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Merja Zerga lagoon: study of the functional structure and bioassessment of the ecological quality of benthic communities

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Abstract

The study of functional diversity based on trophic groups showed a spatial stratification of benthic macrofauna at Merja Zerga lagoon. Thus, from downstream to upstream, we demarcate a successive dominance of suspension feeders, subsurface deposit feeders, grazers and surface deposit feeders, respectively. The surface deposit feeders and carnivores dominate the species richness and the biomass of the structure while grazers dominate the abundance. This structure appears to be related to the diversity of habitats, sediment granulometry and abundance of seagrass and algae. The evaluation of the state of the ecological quality of the lagoon was performed using four biotic indices BOPA, AMBI, M-AMBI and ITI. Accordingly, we highlighted a first evaluation of the lagoon ecological status on the basis of benthic macroinvertebrates. Therefore, it appeared that benthic communities of the Merja Zerga are not severely disturbed as 74% of stations were classified as acceptable ecological status.

1. Introduction

Lagoons and estuaries are very productive but highly fragile ecosystems. They are subjected to intense anthropogenic activities as they provide many goods and services. Their biological, ecological and landscape potential enabled the development of several recreational and tourist activities. They are also an open-air laboratory for research on various scientific and educational themes. These various human activities generally generate pressures that may impact biodiversity and causing malfunctioning of these ecosystems [1].

Merja Zerga lagoon is one of the most important wetlands of the Atlantic coast of Morocco, this Ramsar site contains a remarkable fauna and flora species that are of global importance. This lagoon was the subject of several studies that focused on the aquatic fauna, including the work of Lacoste [2], Rharbi [3], Ameur [4], Benbakhta [5], Dakki *et al* [6], Bayed *et al.* [7], Bazairi [8], Benhoussa [9] and Touhami *et al.* [10]. Most of those studies were devoted to the avifauna as Merja Zerga is one of the best wintering areas and relay migration between the European and African continents for many species of western Palearctic birds [11, 12, 13, 14, 15, 16, and 9]. The interest of the site for these birds is primarily due to the diversity of its natural habitats [17, 18 and 19] and the abundance and variability of benthic macrofauna which are prey of choice for these birds. Merja Zerga lagoon also plays a very important socio-economic role for the local population of more than 26 608 inhabitants [20]. However, the unsustainable exploitation and inadequate management of natural resources of the Merja Zerga caused a serious deterioration of the biodiversity of this natural heritage.

Macrobenthic fauna is recognized as a biological tool of choice and an effective indicator for highlighting disturbances affecting coastal ecosystems. In fact the use of biotic indices based on benthic macrofauna has increased since the 2000s, after the Water Framework Directive implementation (WDF; 2000/60/EC), and various biotic indices were proposed for the characterization of the quality of coastal environments [21, 22, 23, 24, 25, 26, 27 and 28]. The use of these biotic indices is now considered as an integral part of the support that contribute to decision making in the context of integrated management of the coastal zone. These biotic indices have been applied to other ecosystems outside Europe, like Chesapeake Bay in USA, where they have been revealed to give consistent measures, providing high agreement percentages with local indices [29]. Furthermore, the biotic indices were used also in Tunisia [30], Algeria [31] and Morocco [32, 33, 34, and 35]. The objective of this study is within this framework, it aims to provide a contribution to the study of the functional organization of the benthic macrofauna and the assessment of the ecological quality of Merja Zerga lagoon, using benthic macrofauna as bio-indicator.

2. Experimental details

2.1. *Study area*

Merja Zerga lagoon is located in the northern part of the Moroccan Atlantic coast (Figure 1). It has an elliptical shape, with a maximum length of 9 km and a maximum width of 5 km. It is divided into two zones of unequal surface and importance: the Merja Kahla of 3km^2 and Merja Zerga of 27km^2.Its water regime is subject to the swings of the tides and communicates with the Atlantic Ocean by the narrows. It is supplied with fresh water by the canal of Nador in the south and the Drader River in the north-east of the lagoon. The depths vary depending on the influences of the tide and the abundance of rainfall.

