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# Mollusks Evaluation in the Gulf of Arzew, Northwestern Algeria

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***Authors' contributions***

*This work was carried out in collaboration between all authors. Author YA designed the study, wrote the protocol, and wrote the first draft of the manuscript. Author BD supervised the work and author SL carried out biological data, when Authors MEBA and CM managed the analyses of the study and managed the literature searches. Author MA performed the statistical analysis and achieved the whole translation. Author AB participated in the species characterization. All authors read and approved the final manuscript.*

***Original Research Article***

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## ABSTRACT

The Gulf of Arzew, northwestern Algeria, constituting one of the biggest petroleum area in the world, is one of the most polluted region in the Mediterranean Sea. A good way to know the degree of this pollution that undergoes this region is to assess the number of living pollution sensitive species. Consequently, the mollusks populations seem to be a good indicator of the intensity of this pollution.
For this purpose, it has been recorded a certain heterogeneity in the distribution of mollusks species and one found low densities in the different Twin analyses which seems to be due to the progression of the mud in some stations in one hand and the impact of pollution from the industrial area in the second hand. This set of species is, therefore,

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characterized by a stable installation of muddy species. However, in all Twins, has been reported the appearance of a transition zone, consisting of a mixture of sand and vases and characterized by low diversity where species muddy dominate.

*Keywords: Mollusks; pollution; Gulf of Arzew; biodiversity.*

## 1. INTRODUCTION

The settlement of the mollusks in the Gulf of Arzew is exposed to various wastes from both the urban and the principal petrochemical area of North Africa. Industrial spilled wastes discharged into the sea induced a physic-chemical pollution which cause disturbances of the aquatic ecosystem and changes in the structure of the benthic ecosystem both qualitatively and quantitatively [1-3].

The wastewater discharge along the coast of the Gulf influenced by the unstable conditions of the environment causes long-term changes in the composition of the benthic biota [4]. Studies of pollution in the Gulf of Arzew showed that the west zone is mostly affected by serious pollution of hydrocarbons [5].

In addition to pollution, hydrodynamics, morphodynamics and morphology of coastal sands indirectly affect the composition, density, and biomass of the coastal sands macrobenthos. This has allowed some studies to show the existence of a strong link between the macrobenthic populations and sediment type of their habitat [6,7]. The excess of organic matter at the bottoms also presents serious data [8]. Several studies were concerned with biotic and abiotic factors and recognize the importance of these two parameters in the distribution of local diversity and spatial heterogeneity of species [9-11].

In this study, one should explore the Mollusks presence in an area threatened by several form of pollution and witness the distribution of this community based on the texture of the Gulf sediments.

## 2. MATERIALS AND METHODS

The Gulf of Arzew is located to the west of Algeria (35°56 'N and 00 0°25' 09 W, 36°56 ' 00 N and 0°6'00 W) between Cape Carbon and the Salamander Tip (Fig.1). From a morphometric perspective, the continental shelf has a very steep slope at the foot of Ourousse and Sicioum mountains (near Cap Ferrat and Cap Carbon). In other sectors, we note the presence of a gentle slope till the mouth of Cheliff River. Especially between 50 and 100 m isobaths, the bottoms go down to very gentle slope [12]. The Atlantic current entering through the Strait of Gibraltar causes a movement of masses in the Mediterranean basin (Fig. 1). The Algerian current moves eastward flowing the coastline, creating from 1°-2° of upwelling between two cyclonic eddies and anti-cyclonic [13,14]. At the Gulf of Arzew, there is one division from a branch of the Algerian current causing a tackle against the Gulf coast. This allows the movement of the fine fraction in the Gulf, creating an extension of the large mudflat towards the west [15-17].

