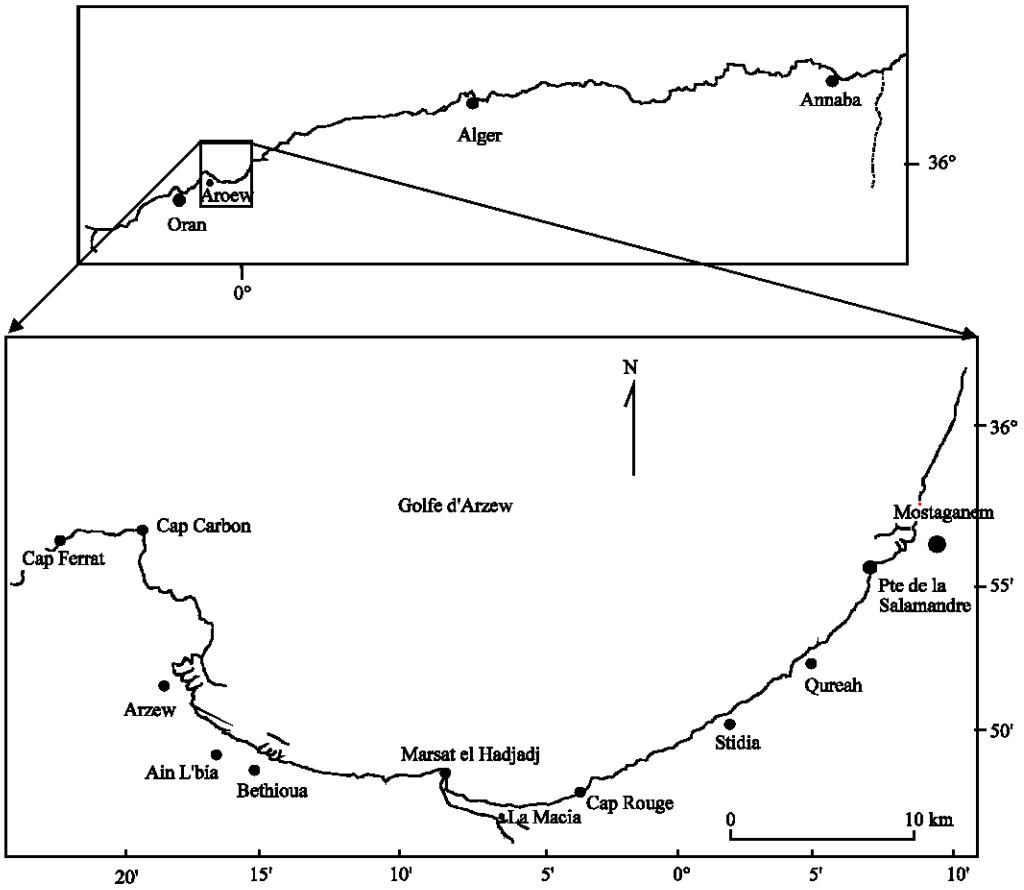

Fig. 1: Location of the Arzew's gulf in Algeria and the Mediterranean Sea

occupied by sandy gravels offshore and by sand in the coast. This latter is sometimes mixed with mud, which confirms the great muddy extension (Amokies, 1993). The hydrological balance shows always a deficit cause of the intense evaporation in the dry season. Fortunately, the Mediterranean Sea fulfils its water deficit by the Gibraltar strait and the water level becomes equilibrated.

The research of Millot *et al.* (1990) have given a new vision to the water masses circulation in the Algerian basin. This east oriented stream, circulates parallel to the littoral, creating from the 1°-2° east longitude upwellings between two cyclonic and anticyclonic whirls. At Arzew and under the Coriolis force effect, a branch of the Algerian stram provokes reverse streams resulting in its flattening against the coastline.

According to the operated measures, on the surface and profound waters of the Arzew's gulf, it has been noticed that it exists three types of water:

- Atlantic waters (Salinity 36 to 36.7‰ between -16 and -50 m).
- Mixed waters (Salinity 36.7 and 37.5‰, between -50 to -80 m).
- Mediterranean waters (Salinity 37.5 to 37.9‰ beyond the -80 m isobath till -96 m).

We have profited from the passage of an international scientific boat, in an unfavourable season (winter) last year to make our sampling operations.