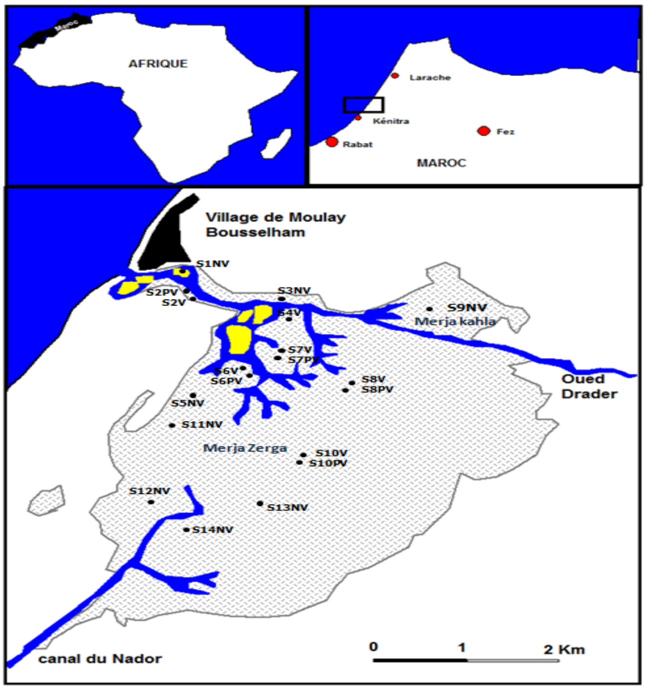

Figure 1: Location of the study area and sampling stations. S: station; V: vegetated (presence of seagrass); PV: in the proximity of seagrass NV: Unvegetated.

2.2. *Sampling*

Nineteen stations were sampled, at low tide at the sand and mudflats of intertidal area of the lagoon, during the winter 2013-2014. The choice of this period coincides with the migration and wintering period during which the lagoon receives an important number of shorebirds, which exceeds 50% of the wintering birds of Morocco [36]. These birds constitute the main consumers of benthic macrofauna. Assessing the state of the ecological quality of the lagoon during this period will be of considerable importance before undertaking a study of the frequentation of these birds at this key site in the East Atlantic Flyway [37].

The samples were taken using a PVC corer with a diameter of 12.5 cm to a depth of 20 cm. 3 replicas per station were undertaken. Each replica results of the fusion of 10 corers in a total area of about 0.36 m^2 per station. Each sample is then washed in situ on a sieve with mesh of 1 mm, the refusal of the sieve were fixed and preserved in sea water with formalin (4 %) and colored with Rose Bengal. In the laboratory, macroinvertebrates were sorted, identified to species level and counted. Biomasses were determined after calcination in the oven at 450°C for 4h. Each sample of the macrofauna was accompanied by a sample of sediment for the analyses of the organic matter and granulometry considering the classification of Chassé and Glémarec [38]. The hydrological parameters (water temperature, salinity, conductivity, resistivity, and the total dissolved solids) were also measured in situ.

2.3. *Study of the functional diversity*

The study of macrobenthic populations through their trophic organization was approached by grouping species into functional units according to their feeding type. Based on the data from the literature, in particular on the work of Fauchald & Jumars [39], Sauriau et al. [40] and those of Hily & Bouteille [41], five trophic groups were selected: suspension feeders, carnivores, subsurface deposit feeders, surface deposit feeders and grazers. To classify benthic communities of our 19 stations according to their trophic groups, we applied to the matrix of trophic group abundances, an ascending hierarchical classification (AHC) with the Primer® program - v7 package [42].

2.4. Assessment of the ecological status

Biotic indices are numerous and complementary, crossing methodologies based on various assumptions are necessary to achieve a meaningful assessment of a site. Three functional aspects have to be considered in the choice of pertinent biotic indices: (i) the species diversity, (ii) the proportion of different ecological groups, (iii) the trophic structure of the community[28]. According to these criteria, the assessment of the status of the ecological quality of Merja Zerga was assessed by using four biotic indices:

-The BOPA index (Benthic Opportunistic Polychaetes – Amphipods ratio) [43];

-The ITI (Infaunal Trophic Index) [44] is a numerical method for characterizing benthic communities according to the proportion of different trophic groups;

-The AMBI index (AZTI Marine Biotic Index) [45], calculated using the program AMBI (http://ambi.azti.es), which consists in grouping species into five ecological groups;

-The index M-AMBI (AZTI Marine Biotic Index Multivariate) [46], based on a factor analysis depending on AMBI, the biodiversity index of Shannon (H ') and species richness (S). To calculate the M-AMBI, we have taken as reference status historical data from an earlier study conducted at Merja Zerga lagoon [8].

