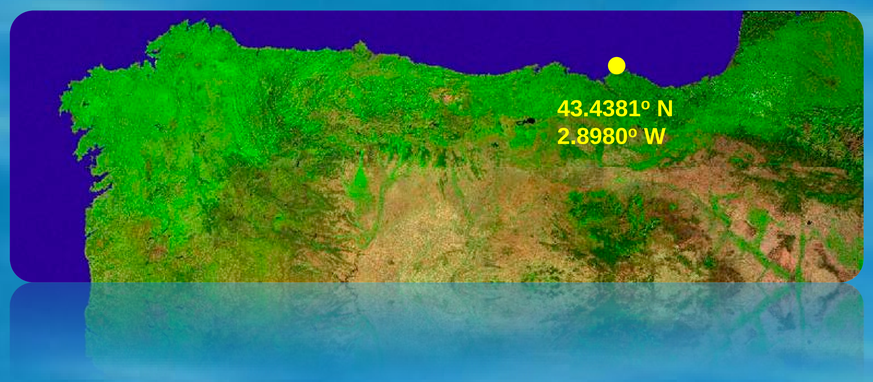
Physiological state and adaptation to the environment of the bacterial community in coastal waters of Southeastern Bay of Biscay

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OBJECTIVE

The aim of this study was to investigate the physiological state of the bacterial community in coastal waters of Southeastern Bay of Biscay under different environmental situations in order to find whether the physiological behavior of the community was closely related to their degree of adaptation.



WORKING STRATEGY

Surface samples were collected from the Armintza station (Biscay, Spain, see map) from February to June 2011 in three sampling sessions: in a situation of Low Production (LP), in a Transitional period (T) and in a situation of High Production (HP). The sampling sessions consisted in five sample collections within two days from each other.

METHODOLOGY

The samples were characterized according to their microbial standing stocks, heterotrophic processes and main environmental variables:

- Bacterial Production (BP) **(1)**
- Bacterial Respiration (BR) **(2)**
- Bacterial Growth Efficiency (BGE) **(3)**
- Aminopeptidase activity (Vmax) **(4)**
- Heterotrophic Bacteria (HB) **(5)**
- Heterotrophic NanoFlagellates (HNF) **(5)**
- Large and small picophytoplankton **(6)**
- Chlorophyll *a* (Chl *a*) **(7)**
- Temperature
- Total Inorganic Nitrogen (TIN) **(8)**
- Phosphate **(8)**
- Silicate **(8)**

RESULTS AND DISCUSSION

Physiological state of the bacterial communities

• The BGE values were similar in the LP and HP situations, and higher than in the T situation *(Fig. 1)*. In the LP and HP situations the bacterial communities showed a close coupling between production and respiration rates and thus, they were well-adapted to the environment *(Fig. 2)*. Previous work in this ecosystem showed changes in species composition of the bacterial community along the seasonal cycle. These results highlighted that different communities may show similar growth efficiencies in contrasted environmental situations.

• However, in the transitional period, the low BGE values *(Fig. 1)* and the uncoupling between production and respiration *(Fig. 2)* indicated that the physiological state of the bacterial community was changing, driving more carbon into energy yielding processes, and suggesting that the community was not functionally adapted to the ecosystem.

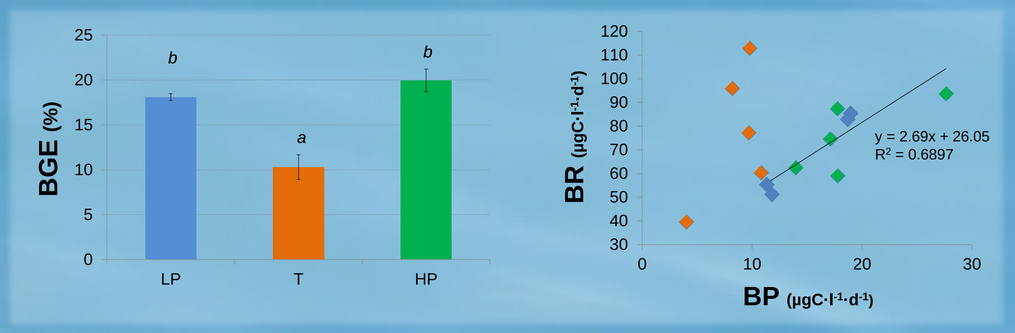


Fig. 1- *Bacterial Growth Efficiency (%) average values and standard errors over the study period. Values in the T situation were lower than in the LP and HP situations (Tukey-Kramer method, P<0.05).*

Fig. 2- *Relationship between BP and BR in the three contrasted environmental situations (T orange, LP blue and HP green).*

- Likewise, aminopeptidase activity (V_{max}) was also significantly lower in the transitional situation than in the LP and HP situations *(Fig. 3)*.
- Aminopeptidase activity and BGE values were positively correlated suggesting that BGE of the community is related to the capacity to hydrolyze polymeric compounds. Consequently, hydrolytic activities could be considered as an indicator of adaptation of the bacterial community to the environment *(Fig. 4)*.



