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Impact of Desalination Discharges on the Benthic Macrofauna Case Study: ALGERIA

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ABSTRACT

Seawater desalination plants produce large volumes of brine, probable affecting the receiving environment**.** So as to know the influence of this activity on benthic fauna, a qualitative and quantitative study, of the population benthic macrofaune is performed; this study will make it possible to know the state bioecologic of a site affected by Fouka desalination discharges. The population of the study area is rich; it counts it counts 41 species distributed into 233 individuals. The analysis of the index of diversity (H ') as well as the index of equitability (E), at the study area shows high values (H ' > 3, E>0,7) this reflects the biodiversity in the area is very good, this is a species-rich environment and a (stable) balanced and diversified population.
KEYWORDS: Desalination, Benthic fauna, Qualitative, Quantitative, biodiversity.

INTRODUCTION

Desalination has become a very affordable solution to cope with fresh water shortage especially in the southern countries of the northern hemisphere, to coat the needs of their society, and the agricultural and industrial sector [1, 2].
Desalination plants produce large volumes of brine, whether the method used reverse osmosis or distillation, which are then unload into the sea and can, consequently, assign beneficiary biological communities [3].
Reverse osmosis is the most technique favored by desalination plant, principally by reason of its reduced inversion costs and its lower energy and space use [4, 5, 6].
A strati-field system is formed when the brine disposed into the water due to the divergence of density, this difference can be influence benthic communities existing in environments [7].
A variety of chemicals products (e.g. antiscalant, antifouling, hydrochloric acid, ferric chloride, sodium hexametaphosphate, ect) are used all through desalination process[8,9].
The degree of the effect above those biological communities existing around any point of brine discharge depends together the amount of the brine disposed, which is reliant on the size of the desalination plant, as well as on the sensitivity of those communities receiving the effluent [10,8].Accessible study of these brine over faunal assemblages are, though ,really limited [11,12,13].
These possible effects can be reduced by selecting a suitable effluent position, and/or prior dilution of the effluent. In addition, it is also essential to create a carefully intended monitoring plan to evaluate the diffusion over time of any brine plume, in order to obtain apt action capacity essential [4,14,15].The purpose of this study was to evaluate the impact of Algeria desalination discharges on abundance, assemblage structure, and the diversity of macrobenthic faunal assemblages.

2. MATERIALS AND METHODS

This work was taken about Fouka desalination plant, situated on the coast of the Bay of BouIsmaïl (from West to East Chenoua in Sidi Fredj) north of Algeria (Fig. 1).which started to work in 2011.
The plant uses reverse osmosis technology to turn saline sea water into fresh water. The feed water for the process is taken through an open intake system located about 1,800 m offshore. The intake system is connected to the plant via a pipeline measuring 1,60 mm in diameter. Length of the brine outfall pipeline is 380 m and measures 1,200 mm in diameter.
The pre-treatment facility comprises sand and cadridge filtration, as well as chemical dosing.

Sample collection

The sampling of the benthic macrofauna was collected form 5 stations from desalination plant using a Van Veen grab sampler, samples took place at a depth of 10,20,30,35 and 43 m. Four replicates were collected for faunistic determination at each depth.

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The physic-chemical characteristic used in this work concerned the in situ measurement analysis of temperature, pH,salinity,dissolved oxygen (these parameters were measured by multi-parameter, and nutrient salts (nitrites,nitrates,ammonia nitrogen, and phosphorus) as previously described elsewhere [16,17].The water samples were collected at 50 cm below the surface using plastic bottles, previously rinsed with water.
Samples were fixed in a 10 % formaldehyde solution, and then the sieving was carried out using sieve of 1mm mesh. The sorting of macrofauna is carried out by separating the species into distinct zoological groups (Polychaetes, Molluscs, crustaceans, Echinoderms) under a binocular microscope, and stored in 70 % ethanol to be identified later.