For each index, the state of ecological quality is qualified, by reference to the European Water Framework Directive, as Excellent, Good, Moderate, Poor or Bad. The final assessment of the state of the ecological quality of the benthic ecosystem of our study site was realized by adopting an approach of 'scoring' [47]. Therefore, we give a score of 1 for the ecological states Excellent and Good. In this case, the state of the environment is considered acceptable. For the states Moderate, Poor and Bad, we assign a score of 0, which means that the quality state of the environment is not acceptable. The scores given to each of the four biotic indices used were then summed for each station (range: 0-4). This sum of scores allowed measuring the level of agreement/disagreement between biotic indices: If the sum of the scores equal to 0 or 1: agreement on an unacceptable state, 3 or 4: agreement on an acceptable state and if the sum equal to 2: disagreement on the state of the ecological quality.

3. Results and Discussion

3.2. Sediment characteristics

Four sediment types were identified in the intertidal area of Merja Zerga lagoon:

Type 1 (S1NV and S2NV) called heterogeneous muddy sands which are characterized firstly, by a rate mud between 10 and 30% and, secondly, by coarse sand-gravel rate of the order of 8% to 40%. The coarse fraction consists mainly of shell debris;

Type 2 (S3NV and S4V) appointed muddy sands, present a pelites rate between 10 and 35%, while that of coarse sand- gravel does not exceed 10%;

Type 3 (S6NV, S8V and S8NV) identified as sandy mud, with a rate of mudstones between 35 and 70% and that of coarse sand-gravel does not exceed 15%;

Type 4 (S2V, S5NV, S6V, S7V, S7NV, S9NV, S10V, S10NV, S11NV, S12NV, S13NV and S14NV) is the most represented, it is pure vases with rate of pelites is higher than 70% while the rate of coarse sand-gravel does not exceed 7%.

The lowest organic matter level is noted at downstream stations of the lagoon, which are characterized by a low rate in pelites. The level of organic matter in sediments varies between 2.64% recorded at the S1NV station and 10.56% identified at the S11NV station (Table 1).

3.2 Hydrological characteristics

Salinity showed a decreasing gradient from the downstream to the upstream of the lagoon, its values varied between 34 PSU measured at the downstream station S1NV and 2.34 PSU recorded in the upstream stations (S12NV, S13NV and S14NV) located at the mouth of the Nador canal. The conductivity and the total dissolved solids followed the same gradient exhibited by the salinity. The spatial evolution of the water temperature showed also a slight decreasing gradient from the downstream to the upstream of the lagoon. Nonetheless, the resistivity showed an inverse gradient by increasing from downstream to upstream (Table 2).

3.3 Trophic structure of benthic macrofauna

A total of 46 macrobenthic species were identified in the 19 sampled stations in the intertidal area of the lagoon (Annex). The taxonomic structure of the lagoon benthic community is characterized by a classical faunal cortege common to the lagoon environments with the presence of three major zoological groups: mollusks, crustaceans and polychaetes [48, 49 and 50]. The number of dominant species in terms of density and biomass is restricted. Hence, seven species constitute more than 95% of the macrofauna of the lagoon (*Peringia ulvae*, *Scrobicularia plana*, *Heteromastus filiformis*, *Cerastoderma edule*, *Hediste diversicolor*, *Cyathura carinata* and *Lekanesphaera rugicauda*).

Table 1: Spatial variation of sediment granulometry and organic matter in the different stations. OM: Organic Matter; CSG: Coarse Sands and Gravels.

Station	% OM	% CSG	% Fine Sand	% Pelites
S1 NV	2.64	11.57	73.17	14.59
S2 V	9.63	1.08	12.07	86.79
S2 PV	2. 94	15.05	58.23	26.33
S3 NV	3.35	3.63	73.55	22.61
S4 V	3.35	1.37	63.66	34.34
S5 NV	10.14	2.21	14.17	83.53
S6 V	8.19	2.33	22.42	75.20
S6 PV	5.94	2.05	40.47	57.33
S7 V	10.35	1.43	16.30	82.11
S7 PV	6.31	1.82	22.75	73.69
S8 V	5.99	7.77	27.95	64.25
S8 PV	4.63	7.89	33.04	58.22
S9 NV	8.66	5.42	14.73	79.62
S10 V	10.22	4.02	9.11	86.82
S10 PV	8.65	6.80	12.98	80.19
S11 NV	10.56	2.80	4.77	92.29
S12 NV	9.36	0.49	1.05	98.38
S13 NV	7.88	0.59	3.27	96.05
S14 NV	8.07	1.59	3.73	94.61

Table 2 : Variation of hydrological parameters in different stations of Merja Zerga lagoon: SAL: salinity; T: water temperature; COND: conductivity; RSV: resistivity and TDS: rate of total dissolved solids.