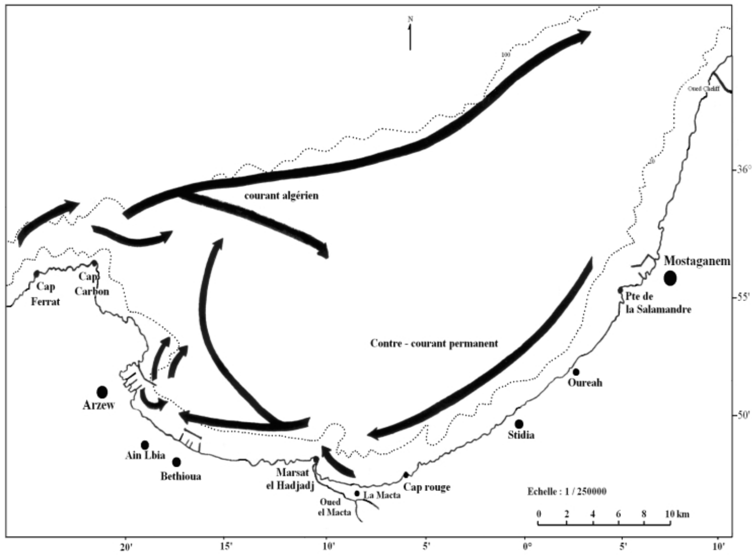



**Fig. 1. Surface Streams in the gulf of Arzew [12]**

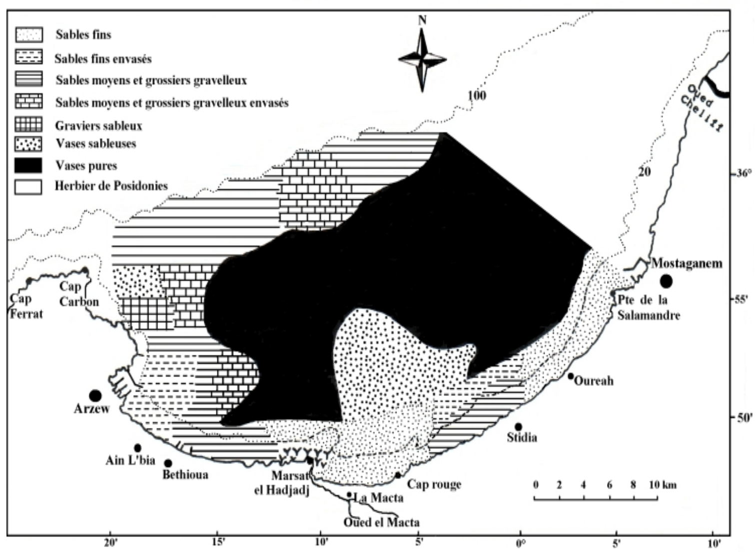



**Fig. 2. Sedimentary map of the gulf of Arzew**

The study of mollusks population in the Gulf of Arzew is based on a sampling campaign carried out in winter 2011. The samples were collected from 46 stations between -16 m and -96 m, using the Aberdeen (Smith McIntyre) grab with two shots of skips per station, sweeping an area of 0.2 $m^2$ sample (Fig. 3). For each station, a rude sort was provided by a sieve of 1mm mesh size. Filtered samples are kept in 10% formalin and then identified into species. In sediment, samples were collected for particle size analysis in order to delineate the different parts of the litho logic Gulf (Fig. 2).