Table 1: Mean abundance of macrofaunal group situated at diverse depth (10, 20, 30, 35 and 42 m) from the brine discharge point.

group	taxa	Total abundance	Abundance in each depth				
			10 m	20 m	30 m	35 m	42 m
Mollusca	*Acanthocardia paucicostata*	2	0	0	2	0	0
Mollusca	*Aclis supranitida*	1	0	0	0	1	0
Crustacean	*Ampelisca multispinosa*	6	0	0	0	1	5
Echinoderms	*Amphipholis squamata*	5	0	0	0	3	2
Crustacean	*Bathyporeia guilliamsoniana*	9	4	5	0	0	0
Mollusca	*Bornia sebetia*	79	24	26	25	4	0
Mollusca	*Calliostoma zizyphinum*	1	0	0	0	0	1
Mollusca	*Cancellaria cancellata*	3	3	0	0	0	0
Mollusca	*Cerithiopsis tubercularis*	1	0	0	0	0	1
Polychaeta	*Cirratulus cirratulus*	3	0	0	0	0	1
Crustacean	*crevette juvénile*	3	0	0	0	0	3
Mollusca	*Cythara costata*	1	1	0	0	0	0
Mollusca	*Cythara laevigata*	16	0	0	0	8	8
Mollusca	*Diplodonta rotundata*	1	0	0	0	1	0
Mollusca	*Epitonium commune*	2	0	0	0	2	0
Polychaeta	*Eteone sp*	7	2	4	0	0	1
Mollusca	*Fusinus rostratus*	2	0	0	0	0	2
Mollusca	*Gari fervensis*	3	2	0	0	1	0
Mollusca	*Hinia incrassata*	1	0	0	0	1	0
Mollusca	*Hydrobia ulvae*	4	3	1	0	0	0
Crustacean	Isopode	2	0	0	1	0	1
Crustacean	*Jassa marmorata*	1	0	0	0	0	1
Crustacean	*Lembos spiniventris*	1	1	0	0	0	0
Crustacean	*Leucothoe lilljeborgi*	1	0	0	1	0	0
Crustacean	*Megamphopus brevidactylus*	5	0	0	0	0	5
Crustacean	*Microdeutopus statiois*	3	0	0	0	0	3
Mollusca	*Nassa mutabilis*	2	0	2	0	0	0
Mollusca	*Neverita josephina*	10	2	2	2	2	2
Polychaeta	*Notomstus latericeus*	1	0	0	1	0	0
Mollusca	*Nucula nucleus*	3	0	0	0	1	2
Mollusca	*Nuculana pella*	5	0	3	2	0	0
Mollusca	*Pirenella conica*	1	0	0	0	1	0
Mollusca	*Ringicula auriculata*	10	1	1	0	6	2
Polychaeta	*Sabella fabricii*	1	0	0	1	0	0
Polychaeta	*Sabella pavonina*	10	0	2	0	8	0
Crustacean	*Siphonoecetes sabatieri*	6	6	0	0	0	0
Polychaeta	*Syllis krohnii*	2	0	0	0	0	2
Mollusca	*Turbona cimex*	3	3	0	0	0	0
Mollusca	*Turritella communis*	6	0	0	0	6	0
Mollusca	*Venus gallina*	6	2	0	0	0	4
Mollusca	*Venus ovata*	1	0	0	0	1	0
others		3	0	0	0	0	3

Figure 1: Map of the study area, showing the location of desalination plant.

RESULTS

The sampling of the benthic macrofauna carried out represents a species richness of 41 species distributed into 233 individuals. The crustaceans, Molluscs, Polycheates, and Echinoderms are the main identified zoological groups.

Molluscs are the most represented with (32.2 ind, 71% of the overall abundance) in succession Crustaceans with (7.4 ind, 16%) followed by Polychaete with (4.8 ind, 10% echinoderms are poorly represented (1 ind, 2%). In terms of species, the two main species are Molluscs, *Bornia sebetia* and Cythara lavigata, respectively, with percentages of 33, 91% and 6,87%, followed by the gastropod Mollusc *Neverita josephina* and the Polychaete *Sabella pavonina* with a proportion of 4.29% and finally the Crustacean Amphipode *Bathyporeia Guilliamsoniana* with 3,86%.

