ORGANIC MATTER COMPOSITION, BACTERIA RESPONSE AND FUNCTIONING IN WELL ESTABLISHED FISH FARM SEDIMENTS OF THE LIGURIAN SEA (WESTERN MEDITERRANEAN)

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Abstract

The impact of a well established fish farm has been investigated in surface sediments of the Ligurian Sea in order to assess the biodeposition, bacteria response and functioning at a mature stage of organic enrichment. The biopolymeric fraction of organic matter showed very high values beneath the fish cages. Bacteria abundance was also very high and was positively correlated with OM values. Although enzymatic activity recorded high level in fish farm sediments, bacterial degradation rates showed a functional stress, thus representing a valuable environmental index to highlight the unbalance occurring between the supply and exploitation of OM in eutrophic environments.

Key-words: Bacteria; Organic matter; Aquaculture

The large diffusion of intensive fish-farm activities on the continental shelf of the Mediterranean Sea is causing increasing concern for the strong environmental impact. The most evident effects of the fish cages on bottom sediments are the accumulation of organic matter (OM) and the progressive transformation of the substrate into a flocculent anoxic environment (1). Previous studies have clearly demonstrated that disturbance induced by increasing organic loads in coastal areas might determine changes in the community structure and biodiversity of the benthic assemblages (2), and in some extreme cases might even result in azoic sediments (2). However little is known on the functioning and response of the benthic community and in particular to those compartments more directly affected by OM input such as bacteria (3).

We studied the impact of organic loads due to the biodeposition of a well established fish farm in a coastal area of the Ligurian Sea (Gulf of La Spezia, Western Mediterranean) in order to assess organic matter composition, bacterial response and functioning at a mature stage of organic enrichment.

Sediment chemistry and microbial parameters were investigated in June, July, September and October 2000 at two stations located along a transect crossing the farming area and directed from coast to the open sea (inshore and offshore) while a third station was investigated at about 200m distance and served as a control (Fig. 1).

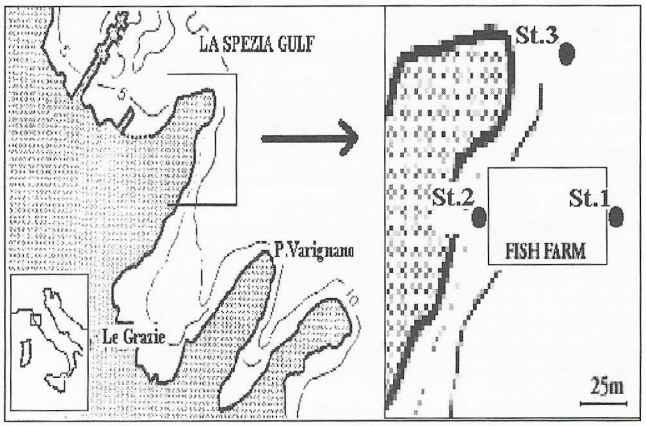

Fig. 1- Sampling area and stations locations (Gulf of La Spezia, Western Mediterranean)

Reducing conditions were recorded in the top sediment layer for stations located under the fish cages (Eh<-50mV). The accumulation of organic matter (in term of proteins, carbohydrates and lipids) were significant (Fig. 2a) and higher in June and October; moreover the highest OM concentrations were detected at the inshore station where water exchange was scarcer. Lipids and carbohydrates highlighted the most pronounced changes if compared to the control while proteins were the more conservative; lipids in particular showed very high values (up to 4973.2 μg g^{-1}) in relation to the feeding activity and could be identified as important biomarkers of organic loads in fish farm sediments.

Benthic bacteria appeared to be strictly related to organic enrichment as their abundance were three fold higher (up to 344.38 108cells g-1) in stations beneath the cages if compared to the control. The autofluorescent cells (AFC) accounted for less than 1.5% of total bacterial abundance (TBN). Furthermore the AFC to TBN ratio does not represent a useful tool in evaluating the impact of biodeposition displaying similar values both in fish farm and control stations (3).

(a)

Area	Depth (m)	Lipids ($\mu g g^{-1}$)	Proteins ($\mu g g^{-1}$)	Carbohydrates ($\mu g g^{-1}$)
Station 1	10	1706.851	1922.585	3469.949
Station 2	10	3979.704	2593.042	3719.307
Station 3	10	1115.259	2124.805	812.843

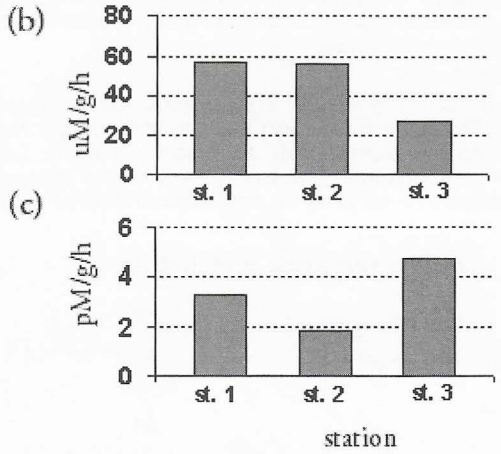

Fig. 2 – Four months average of (a) OM values, (b) aminopeptidase activity and (c) aminopeptidase activity per bacterial cell for the top 1 cm sediment layer in the three sampling stations.

The dynamic of microbial community has been investigated by means of functional parameters such as the Frequency of Dividing Cells (FDC) and aminopeptidase enzymatic activity. Both FDC than aminopeptidase displayed higher absolute values in sediment beneath the cages; by contrast enzymatic activity per cell was lower (Fig 2b,c). According to what was observed in other eutrophic systems such as the Northern Adriatic Sea (4) we hypothesise that in conditions of strong and continuous organic enrichment the bacterial degradation rates may show a functional stress. This can be viewed as a valuable environmental index to highlight the unbalance occurring between the supply and exploitation of OM in eutrophic environments.

3. References

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