Station	SAL (PSU)	T (°C)	COND (µS /cmA)	RSV (Ohm·cm)	TDS (ppm)
S1 NV	34.4	16.52	43730	19	26070
S2 NV	32.48	16.28	41330	20	24770
S3 NV	23.27	13.91	28700	27	18180
S4 V	15.84	11.54	19260	39	12940
S5 NV	16.42	12.9	20570	37	13350
S6 V	22.34	13.66	28480	28	18150
S6 PV	22.34	13.66	28480	28	18150
S7 V	8.66	12.67	11340	68	7407
S7 PV	8.66	12.67	11340	68	7407
S8 V	8.06	12.42	11010	69	7232
S8 PV	8.06	12.42	11010	69	7232
S9 NV	7.52	12.62	9946	77	6502
S10 V	4.7	11.89	10420	72	6935
S10 PV	4.7	11.89	10420	72	6935
S11 NV	15.04	12.61	18850	41	12330
S12 NV	2.34	12.49	6391	119	4192
S13 NV	2.34	12.49	6391	119	4192
S14 NV	2.34	12.49	6391	119	4192

Functional diversity of benthic communities of the lagoon is characterized by the presence of the five trophic groups: suspension feeders (S), carnivores (C), subsurface deposit feeders (SSD), surface deposit feeders (SD) and grazers (G). This functional diversity observed in Merja Zerga is an indicator of the availability and diversity of trophic resources for benthic species.

The analysis (AHC) based on the density matrix of trophic groups of the 19 sampled stations showed a spatial stratification of the stations according to their functional diversity (Figure 2). This spatial differentiation of macrofauna according to the trophic guilds is generally related to the environmental factors of the lagoon. In fact, previous studies have shown that the spatial distribution of the benthic communities at Merja Zerga lagoon follows an upstream-downstream gradient, resulting from the combined action of all mesological factors especially salinity, edaphic and hydrodynamic parameters as well as the presence of seagrass [51, 10].

Three groups of stations were identified (GT1, GT2 and GT3) whose rate of participation by number of trophic categories varies widely. The preponderance of one of the trophic categories in these groups is influenced by the dominance of pilot species.

The group GT1 (downstream) contains populations essentially characterized by subsurface deposit feeders which contribute with 73% of the similarity of this group followed by carnivores which present 10%. The stations representing this group (S2PV, S2V and S3NV) are characterized by heterogeneous sediment and high energy levels view their proximity to the narrow. These stations are also very frequented because of their proximity to camping and the two points of embarkation of the lagoon.

The group GT2 includes the central stations of the lagoon, is divided into two subgroups GT2 V (vegetated stations) and GT2 PV (stations near to vegetation). Their populations are characterized mainly by grazers (82%) followed by surface deposit feeders (13%). This dominance is favored by the presence of seagrass which constitutes the essential source of food for these trophic categories.