Fig. 3- *Aminopeptidase activity rates (V_{max}), average values and standard errors over the study period. Values in the T situation were lower than in the LP situation (Tukey-Kramer method, P<0.05).*

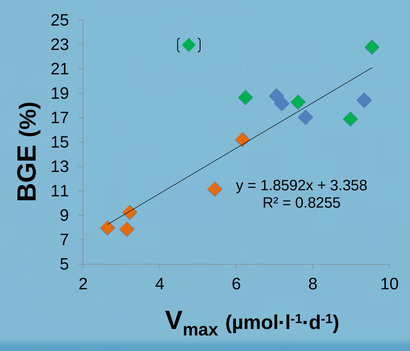


Fig. 4- *Relationship between Bacterial Growth Efficiency and aminopeptidase activity (HP5 data were not included in the regression) (T orange, LP blue and HP green).*

Environmental situation of the ecosystem

- The average temperature of the water ranged between 12ºC (in LP) and 18.8ºC (in HP) during the study period.
- The concentration of inorganic nutrients was higher in the LP situation and showed a pronounced decrease in the transitional period *(Fig. 5)*.
- A peak in chlorophyll *a* concentration and picophytoplanktonic abundance at the end of the LP situation *(Fig. 6)* evidenced the existence of an early spring bloom that would drive changes in the nutritional status of the environment and subsequently in the physiological state of the community due to “bottom-up” processes. The changes in the physiological state were accompanied by changes in the species composition (Uranga A. *et al.*, ISOBAY 13).

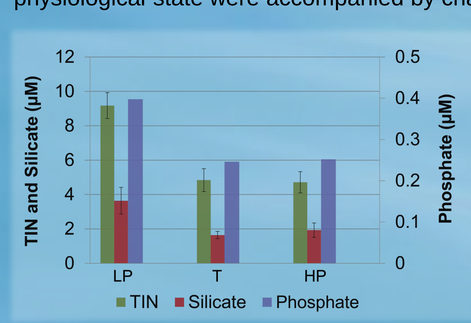


Fig. 5- *Main inorganic nutrient (µM) average values and standard errors over the study period.*

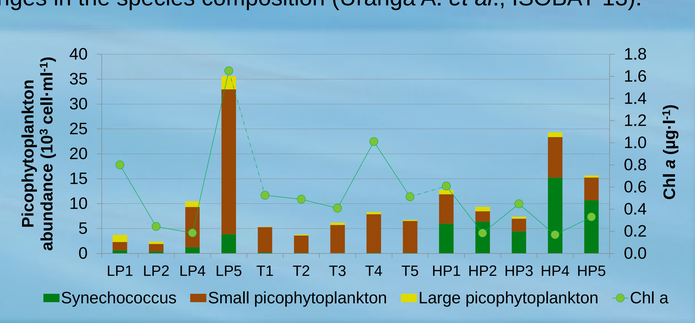
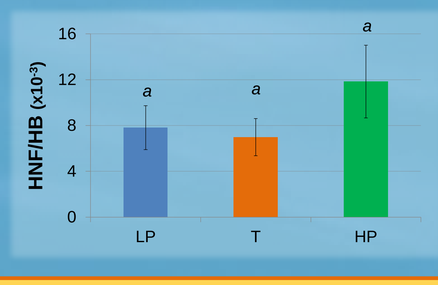


Fig. 6- *Picophytoplanktonic abundance (10^3 cell·ml^{-1}) and chlorophyll a concentration (µg·l^{-1}) over the study period.*



- In the HP situation the grazing pressure increased as it is shown by the ratio HNF/Heterotrophic Bacteria *(Fig. 7)*. The selective grazing due to heterotrophic nanoflagellates would have changed the key members of bacterial communities by selecting the best adapted.

Fig. 7- *HNF/HB ratio average values and standard errors over the study period (T orange, LP blue and HP green). Ratio values were not significantly different from each other (Tukey–Kramer method, P>0.05).*

CONCLUSIONS

1. There are two contrasting environmental situations maintained over time (HP and LP); however, the bacterial communities are well adapted, which can be deduced from the high BGE values and high rates of hydrolytic activity.
2. Between these two contrasted situations, there is a short transitional period with low BGE values and low hydrolytic activity in which the community is not fully adapted to the ecosystem.
3. The changes in the adaptation may be due to noticeable changes in its specific composition as a result of "bottom up" control in the shift from low production to transition period and “top down" control in the change of transition to high production period due to the selective grazing of heterotrophic nanoflagellates.

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