Forty six stations have been prospected between -16 to -96 m. The samples were done using the Smith McIntyre (Aberdeen) benne, with two benne hits by station between Carbon Cape and the Salamander headland (Fig. 2).

The sampling was done in February in winter (which is an unfavourable season for the most benthic species). An under sample of sediment was picked up in view of the granulometric analysis. The samples were filtrated by a 1 mm mesh sieve. The surface temperatures and salinities were measured at the same time during the sampling.

The fauna was extracted by sieved sediment floating and was then identified, as shown in Table 1.

Several classical and synthetic analysis methods were used in order to evaluate the annelid population

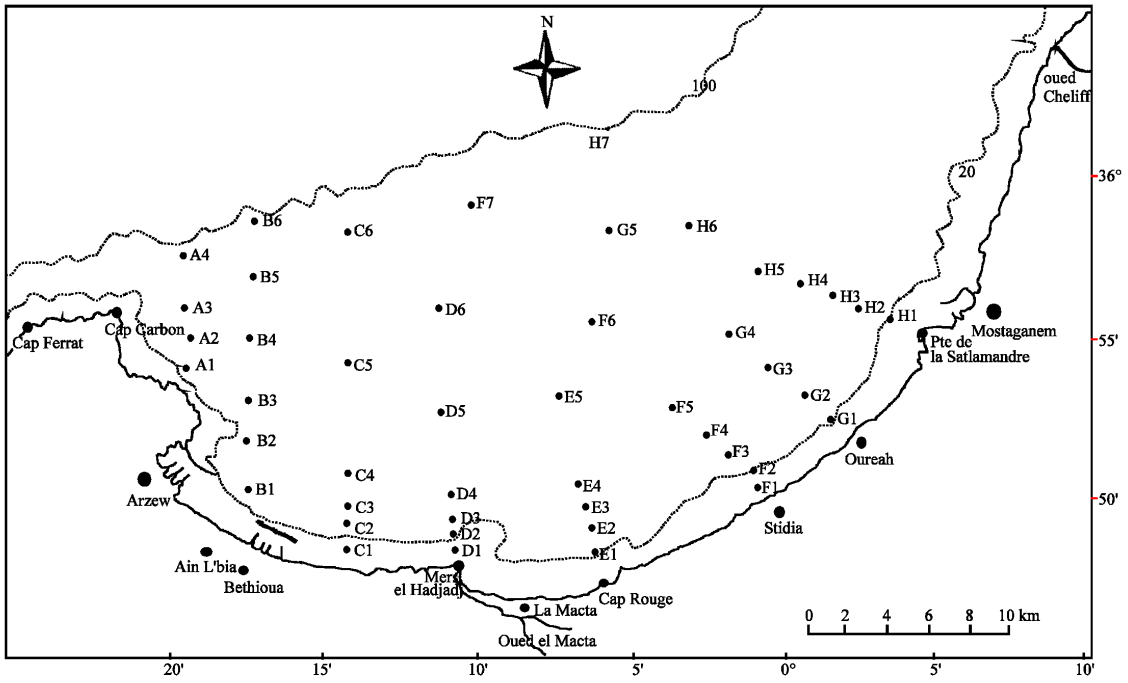

Fig. 2: Site of the examined stations in the gulf

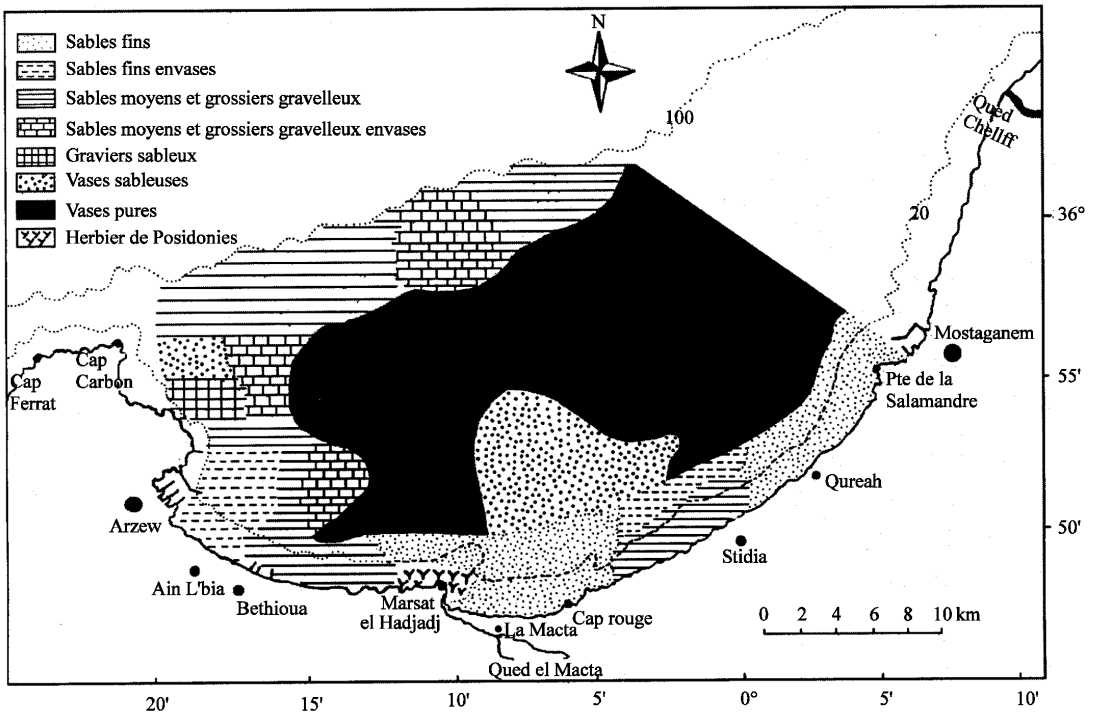

Fig. 3: Sedimentary analysis of the gulf

distribution and its faunistical structure, like the specific diversity described by the Shannon diversity index.

The Fig. 3 shows, also, the sedimentary map of the concerned area. A sample's specific diversity must be

Table 1: Characterization of the studied stations in the gulf

	Stations	Sediments	Sediments fraction (%)
	D2, D3, E1, E2, G1, E3, H1	Fine sands	Pelite rate 10
TWIN 1	D1	Posidoniae herbier	
TWIN 1 +	A3,A4,B3,B5, C6, H7, B6,C1,C2,F1,F2,G5	Gravelled sands	Gravels rate 10
TWIN 2	A2	Sandy gravels	Gravel dominating (75)
	B1,B2,F3	Muddy fine sands	Pelite rate 10
TWIN 3	B4,C4,F7	Muddy gravelled sands	Pelite rate 10
	A2,E4,E5,F4	Sandy mud	Pelite rate 79