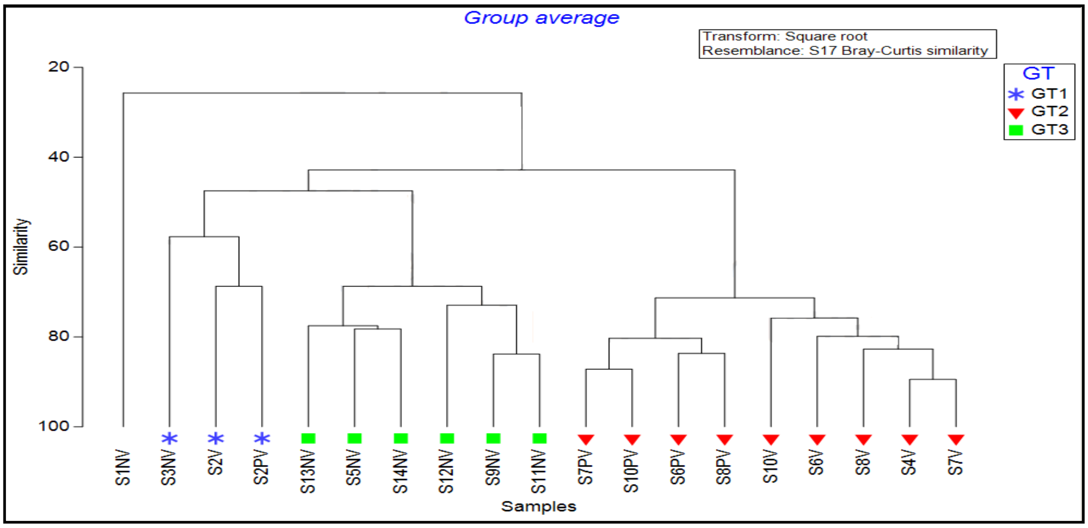

Figure 2: Dendrogram obtained from the ascending hierarchical classification (AHC) based on the matrix of trophic groups densities. GT1, GT2, and GT3: clusters of stations.

The group GT3 consists of upstream stations of the lagoon characterized by low hydrodynamics and muddy sediment, rich in organic matter (Table 1). Their benthic communities are mainly composed of surface deposit feeders. The latter are known to be better represented on muddy substrates under the influence of continental sediment inputs [52, 53].

The S1NV station, the most oceanic of the lagoon, is very isolated and it is not related to any group, its population is mainly composed of suspension feeders related to environment with strong currents that predominate at the sand flats located close to the pass area.

Analysis of the variation of the relative density and biomass of different groups (Figure 3) showed that despite the low density of carnivores at the GT1 group, they dominate the biomass level; this is due in particular to the presence of large individuals of the crustacean *Clibanarius erythropus* at the S2V station. Contrary to carnivores, the subsurface deposit feeders represent only 9% of the overall biomass of GT1 but dominate in numbers due to species of small sizes such as *Heteromastus filiformis* and *Capitella capitata*.

The largest biomass of grazers are observed at the GT2 group populations because of the strong presence of gastropod *Peringia ulvae* that proliferates at the vegetated stations or those close to them.

The surface deposit feeders dominate the biomass and abundance of populations of muddy habitats in the group GT3. The population of the S1NV station is dominated numerically as well as in biomass by suspension feeders represented by *Cerastoderma edule*, a species of relatively large size.

3.3 Assessment of the ecological status

The overall pattern of ecological quality status at Merja Zerga lagoon was not the same according to all four biotic indices used in this study (Table 3). Despite the fact that they share the common goal of assessing the system's ecological quality, the conceptual basis of each index is based on different assumptions and parameters. As an example, the marine biotic index AMBI, based on the distribution of species into five ecological groups according to their sensitivity to an increasing stress gradient of organic matter enrichment [54, 55 and 56], showed that most stations of Merja Zerga lagoon have a good ecological status except for three downstream stations (S2PV, S2V and S3NV) that present a moderate ecological status, because of the dominance of subsurface deposit feeders at these stations especially polychaete *Capitella capitata*, an opportunistic species of the first order and *Heteromastus filiformis*, opportunistic species of second order. The BOPA index classified all stations in an acceptable state (95% as excellent and 5% in good state).

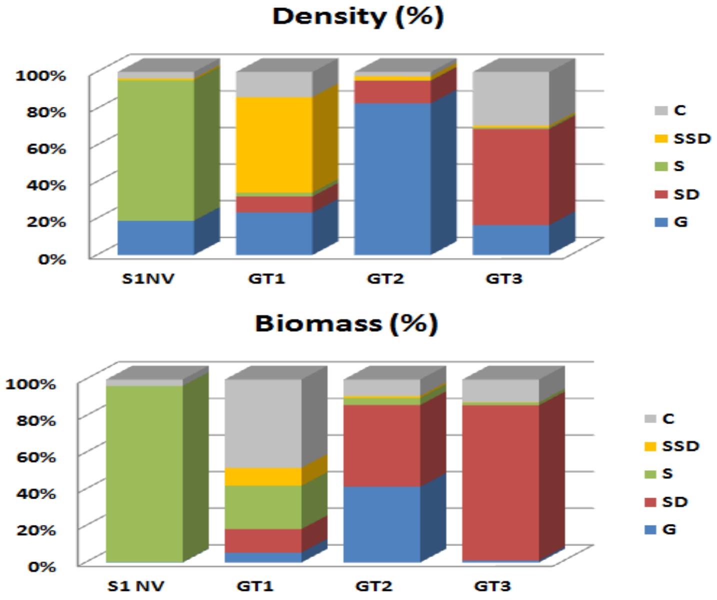

Figure 3: Spatial variation of density and biomass of trophic groups of macrozoobenthos at the identified groups of stations. (S) Suspension feeders, (C) Carnivores, (SSD) Subsurface Deposit feeders, (SD) Surface Deposit feeders and (G) Grazers.

