SEDIMENT MOBILIZATION AND SEAWATER WARMING AFFECT ECOPHYSIOLOGY OF THE CLAM POLITITAPES RHOMBOIDES

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Introduction

High-energy hydrodynamic events associated to currents and waves may disturb bivalve mollusks´ ecophysiology, especially those buried in the the sea bed due to sediment mobilization. Evidences of massive mortality for the clam *Polititapes rhomboides* (banded carpet shell clam) in Galicia (NW Spain) have been associated to warm water temperatures and high wave magnitudes above climatic averages and the presence of rickettsias (intracellular prokaryotic colonies) in gills (Villalba et al. 1999; Darriba et al. 2019; Villacieros-Robineau et al. 2021).

Material and Methods

Behavioural, ecophysiological and immune system responses of the clams subjected to sediment high mobilization cycles (SM) and seawater warming (SW) were monitored. A number of 420 clams (35 per tank) were disposed in twelve experimental tanks (three tanks per treatment: SM *vs.* calm scenarios, and temperature: 15 *vs.* 18ºC) (Figure 1). Responses were analysed following three-way ANOVAs (treatment, temperature regime and SM cycle).

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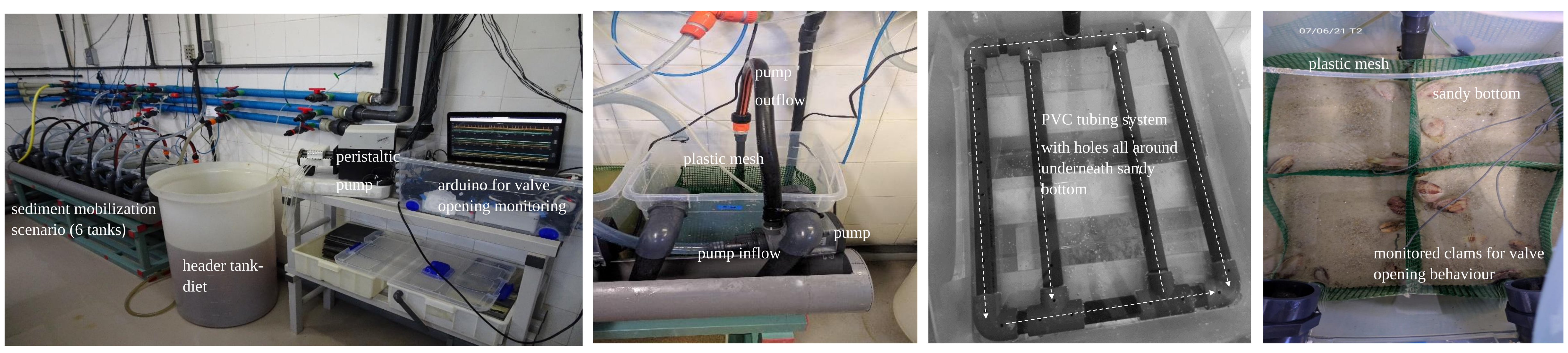

Figure 1. (A) Experimental set-up showing half of the complete design (6 experimental tanks, header tank with the diet and peristaltic pump together with the valve opening monitoring cables and computer). (B) A single experimental tank showing the mesh structure (∅ 16mm^2) to individualize clams for valve opening monitoring at each of the four quadrants per tank and the pump used for SM. (C) PVC tubing distribution on the bottom of each experimental tank for creating currents that mobilize the sandy floor (holes each 4 cm) . (D) sediment covering the bottom of each tank showing clams unburied after SM cycles.

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Results and Discussion

Valve opening of clams was negatively affected by sediment remobilization (SM) (Figure 2). Recovery after such disturbance supposed comparable valve opening values than non-disturbed scenario. Seawater warming (SW) and SM presented synergistic effects causing the lowest opening amplitude though not statistically significant with regard to SM and cold treatment (Figure 2).

SM and SW caused abrupt decrease and increase in clearance rates of the clams, respectively (not shown). Reduction of valve opening during high SM may have altered filtration processes of the food particles whereas temperature increase may have not overpassed the optimal range for maintaining filtration activity.

