EPS production in periphyton metacommunities

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Background

Extracellular polymeric substances (EPS) are an important function of periphyton communities: They build the biofilm matrix and channel a substantial amount of carbon into the microbial loop.

Heat waves are predicted to increase in the next century both in frequency and intensity.

Experiment

Using spatially heterogeneous metacommunities of marine benthic diatoms, we investigated the effects of initial presence/absence of two dominant species on resistance and resilience of an ecosystem function (EPS concentration) in the face a of a realistic heat wave.

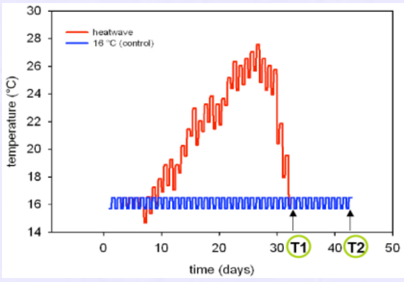


Fig. 1. Temperature curves of the 16°C control (blue) and the simulated heat wave (red), and sampling times T1 and T2.

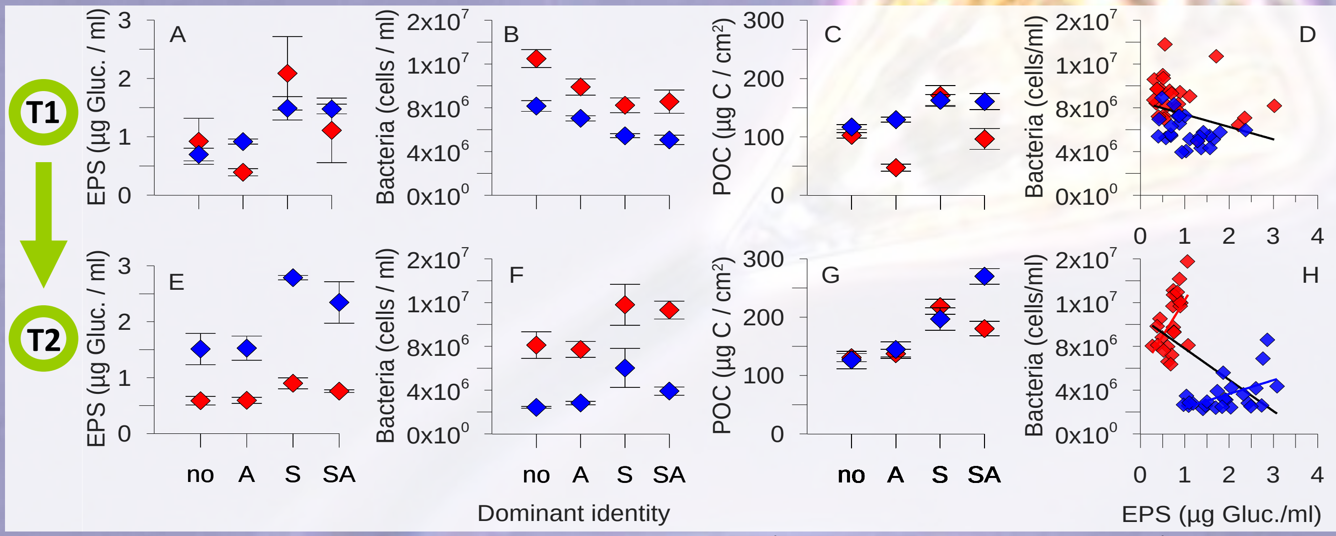


Fig. 2. Response variables (means ± SE): EPS concentration (µg Glucose/ml; A,E), bacterial abundance (cells/ml; B,F), POC as biomass proxy (µg C/cm^2; C,G), and correlation between EPS concentration and bacterial abundance (D,H), immediately after the heat wave (**T1**, A-D) and ten days later (**T2**, E-H).

◆ 16° C Control
◆ Heat wave

Conclusions

-A relatively short heat stress event sufficed to shift the dynamics between algae and bacteria in the long term into an alternative state.

-Also the presence of dominant algal species (strong producers) could not confer resilience to the communities.

Results and Discussion

Immediately after the heat wave, EPS and POC concentration were significantly lower, bacterial abundance higher than in the control.