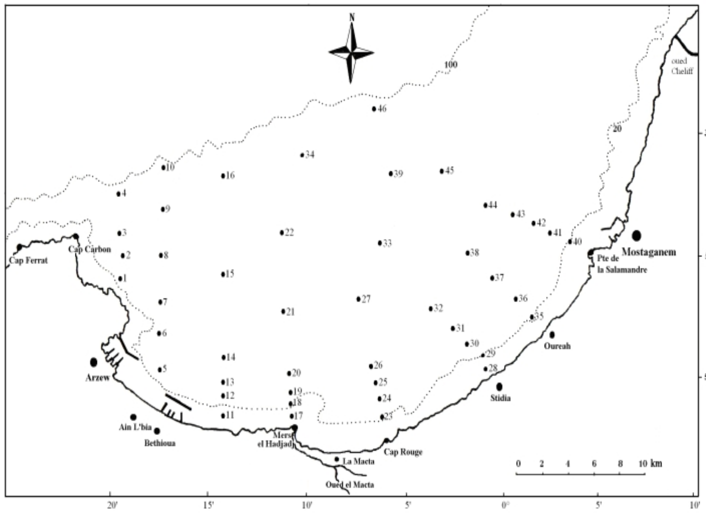



**Fig. 3. Gulf of Arzew. Location of sampling stations**

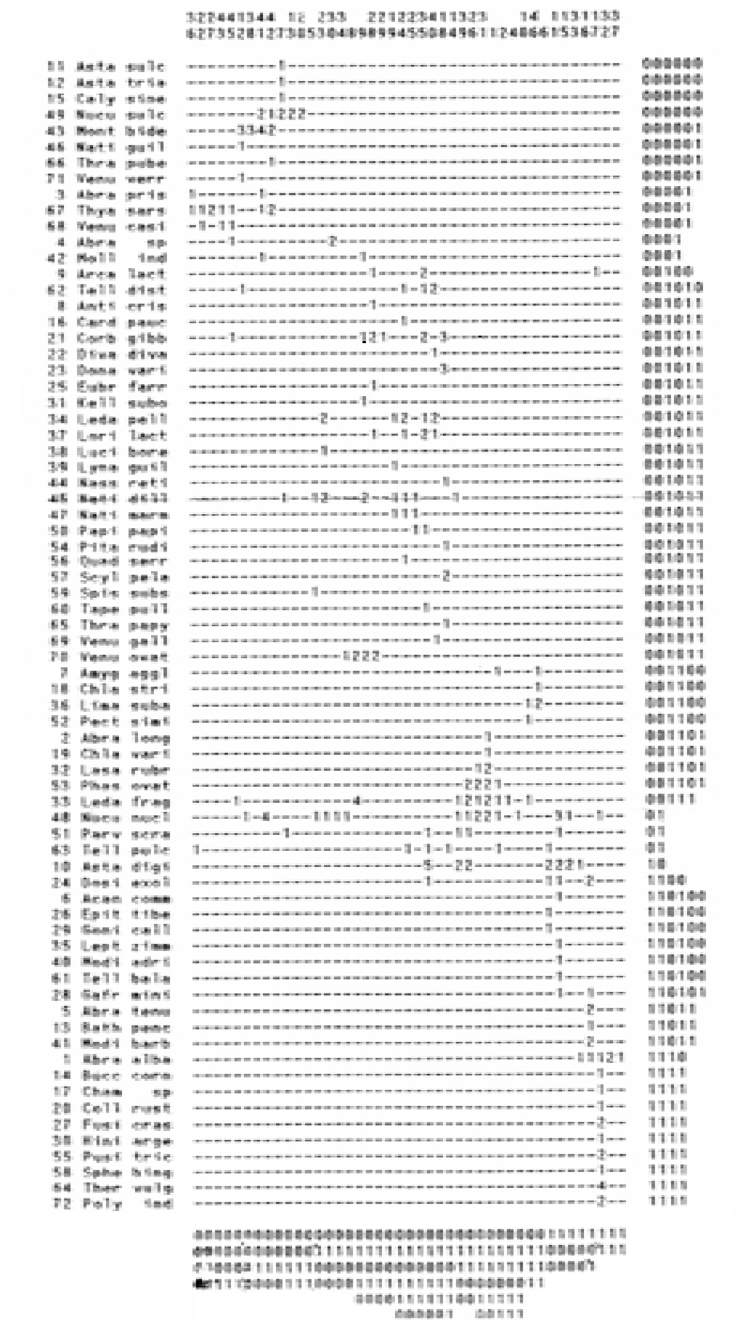
Distribution and community structure of mollusks were described on the basis of the use of diversity indices. To evaluate the distribution structure of the population of mollusks, we used species diversity described by the Shannon diversity and Evenness indices [17]. The results interpretation is based on faunal data expressed as species richness and dominance. The data were processed by the method of TWINSPAN (Two Way Indicator Species of Analysis) using a table of presence and absence with a richness of 66 species. The result of the analysis provided a table (in the intersection of rows and columns there is the class of the species in the station) from which we perform a classification based on several dichotomies (Table 1). This classification was used for stations in this analysis as a basis and then the species were distributed and classified according to their ecological preferences [18]. This is followed by the CFA (Correspondences Factorial analyses) to better visualize the distribution of groups of stations in a graph.