Metabolic rates as oxygen consumption (VO_2) showed an increase (greater metabolism) with both SW and SM. Both abiotic factors of stress simultaneously supposed the greatest metabolic rates (not shown).

Scope for Growth (SFG), as potential growth values (Jules.h^{-1}) integrating energy uptake through filtration and food absorption, and energy expenditure through metabolism, showed significant differences with regard to calm *vs.* sediment mobilization treatments (Figure 3A). By contrast, SFG did not change significantly with temperature increase. Re-burrowing actions after the successive SM cycles were significantly activated by temperature increase (Figure 3B).

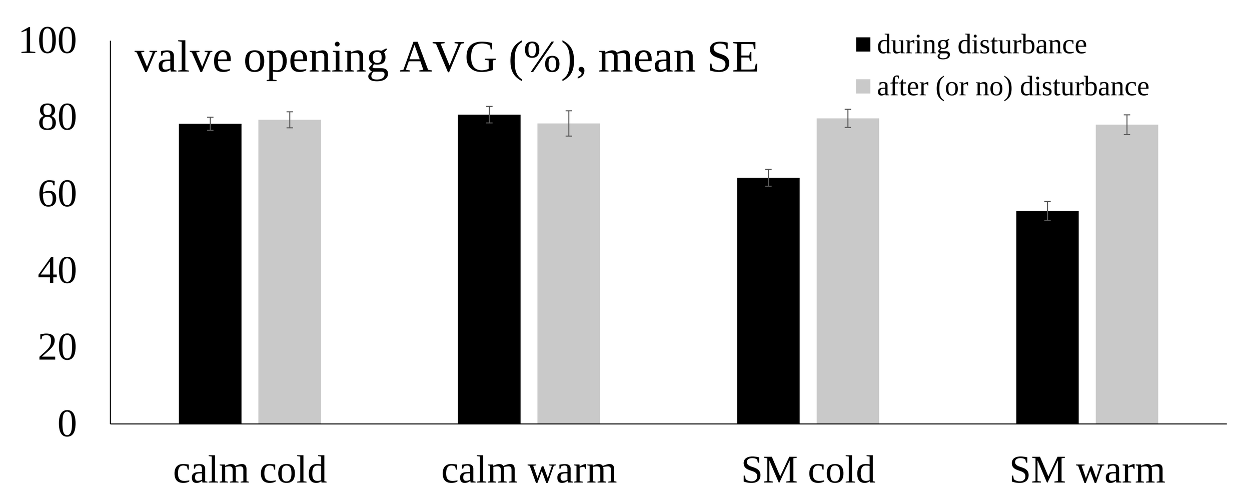

Figure 2. Valve opening (%) of the clams during the experimental time as a function of treatments and categories e.g. during SM and recovery periods between SM cycles.

Nitric oxide (NO) production increased synergistically with seawater warming and sediment remobilization (Figure 4A). Taking into account the four cycles of SM, clams responded by increasing NO production as early as the first cycle in what we could call an acute effect. However, the most striking effect was the increment of the NO basal levels (initial time) after a second SM cycle, suggesting that clams achieve a kind of alertness the first time they are exposed to a stimulus through a mechanism possibly related to "trained immunity" (Figure 4B).

