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Biogeosciences Discussions

Interactive comment on "Response of Nodularia spumigena to pCO₂ – Part 2: Exudation and extracellular enzyme activities" *by* S. Endres et al.

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We thank you for your comment and your valuable suggestions on our manuscript. Please find our specific answers below:

K. ZIERVOGEL: Dear Sonja, I read your recent paper in BG Discussions on the response of Nodularia on varying pCO2 levels in the ocean. I also saw the comments from reviewer 1 (and your response to that), and I absolutely agree with the reviewer that your paper/ research is novel, well designed and written, and therefore deserves publication in the Biogeosciences journal. As you know, I am very interested in heterotrophic bacterial activities in the ocean myself. I read the parts about the role of

heterotrophic bacteria in your experiment very carefully, and I do agree with reviewer 1: I suggest you discuss your results on patterns of enzyme activities a bid more carefully, especially the patterns/nature of aminopeptidase activity. I am actually not sure that all of the peptidase activity in the later stage of the experiment can be attributed to Nodularia itself. I suggest you also discuss a possible role of heterotrophic bacteria that were likely attached to Nodularia. If I understand correctly, your Nodularia culture wasn't axenic, right? Although at one point in the paper (p.5130, l.11-13) you are saying that you tried to exclude heterotrophic bacteria – it is unclear to me how you were trying that - please explain. The relatively low cell counts (10ˆ5 L-1) most likely represent the 'free-living' bacteria in your culture medium, but again, what about the ones that were likely attached to the Nodularia filaments? Are those included in the 10ˆ5 L-1? I don't think so, because you do not say in the methods section that you treated the samples in a specific way to detach the cells prior to counting. I would speculate that the attached communities may significantly contribute to the degradation of macromolecules in Nodularia cultures. In this regard, I wanted to draw your attention to a recent paper from Van Mooy et al. (2012) puplished in the ISME journal (6, p. 422). They looked at the activities of Trichodesmium-attached heterotrophic bacterial communities. You may want to cite this paper.

REPLY: We tried to exclude heterotrophic bacteria by UV radiation and several filtrations of the seawater medium (0.2 μm). The parent culture of Nodularia spumigena was axenic. Heterotrophic bacteria cells counts at the start of the experiment were below the blank value (Wannicke et al. 2012). However, during handling of the culture in the laboratory some bacteria remained or entered into the culture. We agree that these heterotrophic bacteria may have contributed to leucine aminopeptidase activity. As mentioned in the manuscript, growth and productivity of heterotrophic bacteria was low and no correlation was found between LAP activity and bacterial cell numbers. However, LAP showed significantly positive correlation with cyanobacteria biomass (POC) and significantly negative correlation with N2 fixation rate Therefore we assumed that LAP activity was principally due to cyanobacteria. However it is true that some het-

erotrophic bacteria might be attached to the filaments. These are not included in the given cell numbers. They may be responsible for the slight increase in glucosidase activity towards the end of the experiment and also for some percentage of LAP activity. We will include these considerations in our manuscript.

K. ZIERVOGEL: One more suggestion: I think your conclusion paragraph starts on p. 5130, l. 23. You are commenting on the possible role of temperature – but what about CO2? What do we really learn from your experiments? What are possible consequences for the ecosystem Baltic Sea? You mention in the Intro the important ecological impact of Nodularia; what are the possible consequences on food web interactions in the Baltic?

REPLY: Thank you for these suggestions. We will deepen the discussion in possible consequences on the Baltic Sea food web. As Nodularia is able to fix nitrogen and to utilize inorganic and organic phosphorus they may benefit from decreasing seawater pH and possibly also from ocean warming. Mass occurrences of Nodularia might lead to an overall increase in cyanotoxin concentration which then accumulates in the invertebrates and vertebrates and is harmful to higher organisms with so far unknown impact on the marine food web. Extended blooms lead to higher microbial degradation afterwards which means higher consumption of oxygen in the deeper water of the Baltic Sea. This may increase the already existing oxygen-deficient zone in the Baltic proper.

K. ZIERVOGEL: By the way, 'Nodularia is of high biogeochemical importance ...' (p. 5111, l. 13) sound a bit awkward and is not powerful enough; I would say: "Therefore, Nodularia is highly important for ecosystem functions in the Baltic Sea."

REPLY: Thank you. We will change this sentence according to your suggestion.

Interactive comment on Biogeosciences Discuss., 9, 5109, 2012.