## 3. RESULTS AND DISCUSSION

A total of 66 species were identified in all sampling stations. From the perspective of species richness, we report a significant diversity of mollusks in the eastern Gulf and high abundance in stations far from the pollution sources of the industrial area and in the stations with negligible silt fraction. The result of the TWINSPAN analysis was pictured horizontally and vertically with stations species (Table 1). Intersections express different classes of species.The biological analysis shows the existence of different groups of mollusks which are distributed according to the sediment texture. The edaphic factor allows installation of the species according to their ecological preference [19].

The observations show that the distribution of mollusks in the Gulf of Arzew takes into account their ecological preference in relation with the substrate. We record some heterogeneity in species distribution due to siltation of much of the Gulf, on one hand and an imbalance between species and individuals which is much more in the West than, on the other hand. The information provided by the TWINSPAN classification and the AFC also confirms this result (Table 2 and Figure 4). We observe in the dendrogram the appearance of three (03) sets of stations, each of which is a set of stations in the form of twin1, 2 and 3.

**Table 1. Matrix dual inputs (Code of species richness and relative abundance) in different stations of the Gulf of Arzew**



| | | | |
|---|---|---|---|
| 11 | Asta sulc | 1 | 000000 |
| 12 | Asta tria | 1 | 000000 |
| 15 | Caly sine | 1 | 000000 |
| 49 | Nucu sulc | 21222 | 000000 |
| 43 | Mont bide | 3342 | 000001 |
| 46 | Nati gull | 1 | 000001 |
| 66 | Thra pube | 1 | 000001 |
| 71 | Venu verr | 1 | 000001 |
| 3 | Abra pris | 1, 1 | 00001 |
| 67 | Thya sars | 11211, 12 | 00001 |
| 68 | Venu casi | 1, 11 | 00001 |
| 4 | Abra sp | 1, 2 | 0001 |
| 42 | Moll ind | 1, 1 | 0001 |
| 9 | Arca lact | 1, 2, 1 | 00100 |
| 62 | Tell dist | 1, 1, 12 | 001010 |
| 8 | Anti cris | 1 | 001011 |
| 16 | Card pauc | 1 | 001011 |
| 21 | Corb gibb | 1, 121, 2, 3 | 001011 |
| 22 | Diva diva | 1 | 001011 |
| 23 | Dona vari | 3 | 001011 |
| 25 | Eubr farr | 1 | 001011 |
| 31 | Kell subo | 1 | 001011 |
| 34 | Leda pell | 2, 12, 12 | 001011 |
| 37 | Lori lact | 1, 1, 21 | 001011 |
| 38 | Luci bore | 1 | 001011 |
| 39 | Lyna gutt | 1 | 001011 |
| 44 | Nass reti | 1 | 001011 |
| 45 | Nati dill | 1, 12, 2, 111, 1 | 001011 |
| 47 | Nati mara | 111 | 001011 |
| 50 | Papi papi | 11 | 001011 |
| 54 | Pita rudi | 1 | 001011 |
| 56 | Quad serr | 1 | 001011 |
| 57 | Scyl pela | 2 | 001011 |
| 59 | Spis subs | 1 | 001011 |
| 60 | Tape pull | 1 | 001011 |
| 65 | Thra papy | 1 | 001011 |
| 69 | Venu gall | 1 | 001011 |
| 70 | Venu ovat | 1222 | 001011 |
| 7 | Amyg eggl | 1, 1 | 001100 |
| 18 | Chla stri | 1 | 001100 |