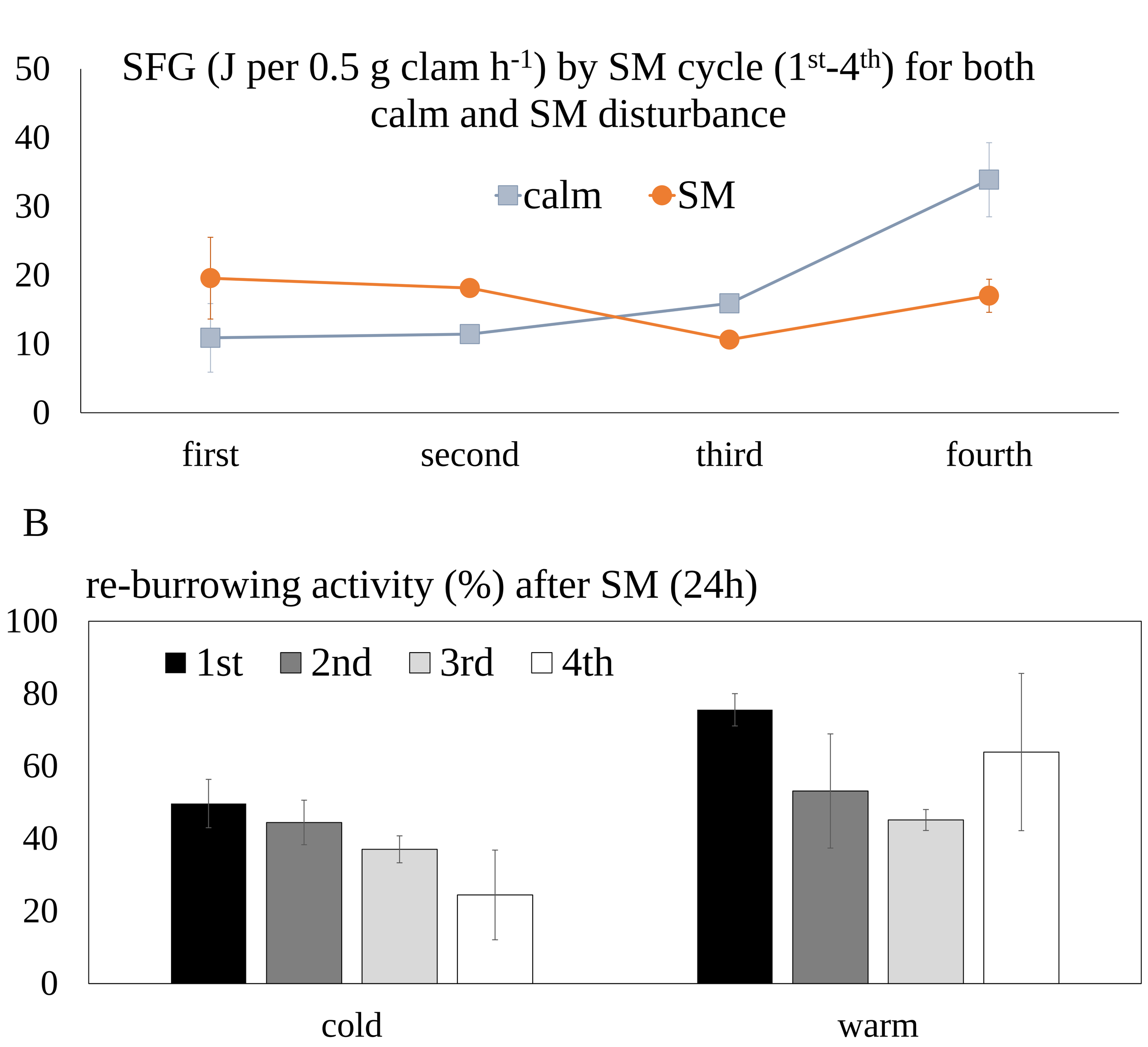

Figure 3. (A) SFG (J per 0.5 g clam h^{-1}) and (B) re-burrowing actions (% of individuals) as a function of SM and calm scenarios and temperatura, respectively, for the four SM cycles