Table 3: Status of the ecological quality according to the four biotic indices.

Stations	BOPA	ITI	AMBI	M-AMBI
S1NV	High	High	Good	Poor
S2V	High	Moderate	Moderate	Good
S2PV	Good	Poor	Moderate	Moderate
S3NV	High	Moderate	Moderate	Moderate
S4V	High	Moderate	Good	Good
S5NV	High	Moderate	Good	Good
S6V	High	Good	Good	Good
S6PV	High	Moderate	Good	Good
S7V	High	Good	Good	Good
S7PV	High	Good	Good	Moderate
S8V	High	Good	Good	Good
S8PV	High	Good	Good	Good
S9NV	High	Moderate	Good	Good
S10V	High	Moderate	Good	Good
S10PV	High	Good	Good	Good
S11NV	High	Moderate	Good	Good
S12NV	High	Moderate	Good	Moderate
S13NV	High	Moderate	Good	Good
S14NV	High	Moderate	Good	Moderate

Only opportunistic polychaetes and amphipods have a direct effect on this index calculation and when low values of opportunistic species are presented, the BOPA index classify the area as excellent/good status. The ITI is based on the evaluation of the feeding behavior of the benthic invertebrates as a response to the organic matter content in the sediment or water column. According to this index, an undisturbed environment is characterized by a majority of suspensivores; while the dominance of subsurface deposit feeder main that the environment is degraded [44]. This index was the most severe in assessing the stations ecological status and classified 63% of stations of the stations as not acceptable, 31% in a good state, and attributed an excellent state to the S1NV station given the dominance of suspension feeders in its population. The M-AMBI index categorized 68% of the stations in good ecological status and 26% in moderate state, while the station (S1NV) is considered of poor quality. This multivariate tool is based on the computation of Shannon-Wiener diversity index, number of species and AMBI. Its results express the relationship between the observed values and reference condition values taken from a previous study on the benthic macrofauna of Merja Zerga [8].

The problem of disagreement between biotic indices was also identified by Blanchet *et al*. in two semi-enclosed ecosystems, Marennes-Oléron Bay and Arcachon Bay [47] along the French west coast, and also by Quintino *et al*. [27] in a study including three estuarine and coastal areas of the western coast of Portugal. Nevertheless, the use of several indices is always advised in order to get a better evaluation of the benthic community health [57, 58, and 59]. In this study, the use of the Scoring approach based on the four selected biotic indices showed that 73% of stations have an acceptable quality by judgment of three or of all biotic indices (Table 4); the same results were obtained in an earlier study in Merja Zerga lagoon [32].

Table 4: Final assessment of the ecological status of the Merja Zerga lagoon

Stations	BOPA	ITI	AMBI	M-AMBI	SCORE	State of the environnent
S1NV	1	1	1	0	3	ACCEPTABLE
S4V	1	0	1	1	3	ACCEPTABLE
S5NV	1	0	1	1	3	ACCEPTABLE
S6V	1	1	1	1	4	ACCEPTABLE
S6PV	1	0	1	1	3	ACCEPTABLE
S7V	1	1	1	1	4	ACCEPTABLE
S7PV	1	1	1	0	3	ACCEPTABLE
S8V	1	1	1	1	4	ACCEPTABLE
S8PV	1	1	1	1	4	ACCEPTABLE
S9NV	1	0	1	1	3	ACCEPTABLE
S10V	1	0	1	1	3	ACCEPTABLE
S10PV	1	1	1	1	4	ACCEPTABLE
S11NV	1	0	1	1	3	ACCEPTABLE
S13NV	1	0	1	1	3	ACCEPTABLE
S2PV	1	0	0	0	1	NOT ACCEPTABLE
S3NV	1	0	0	0	1	NOT ACCEPTABLE
S12NV	1	0	1	0	2	DISAGREEMENT
S2V	1	0	0	1	2	DISAGREEMENT
S14NV	1	0	1	0	2	DISAGREEMENT

This study revealed that the benthic communities are not deeply disturbed and therefore appear to tolerate the current anthropogenic pressures. The opening of the lagoon on the ocean allows the regular renewal of the waters of Merja Zerga, which is a natural asset limiting the eutrophication problems associated with primary production and the local accumulation of organic matter.