| 36 | Lima suba | 12 | 001100 |
| 52 | Pect simi | 1 | 001100 |
| 2 | Abra long | 1 | 001101 |
| 19 | Chla vari | 1 | 001101 |
| 32 | Lasa rubr | 12 | 001101 |
| 53 | Phas ovat | 2221 | 001101 |
| 33 | Leda frag | 1, 4, 121211, 1 | 00111 |
| 48 | Nucu nucl | 1, 4, 1111, 11221, 1, 31, 1 | 01 |
| 51 | Parv scra | 1, 1, 11, 1 | 01 |
| 63 | Tell pulc | 1, 1, 1, 1, 1, 1 | 01 |
| 10 | Asta digi | 5, 22, 2221 | 10 |
| 24 | Ensi ensi | 1, 11, 2 | 1100 |
| 6 | Acan comm | 1 | 110100 |
| 26 | Epit tibe | 1 | 110100 |
| 29 | Gast call | 1 | 110100 |
| 35 | Lept zima | 1 | 110100 |
| 40 | Modi adri | 1 | 110100 |
| 61 | Tell bala | 1 | 110100 |
| 28 | Gafr mini | 1, 1 | 110101 |
| 5 | Abra tenu | 2 | 11011 |
| 13 | Bath pane | 1 | 11011 |
| 41 | Modi barb | 2 | 11011 |
| 1 | Abra alba | 11121 | 1110 |
| 14 | Bucc coro | 1 | 1111 |
| 17 | Cham sp | 1 | 1111 |
| 20 | Coll rust | 1 | 1111 |
| 27 | Fusi cras | 2 | 1111 |
| 30 | Hini arge | 1 | 1111 |
| 55 | Pusi tric | 2 | 1111 |
| 58 | Spha bing | 1 | 1111 |
| 64 | Ther vulg | 4 | 1111 |
| 72 | Poly ind | 2 | 1111 |

The Twin 1 is characterized by pure mud stations except Station 24. This group consists mainly of species including *Nucula sulcata* Bronn, 1831 Abra (Lamarck, 1818) and *Abra alba* (W. Wood,1802) accumulating on their own, a dominance of 77.83%, followed by *Corbula* *gibba* (Olivi,1792), *Thyasira sarsi (Philippi,1845)*, species with wide ecological distribution. This set is a little diverse population because of poor distribution of individuals among species (Table 2). The Twin 2 collects sediment stations whose texture is dominated by fine sand except sand vases stations: A2, E4 and F4 where the fine fraction is very important, 85.10%. The faunal composition is mainly composed by sandy species: *Spisula substruncata* (da Costa, 1778), *Notocochlis dillwynii* (Payraudeau, 1826), *Loripes lucinalis* (Lamarck, 1818), *Astarte digitaria* (Linnaeus, 1867) and *Tellina pulchella* (Lamarck, 1818) whose cumulative dominance is 82.24%. The Twin 3 is a transition zone where we meet a set of stations vase pure, fine sand and silt silted sand which has enabled the group to collect various sandy species (*Astarte Digitaria* (Linnaeus, 1867), *Abra tenuis (Montagu, 1803)* and *Tellina pulchella* (Lamarck, 1818)) vasicola (*Nucula sulcata* (Bronn, 1831), *Abra alba* (W. Wood, 1802) and *Acanthocardia paucicostata* (G.B. Sowerby II, 1834) and LRE (*Cerithium vulgatum* (Bruguières, 1792) and *Modiolus barbatus* (Linnaeus, 1758)). The installation of a considerable rate of mud limits the biodiversity in these stations. We observe in the dendrogram the appearance of three (03) sets of stations, each of which is a set of stations in the form of twin (Twin 1, Twin and Twin 2 3). The information provided by the TWINSPAN classification and the AFC also confirms this result (Table 2 and Figure 4).