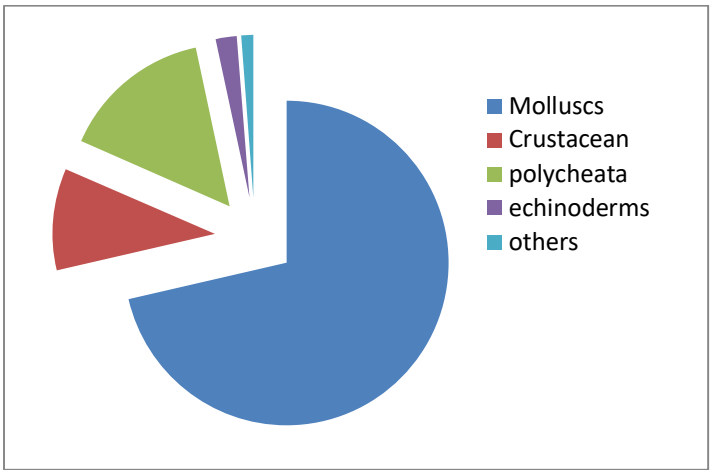

Figure 2: Presentation of the dominance of zoological groups at the study area

Station S3 has a total of 36 individuals, with a clear dominance of the Molluscs group whose proportions exceed 89%. Polychaetes and Crustaceans are equitably represented with a percentage not exceeding 6%.

For station S 4, which is characterized by a total of 46 individuals, a clear dominance of the Molluscs is also observed with proportions exceeding 74%. In second place the Polychaetes dominate with a percentage of 17% followed by echinoderms with a percentage of 7% while Crustaceans are represented only by a small percentage which does not exceed 2%.

At the S5 station, a total of 49 individuals was recorded, the Molluscs are observed with a 48% ,followed by Crustacean with 39%, the Polychaete are represented by 9% while the Echinoderms are represented only by 4%.

The other two stations are located at a shallow depth, namely 20m for station 2 and 10m for station S1.

At station S 2, the total number of individuals is 49, Molluscs predominate with more than 78% and polychaetes with 12%, followed by Crustaceans with a percentage of 10%.

On the other hand, at the level of station S 1, a total of 53 individuals is recorded, the group of Molluscs is best represented by a percentage of 72%, followed by Crustaceans with a percentage of 21%, and polychaetes who contribute less with a Percentage of 7%.