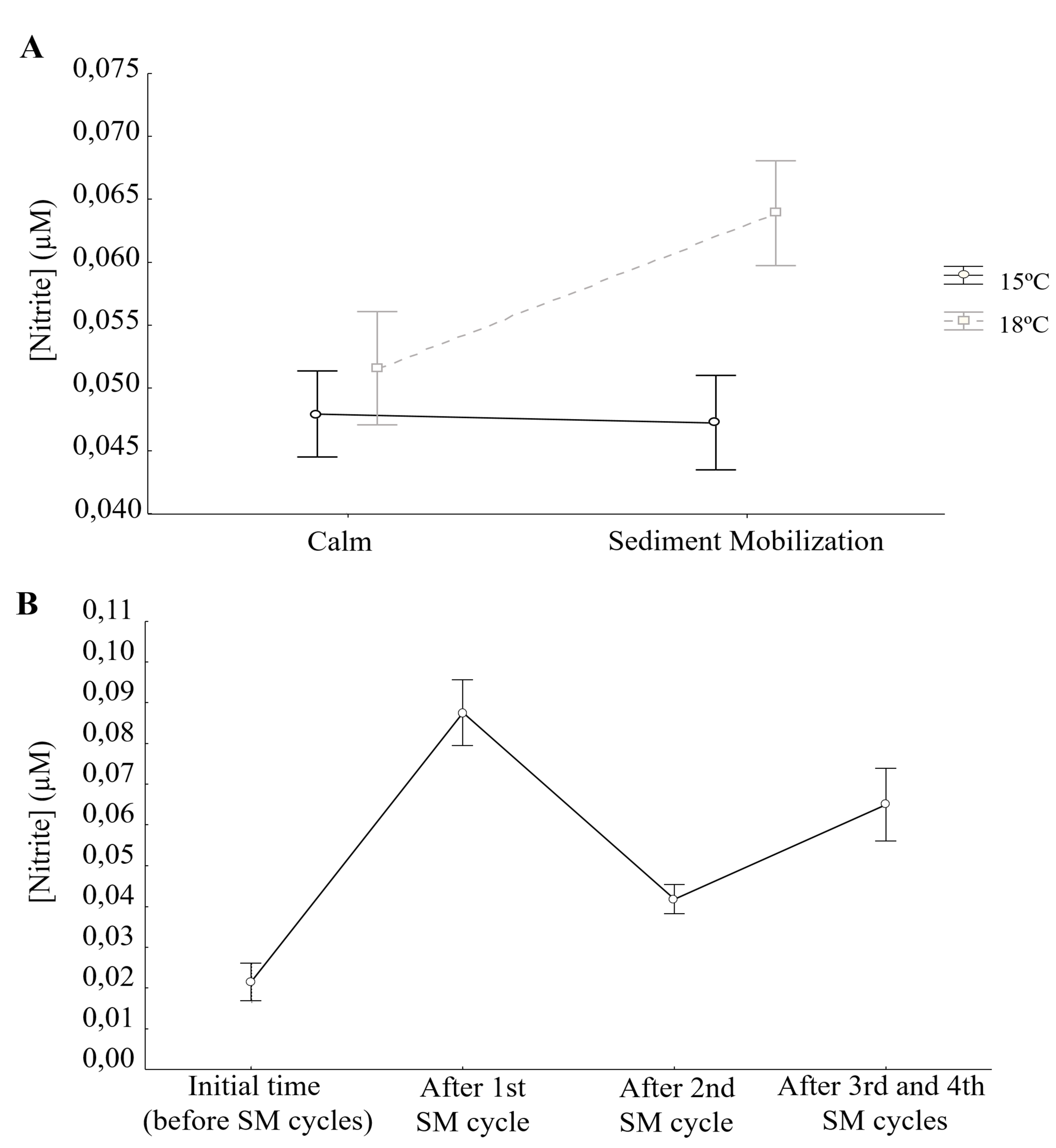

Figure 4. Nitric oxide (NO) production. (A) Synergistic NO increase with SW and SM. (B) NO response over the time course (SM cycles)

Conclusions

- Synergistic effects betwen both stressors (sediment mobilization and seawater warming) caused the most significant changes in behavioural and ecophysiological responses of the clams

- Valve opening values were negatively affected by SM, which together with physiolgical responses monitored after four SM cycles supposed lower SFG values as compared to calm scenarios

- Temperature increase activated re-burrowing actions after the successive SM cycles

- NO production increased synergistically with SW and SM. After the 2nd SM cycle, clams basal NO levels increased, suggesting a kind of alertness state possibly related to "trained immunity"

References

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