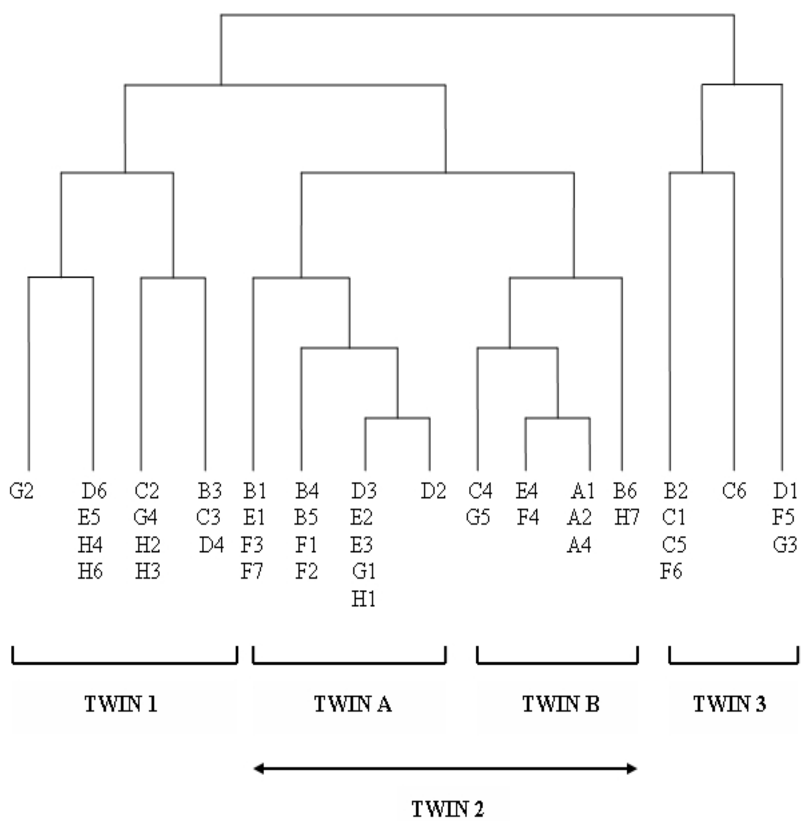



**Fig. 4. Gulf of Arzew. Dendrogram of stations classification.**

**Table 2. Mean values of diversity indices stations in the Gulf of Arzew.**

| | Shannon index (H') | Evenness (J) |
|---|---|---|
| **Twin 1** | 1.04 | 0.53 |
| **Twin 2** | 1.73 | 0.84 |
| **Twin 3** | 1.49 | 0.67 |

The second twin is divided into two sets A and B. Twin A is characterized by a high percentage of stations comprising sandy species characteristic of fine sands. Twin B brings together a group of stations with a heterogeneous composition of fauna due to the presence of significant levels of silt in the stations that constitute it.

As for the correspondence analysis, the results are similar to those of the TWINSPAN analysis. We observe about 60% of the total inertia of the system with two factorial axes 1 and 2 (Fig. 5).

Axis F1 brings together a number of stations with the fine fraction dominating and is characterized by a group of muddy species low abundance.
In this case, the high fraction of negative pelite impacts on the production of this area and causes heterogeneity of the community of mollusks.

The second set is characterized by a high percentage of sand silt stations except E4, F4 and A2. This set offers two Twins corresponding to richness and a fair distribution of individuals among species (positive values of axes F1 and F2).