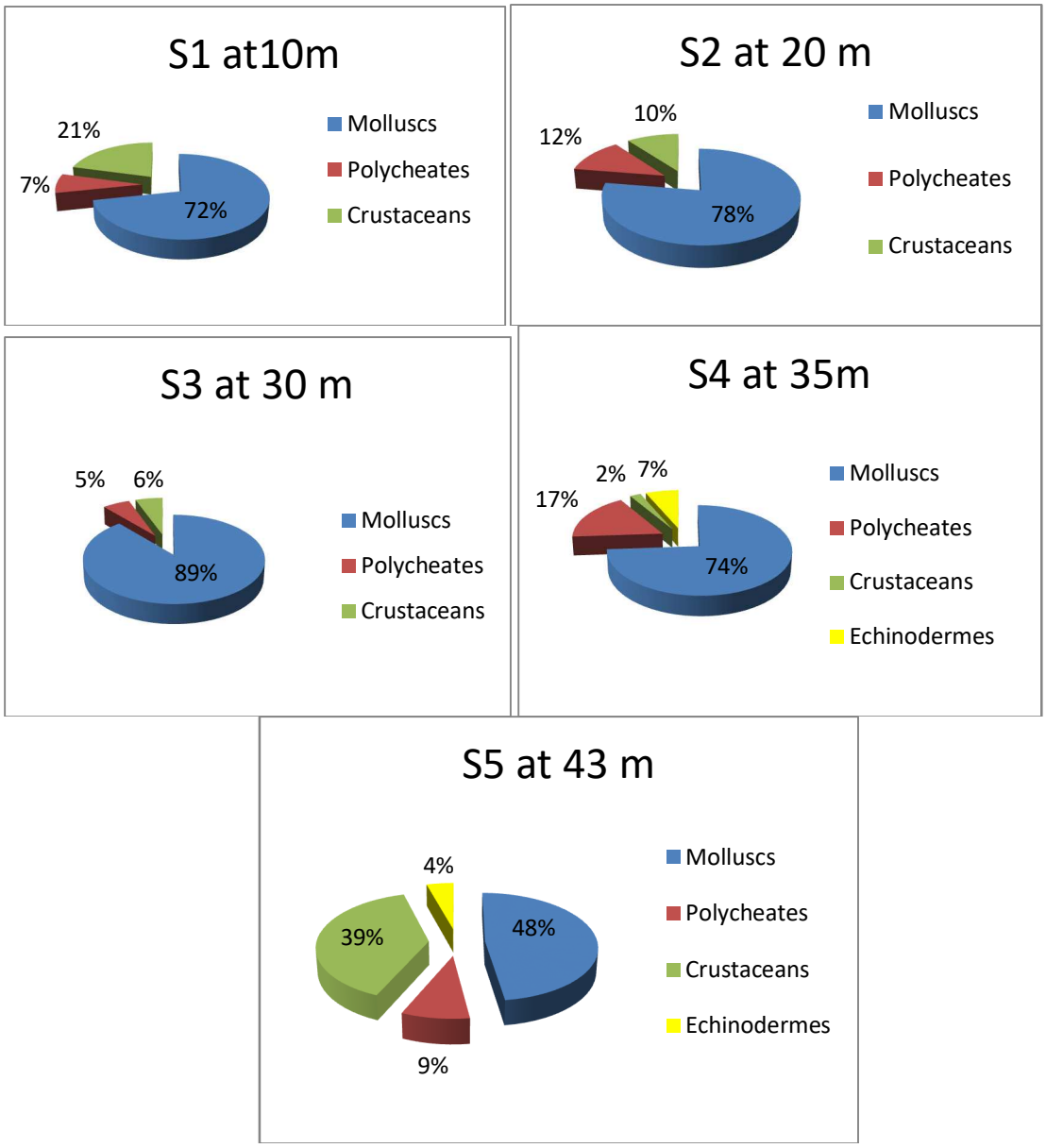

Figure 3 : Proportions of major zoological groups

The ecological classifications of the species allowed to identify eleven ecological groups where are always the **Species no ecological significance specified** (Sness) which dominate with 53%, followed by **Muddy sand** group (Sv) with a percentage of 12% in third position come the group of species of Sand Finely Calibrated by A proportion of 5%, the five (05) groups represent a dominance of 5% that is the group, posidonia herbarium,

photophilic algae, Mixticole,. The other groups are represented by low percentages which do not exceed 4%, indicating instability, large reparations, sabulicoles, fine sand, a strict vase, miniature.

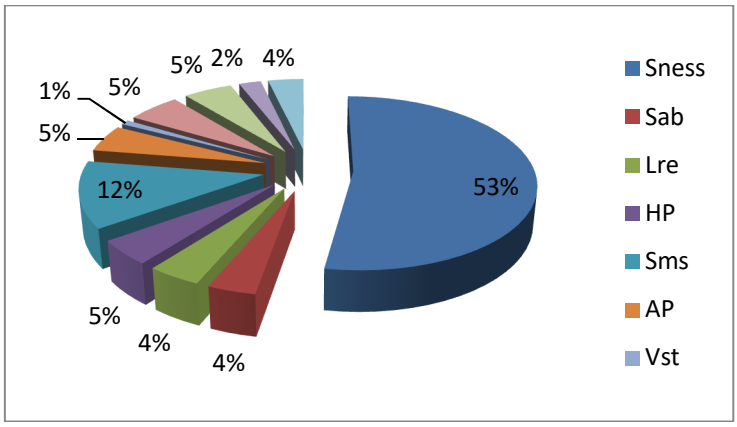

Figure 4: Main ecological groups.