Stations located at the central mudflats of Merja Zerga seem to be all in an acceptable ecological state. In fact, most of these stations are characterized by the presence or proximity of the seagrass beds, considered as indicators of a good environmental quality with respect to eutrophication [60, 61 and 62]. However five stations were found to be in unacceptable state; first the downstream stations (S2V, S2PV and S3NV), very frequented by tourists and fishermen because of their proximity to camping and the two points of embarkation of the lagoon. Second, the upstream stations (S12 NV and S14 NV) close to the artificial channel of Nador which drains the excess of irrigation water from the Gharb plain. The water richness of this channel by phytosanitary products contaminates the sediments of the last two stations, resulting in destruction and deterioration of their benthic macrofauna.

Conclusions

The present study highlighted the diversity of benthic macrofauna, the state of its trophic organization and the bioassessment of the ecological quality of the Merja Zerga lagoon. Five trophic groups were identified showing a spatial downstream-upstream stratification. This structure reflects a high diversity of trophic resources of the site for benthic macrofauna. Its trophic organization was dominated by a few species, such specificity is a common characteristic of benthic communities of lagoon environments which are very vulnerable and highly fragile. The results obtained from the biotic indices showed that benthic communities of Merja Zerga are not deeply disturbed and so appear to tolerate the impact of current human pressure. Nevertheless five stations were found to be in an unacceptable state, the downstream stations, very frequented by tourists and fishermen and two upstream stations close to the artificial channel of Nador. These results give a first overview of the ecological status of the lagoon based on benthic macroinvertebrates and should be considered as a step to be integrate with other parameters towards more comprehensive and robust evaluation of human pressures and their impact to achieve a sustainable management and good preservation of the site.

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Annex: List of taxa collected in the 19 stations sampled during the study.

Station	S1NV	S2V	S2PV	S3NV	S4V	S5NV	S6V	S6PV	S7V	S7PV	S8V	S8PV	S9NV	S10V	S10PV	S11NV	S12NV	S13NV	S14NV
Gastropods																			
Bittium reticulatum		x					x				x		x		x	x			
Cochlis vittata		x			x														
Gibbula pennanti							x												
Haminoea navicula						x	x	x							x				
Hydrobia acuta		x	x																
Peringia ulvae	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
Nassarius sp.		x	x		x		x	x											
Tritia pfeifferi		x	x				x												
Bivalves																			
Abra alba		x			x				x		x				x				
Abra tenuis					x				x	x	x								
Cerastoderma edule	x		x	x	x		x	x	x	x	x	x	x	x	x	x			
Ruditapes decussatus		x			x		x	x	x		x	x	x			x			
Scrobicularia plana		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Venerupis corrugata									x	x			x						
Crustaceans																			
Carcinus maenas					x	x	x	x		x				x			x		
Clibanarius erythropus		x																	
Cyathura carinata		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Gammarus insensibilis								x			x				x				
Idotea chelipes		x	x		x		x		x		x	x							
Lekanesphaera rugicauda		x	x	x	x		x		x	x	x	x		x	x				
Melita palmata		x		x	x		x	x	x	x	x	x		x	x	x			
Monocorophium acherusicum								x	x		x							x	
Palaemon elegans		x						x									x		
Palaemon serratus							x					x							
Pinnotheres pisum	x																		
Sphaeroma serratum				x	x						x				x				
Upogebia pusilla		x		x															
Polychaetes																			
Capitella capitata		x	x	x	x				x		x						x		
Glycera tridactyla		x																	
Hediste diversicolor		x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x
Heteromastus filiformis		x	x	x	x	x	x	x	x		x	x	x	x		x			x
Lumbrineris tetraura	x																		
Nephtys Hombergii		x																	
Mediomastus fragilis					x						x								
Lagis koreni				x															
Phyllodoce sp.		x												x					
Polydora ciliata							x							x	x				
Prionospio fallax																			x
Pseudopolydora antennata															x				
Scoloplos armiger	x	x	x				x	x											
Streblospio shrubsolii					x				x		x			x	x			x	
Others																			
Anguilla anguilla											x								
Chironomidae larvae					x	x	x				x	x		x	x			x	
dolichopodidae larvae				x	x	x		x		x									
Nemertea und.				x			x				x								
Pomatoschistus microps							x	x									x	x	