Ten days after the heat wave had ended (corresponding to up to ten algal generations), there was **no sign of recovery**. On the contrary, EPS concentration had dropped further, whereas bacterial abundance increased even more.

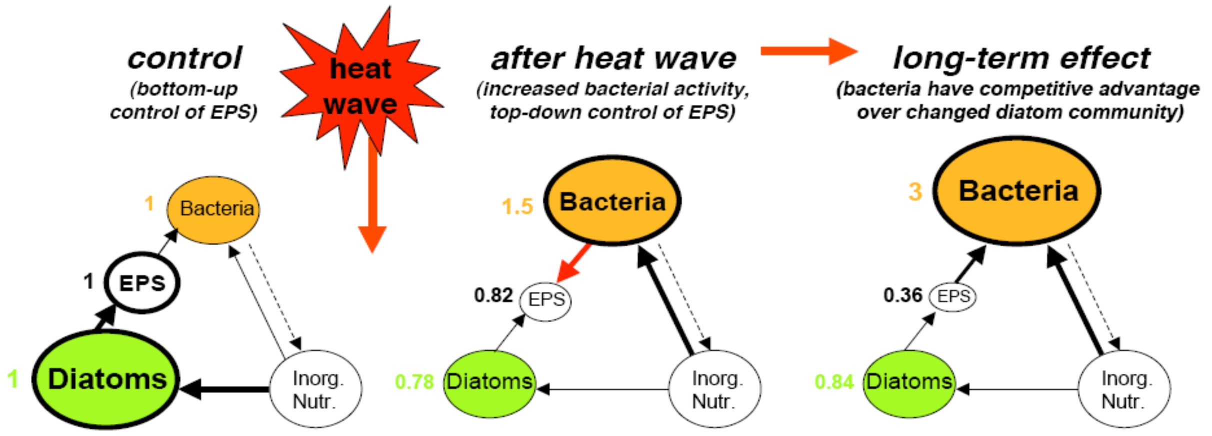
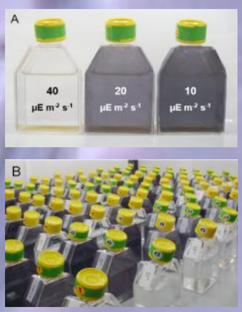


Fig. 3. Bottom-up control by algae is disrupted by increased bacterial activity and metabolic demand due to heat wave. In the long-term, bacteria in high abundance gain competitive advantage for inorganic nutrients over changed diatom community and deplete EPS further. Relative changes of standing stocks are indicated.

Also the presence of the most productive, dominant algal species did not provide long term insurance against environmental disturbance. The levels of dominant identity differed in their resilience, but in all cases, the metacommunities shifted into an **alternative state**. Our results suggest that initial bottom-up control of the system by algae switched to a top-down regulated state by T1, due to the strong response of heterotrophic bacteria to the heat wave. Bacteria, once they had increased in numbers, had a long-term competitive advantage for inorganic nutrients over the weakened algal community.



Methods Spatially heterogeneous metacommunities (3 local patches with differing light intensities, Fig.4A) of marine benthic diatoms (8-10 species) were subjected to a condensed version of the heat wave of summer 2003. Sampling time T1 took place immediately after the heat wave had ended, T2 after a period of ten days, during which the communities had the chance to recover. The fixed factors Dominant identity (i.e. initial community composition, see box), Temperature (presence/ absence of heat wave) and sampling time (T1 immediately after end of heat wave, T2 ten days later) were manipulated in a full-factorial design. Dispersal was simulated every other day. Inorganic nutrients were replenished every 3rd day.

Dominant identity levels:

SA: 10 species; including *Stauroneis constricta* (dominant producer), and *Amphora coffaeiformes* (subdominant)

S: 9 species; *A. coffaeiformes* excluded

A: 9 species; *S. constricta* excluded

no: 8 species; both dominants excluded

Fig. 4. (A) 3 local patches with differing light intensities (40, 20, 10 µmol photons m^{-2} s^{-1}) formed 1 metacommunity, (B) random distribution of metacommunities within climate rooms.

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