TWIN 4 +	C3,C5,D4,D5,D6,F5,F6,H5	Deep mud	Pelite rate 90
TWIN 5	G2,G3,G4,H2,H3,H4,H6	Coastal mud	

Table 2: Mean values of the macrobenthic population variety in the Arzew's gulf

Data	Twin 1	Twin 2	Twin 3	Twin 4	Twin 5
Shannon's indices (H')	4.62	3.81	3.90	3.22	3.76
Evenness (J)	0.80	0.67	0.69	0.55	0.70

Table 3: Sedimentary texture of the various TWINs of the Arzew's gulf bottom

Sediments	Twin 1	Twin 2	Twin 3	Twin 4	Twin 5
Sands	83.89	17.50	61.76	0	0
Gravels	14.85	82.04	5.02	0	1.52
Mud	1.25	0.45	33.21	99.98	98.47

more significant if it is followed by an equitability calculation. The diversity indices are confined in the Table 2.

In order to enhance the quality of the comparison between the obtained data, it has been used the TWINSPAN (Two Way Indicator Species of Analysis) and the CFA (Correspondences Factorial Analysis) methods.

In the present case, a contingence table has been held by eliminating the species that present less than three presences in the whole of the considered prospected stations and an effective comprised between two or three individuals.

A total number of one hundred and 166 species has been retained.

Both analysis use the same table concerning the lines and the columns intersections, corresponding to the total number of the specie in each station.

Both methods lead to more or less the same results but with different graphical representations.

The TWINSPAN offers a classification based on different dichotomies. This latter concerning the stations was used as a base in this analysis and then the species were distributed and classified according to their ecological preferences (Hill, 1979).

