Review Rooks et al 2019, 135

General comments

This manuscript provides novel information on potential (de)nitrification and anammox rates combined with genomics in 6 abundant cold-water sponges, from which 5 have not been analyzed previously. The data show that denitrification is a common process in deep-sea sponges and is relevant for understanding the role of sponges in nutrient cycling. The study seems well planned and conducted.

My main concern is that the potential denitrification rates measured in this study in tissue sections are upscaled to whole sponges and ecosystem level and are even used for future predictions under anthropogenic stress. The rates here should be treated as maximum or potential rates, since they were conducted with 10 times ambient concentrations, on small tissue sections in closed exetainers, under no oxygen and decreasing oxygen concentrations.

My second major comment is that the MS is focused on and biased towards denitrification, with limited attention for other nitrogen transforming processes, such as nitrification, anammox and perhaps DNRA. I suggest to present all labelling incubations, carefully evaluate the results and present and discuss in a more balanced overview of the different nitrogen transforming processes and also include all data in the published Pangea dataset.

Specific comments

- Title: The term “nutrient sink” in the title is confusing and questionable
- P3, L3-11: this is too speculative, see major comment 1.
- P4, L16-19: This sentence doesn’t really fit and perhaps the whole part of N fixation can be moved to the discussion, since it disrupts the introduction on DIN release.
- P7, L20: Add some of the relevant characteristics for this site.
- P2.2 and p2.3: A table or flow chart with the experimental incubations would be very useful.
- P10, L:16: On the previous page it is mentioned that all incubations were done with water sampled from the deep, but here surface site water is mentioned for anoxic incubations. This needs to be clarified.
- P11, L4: Can you be sure that 15-NO_3 is reduced to 15-NO_2, the preferred substrate for anammox? Please elaborate
- P 11, L6-7: This is 1000% above ambient concentrations, and ambient concentrations from which site, arctic or boreal grounds or both?
- P11, L12: This is not *in situ* temperature for the Arctic species, the temperature increase might increase your potential rates.
- Paragraph 2.3.2: There were no oxic sediment incubations?
- Paragraph 2.3.3: Including the calculations is informative for the reader.
- P12,L22-P13, L1: The published dataset contains individuals with tissue degradation
- P13, L:11-13: This needs more explanation. I guess you mean no 29-N_2 was detected in the anoxic incubations? What about 29-N_2 and 30-N_2 production in oxic incubations with

labeled ammonium? Some production can be expected from coupled nitrification and denitrification?

- Paragraph 2.3.4: Also here, the equations would be useful. And following my comment above, can you estimate coupled nitrification-denitrification from your oxic incubations with $^{15}N\text{-}NH_4$?
- Paragraph 2.4: In the results and discussion is mentioned that the sponges were also screened for anammox and N2 fixation functional genes. The screening and description of the functional genes should be described here. Was there also screening for other genes relevant for the nitrogen cycle (e.g. nitrification, DNRA)?
- P16, L1-6: Add graphs or tables with the results under oxic and anoxic conditions.
- P16,L22-23: What about unlabeled N_2 production?
- P18, L5: I would remove "nutrient removal"
- P18, L22: Denitrification has not been directly shown in Fiore et al. 2013, but is given as a potential pathway, together with anammox or DNRA, to explain net consumption of nitrate in some of the sponges.
- P20, L6: I won't state that results are representative for normal conditions, but state that these conditions are not atypical (or something similar).
- P20, L9-L15: I would expect year-round higher (dissolved) organic matter concentrations at the Boreal compared to Arctic grounds. Another explanation might be related to the higher incubation temperature (if it was 6°C) compared to the *in situ* temperature.
- Paragraph 4.2: The relevance of your denitrification rates in view of other nitrogen transforming processes should be discussed in a balanced way (see major comment 2). This paragraph gives the impression that denitrification is more important than nitrification in sponges, even though the majority of sponge studies reveal that sponges are net sources of nitrate, with denitrification being only a fraction of nitrification. Also the possibility of DNRA as competitive process for denitrification should be discussed somewhere.
- P21, L11-14: What is so different between explants and tissue sections? The tissue sections will also dependent on diffusion? There are more differences between Hoffmann et al. 2009, i.e. in your study you added NH_4, which will stimulate nitrification, while in Hoffmann et al. 2009, no NH_4 was added. You could discuss the reliability of nitrification measurements.
- P21, L21-25: "May be higher" should be "are likely higher" and the reported rates are really at the low end of other reported rates.
- P22, L1, yes, but you added 10 µM (unlabeled) NH_4, which can result in 10 µM (unlabeled) NO_3 in oxic conditions.
- P22,L6,9: These last two sentences are not connected to the rest of the paragraph.
- P22, L16-21: I won't use optimized, I guess you want to say there is an active denitrifying community. Perhaps add some statistics to the relationship, this is a nice result.
- P23, L4-6: I disagree that they are realistic, see major comment one.
- P23, 15-17: Are there reported denitrification measurements of Arctic sediments? What about the other nitrogen transforming processes? A comparison to literature should be added with to this statement.

- Paragraph 4.4: The results are not representative for a natural situation, but rather show a potential, so I would be extremely cautious to upscale these numbers and refer to these sponges as efficient nutrient sinks (see major comment 1).
- P24, L6-10: The calculations and conversion factors going from volume to surface integrated measurements are lacking (but see major comment 1).
- P25, L13-15: Combined anthropogenic stressors can also lead to changes in nutrient and organic matter availability which might affect microbial composition and biogeochemical processes. It is too speculative to state that sponges will become nutrient sinks in the future if they reduce pumping.
- P26, L10: Please expand the dataset in Pangaea with all incubation data and results.
- P35, L2: STP is used for the first time, does it stand for standard temperature and pressure?
- Figure 1 and figure 2 should be swapped, based on their reference order in the text.
- The order of references in the citations and full references need to be checked.