The third group takes a character of a transition zone because it consists of a set of stations where sediment texture is different. Thus we record, low abundance and poor distribution of species due not only to the advancement of the mud towards the western Gulf, but also the influence of pollutant discharges that appears at stations B2, C1 and C5. The main conclusion seems to be that the position structure of mollusks is more directly related to soil conditions and chemical environment.

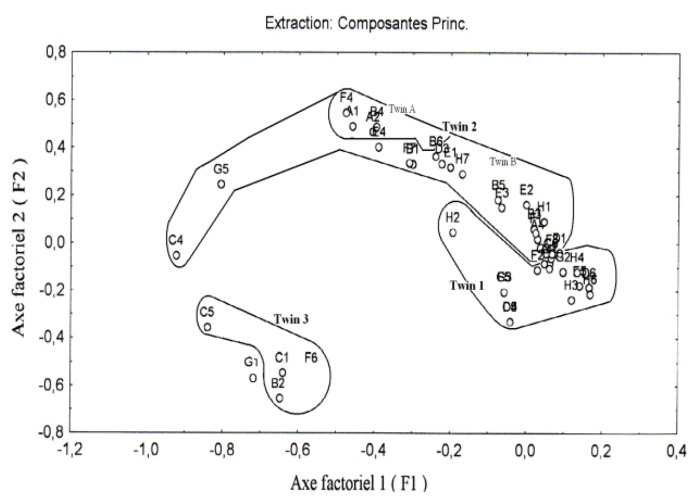



**Fig. 5. Correspondences Factorial analyses.**

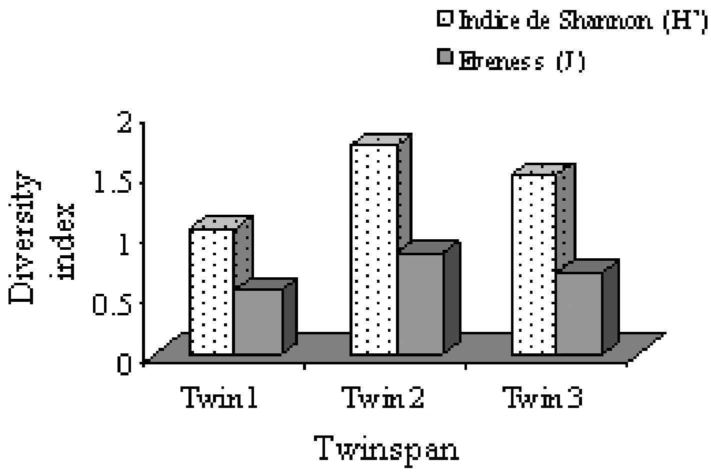



**Fig. 6. Diversity of average sand various mollusks Twin**

Only Twin 2 stations represented by sand with fine fraction are negligible. With a good distribution of species and high diversity of mollusks species, we noted a strong dominance of sandy species.

For the protection of the aquatic ecosystem, previous works has showed both the importance of the milieu characteristics in the region of Marseille (south of France) and the interest of a re-colonization by Polychaetes annelids non animal sediment pollution in the test chambers in the harbor of Toulon [20,21]. Also, recent results showed a response of benthic communities to various disturbances, knowing that the benthic fauna is acting as an ecological indicator of the environment and the system state [22].

## 4. CONCLUSION

This study revealed heterogeneity of the individual distribution among species and low densities in the different Twin which is due to the mud progression in some stations and the potential pollution impacts of the industrial area. This incidence is characterized by a permanent installation of muddy species. In all Twins, the appearance of a transition zone was observed, consisting of a mixture of sand and vases species with low diversity, and where muddy species dominated.

The study clearly showed that the mollusks populations are mainly concentrated in the east of Arzew's Gulf. We persist in thinking that this could be due to the fact that the petrochemical area is in the west of the Gulf and that discharges of oil resulting greatly influence the size of these populations. Thus, in order to repopulate the area western it would make sense to substantially reduce such noxious emissions released.

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## COMPETING INTERESTS

The authors have Declared that no competing interests exists.

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