The CFA offers same results in a graphical representation.

RESULTS

In this study, the several populations show a distinct preference to the substrate. For such a spatial heterogeneity, the values of the obtained densities confirm as well this result.

The first dichotomy in the dendogram divides the whole of the 46 stations in two stations portions, where the first correspond to TWIN 1 and TWIN 2, concerning the whole of the fines sands, mediums, crudes and fines gravels with a negligible pelite rate.

The second regroups the TWIN 3, TWIN 4 and TWIN 5 stations, where the pelite fraction seems to be important (Table 3 and Fig. 4). The table bears horizontally the stations and vertically the species. The intersections express the different species classes.

The obtained dendogram shows that the similarities are high (greater than 40%) between TWIN 1 and TWIN 2. This is justified by the sedimentary texture of the different stations which compose them.

The granulometric analysis permits to show seven lithologic areas, corresponding to the well defined benthic communities, analogue to the TWINSPAN classification and CFA given communities.

Concerning the CFA, near of 60% of the total inertia corresponds to the 3 first axes.

The graphical representation permits to show the following points:

- In the positive art of the F1 and F2 axis, it has been observed two groups of points regrouping stations in which the sand rate is very high (greater than 50%) and a negligible pelite rate. To these positive values, the both stations groups T1 and T2 correspond respectively to TWIN 1 and TWIN 2. The first group is associated to a high percent of sand (83.89%), characterized by the presence of fine sands population dominated essentially by *Hyalinoecia bilineata* and *Limbrinereis latreilli*, species of a wide ecological repartition. This area, located in the coastal sector between -16 to -40 m is represented by two populations: the fine sands population and the *Posidonies* herbiers population (D1). The second set, characterized by a gravels rate higher than 10% represents the gravelled sands populations and sandy gravels. The faunistical structure of both sets is of sabulicole tendency.

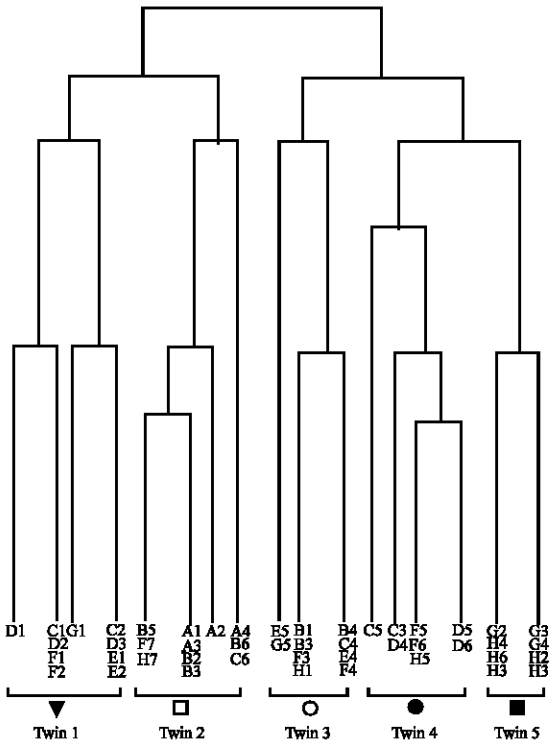

Fig. 4: Dendograms of the TWINSPAN classification of the Arzew's gulf stations

- In the negative part, it appears a big set characterized by a high mud percentage, which permits to regroup the stations T3, T4 and T5 according to their pelite rates. T4 and T5 groups are located differently in the centre of the gulf. Set T4 is characterized by pure deep mud and by a population where the tolerant muddy stock is dominating. Concerning T5 it occupies the east of the gulf with a strict muddy dominance. The T3 set is characterized by a transition zone affected by an important mud rate (greater than 10%). This set is marked by the presence of sands stations and mud. It is dominated also by a tolerant muddy stock.

DISCUSSION

In the fine sands populations, the dominant stock is of the sabulicoles species in a wide sense. It is characterized by a strong abundance of *Ditrepa arietina*, *Chone duneri* and *Astarte digitaria* in stations (D2, D3, E1, E2, G1, E3 and H1). To this ecological group is associated that of wide ecological repartition, represented particularly by *Hyalinoecia bilineata*. This population offers a high diversity and a so goof individuals repartition between the species (Table 2). At -17 m it has been encountered the *Posidonies* herbiers populations at D1 station.