The stand structure was assessed on the basis of the specific diversity indices, namely the Shannon -Weaver index (H ') and the equitability index (E'). Interpretation of the Shannon -Weaver index is often tricky, values are greater than "3" when the stand is normal and less than "1" when the stand is subjected to a disturbance **[18].**
For our station the Shannon index (H '), has a high value (4.15) which implies a healthy and well diversified environment. The equitability index (E ') has a value close to 1 (0.78) which indicates that each of the identified species is represented by the same number.
The combination of the values of the Shannon-Weaver index obtained and the calculated equitability index values shows that the stand of our station is balanced, well diversified and reflects a rich and diversified environment with a good distribution of workforce of the species present.

DISCUSSION

Benthic macrofauna have become well recognized as practical bio-indicators of habitas conditions and for finding of human activities impacts in marine environments [19].
The omnipresence of macrofauna in ecosystems attached with the large range of sensitivities exposed by diverse taxa to environmental stresses returning an attractive choice [20].
Desalination of seawater is an activity that has caused a new effect, the release of brine, in the position where salinity values were beforehand stable. This sudden modification can affect benthic community. It is practical to suppose that the plans in the vicinity of effect of the discharge from the desalination plant present communities that are more like hypersaline zones than less salty coastal areas. Important change of salinity can presumably produce exchange of some species and/or communities for others. Below usual conditions the increases of salinity in the Mediterranean marine environment are uncommon and they habitually occur inactive rise estuaries or shut systems. These hypersaline systems are typified by little diversity, and frequently elevated yield. These communities simplified and they are totally unlike to the next coastal zones characterized through a lot additional stable environmental conditions [7, 13] depicts, in an environmental effect evaluation of desalination plant in key west (florida),the extinction of the unique communities and their exchange for some organisms representative of stress situations.
The results assemble in this work advice that the communities considered are focus to elevate temporal and spatial variability, which is characteristic of communities that stay on soft bottoms where there is high hydrodynamic action [21, 22, 23]. No important changes attributable to the brine discharges from the desalination plant established. The breakdown to note any effect may be described through the elevate natural changeability that is characteristic aspect of bottoms of this kind and in addition by the fast dilution undertake by the hypersaline brine over beginning the discharge conduit, inasmuch as the brine does not ordinarily go through more 10 m as of the diffuser conduit. This speed of dilution was much faster than the charges that have been signaled for discharges conduits having single opening diffusers, where the impacts of the hypersaline brine discharges have been observed out to distance of up to 20 m from the opening [9]. Not many works have evaluated the potential impacts of brine discharges on the adjacent zone, and those that commonly do not contrast communities before and after the perturbation.Perez-Talavera and Quesada –Ruiz (2001) studied the impacts of a reserve osmosis desalination plant on *Cymodocea nodosa* and *Caulerpa prolifera* prairies of the Canary Islands and did not monitor any pronounced dangerous effects. Then again, a complete study of a site in

the Western Mediterranean established lower development and higher mortality rates for *Posidonia oceanica* at salinity levels over 39.1 psu [10].

Hypersaline brine discharges be apt to influence juvenile fish more than adult fish [24] and thus to use an influence on the distribution of the nursery. The resolution ground of sure fish species, e.g., *Xyrichtis noyacula*, Bothus *podas* and *Trachinus araneus*, did not show any important differences among the region in which the brine was discharged and the control sites, and recruits of these species were observed in the area of the discharge conduit. Potential impacts as those that have been mentioned for other species, for example, derogated osmoregulatory aptitude ,did not appear to affect the above-reported species, mainly probable on account of fast dilution of the hypersaline brine in the water. The small effect of the effluent on the benthic macrofauna community contrasts with the impacts of other discharges [25, 26,27], with have been mentioned to result in significant variations in the number and abundance of species in the zone of the perturbation like compared to other, on-impacted areas.

CONCLUSION

The results found in this work shows that hypersaline brine discharges have not necessarily had significant impact on the populations, but it is only possible that these effects can be detected in a statically significant way on a short –term basis.

The absence of any observed effect might be the results of species mobility, or of the surface area impacted. Still, no apparent impacts were observed for some other, sessile species. So if the number of desalination plants in the Mediterranean raise in the future, it would be suitable equip their discharge pipes with many punching and to locate the diffusers in hydrodynamically active area .fast dilution of the hypersaline brine discharges ought certainly help reduce several impact on benthic communities in the adjacent areas.

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