The gravelled sands population is characterized by a gravellicole specie presence: *Kerfesteinia cirrata* and a great number of wide ecological repartition species. The sabulicoles species appears in second position with principally *Eunice oestreldii*, *Clymene oerstedii* and *Pista cristata*. This population is located in the north and west great mud limits. It presents an unbalance, in quantitative point of view and this has been justified by the diversity values (H' = 3.81 and E = 0.67).

The mudded fine sands are located between -40 and -54 m in the west and -36 m in the east. It is not very diversified and presents a bad individuals distribution between species, due to the presence of strong dominances of *Chaetozone setosa*, *Hyalinoecia bilineata* and *Limbrinereis latreilli*.

The mudded gravelled sands population is characterized by an unbalance due to a strong percentage of mud in its whole constituting stations. It is characterized by *Hyalinoecia bilineata* and *Pista cristata*. The ecological stocks study shows obviously the importance of the muddy species, composed essentially by *Ampharete grubei*, *Chaetozone setosa*, *Praxillella gracilis* and *Limbrinereis fragilis*, followed by the sabulicoles species represented by *Pista cristata* and *Eunice oesrtedii*.

The sandy mud population regroups four stations (A2, E4, E5 and F4) located in the great mud limit. It is characterized by a clear muddy species stock dominance. It has been recorded inside this population a bad individual distribution between species, due essentially to the extension of the great mud.

The pure mud regroups two populations according to their localization and their bathymetry. In the east coastal gulf area it has been encountered the pure coastal mud population characterized by a clear muddy stock dominance, with particularly *Sternapsis scutata*. After come the tolerant muddy species. In the central part appears the deep pure mud population, marked by a tolerant muddy dominance accompanied by strict muddy stock, essentially by *Hyalinoecia bilineata* and *Limbrinereis latreilli*, species of wide ecological repartition.

In the point of view of the species repartition, the biological analysis shows that several populations present each one affinity in respect to the sedimentary fraction. This edaphic factor is very important because it permits the definition of a well defined biocenose (Picard, 1965).

Table 4: Zoological groups characterization of Arzew's gulf macrobenthic population

Twins	Lre	San. Tol	San. str	Grav.	Mud. tol	Mud. str	Mixed
Twin 1	23	18.01	33.18	3.19	11.11	8.42	3.09
Twin 2	29.85	11.44	27.33	16.41	6.72	2.15	6.10
Twin 3	28.19	25.03	3.92	0.88	15.61	21.34	5.03
Twin 4	13.93	6.79	3.22	-	23.18	50.89	1.99
Twin 5	15.27	15.31	7.04	0.46	31.67	25.87	4.38

Let's, also signalize that the fine sands and the gravelled sands present a great specie variety. They seem to be the more diversified mediums. Those of the pure coastal and even deep mud are the poorest.

On a quantitative point of view, both TWIN 1 and TWIN 2 offer higher densities compared to the other Twins. Concerning the diversity the higher values were observed in the sandy gravels medium at station A1 and the *Posidoniaes* herbier at the station D1. Low values of the diversity appeared in both pure and sandy mud.

In the gulf of Arzew, the muddy sands population was localized in the vicinity of the industrial area. This population is characterized by an abundance of *Chaetozone setosa* and *Hyalinoecia bilineata*. The former specie has been signalled with very high densities inside the hydrocarbons polluted area. The fine sands mixed with an important amount of mud are considered as muddy facieses. They are specified by the presence of *Nephthys hombergii*, *Abra alba* and *Donax vittatus*. They have been observed, essentially, in the muddy sands area in the west sector of the gulf.

The results obtained by both Twinspan and CFA used methods are very similar. These analyses gather stations and species proper to the sandy fractions (Twin 1 and 2) in one hand and another set (Twin 4 and 5) strongly joined to the fine sands fraction in the other hand, composed by strict and tolerant mud species. Between these two sets, it has been observed the apparition of a transition zone constituted by a combination of sands and mud.

Let's note that the stations located in the surrounding area of the Arzew's port presented some disturbances in both quantitative and qualitative points of view (Table 4).

We are still waiting for another international scientific boat passage this year, in order to make another sampling operation to compare with the obtained results of last year.

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