

# ***Interactive comment on “Total nitrate uptake by an invasive benthic foraminifer in marine sediments” by Constance Choquel et al.***

## **Anonymous Referee #1**

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This study is an important work using advanced techniques to better our understanding of the role of benthic foraminifera in the marine N cycle. In recent years, an increasing number of studies help us to see the “so far underestimated” contribution of benthic denitrification in N budget and cycling, and this study is an important input for the scientific advancement of this specific topic. Maps and figures are really nicely prepared and representative enough. I few questions and suggestions for the authors.

1) The title in the current format gives the impression of a study that only focuses on this invasive species in randomly chosen marine settings. Why exactly is important that this species is invasive to Gullmar Fjord? Overall, this study presents the important contribution of *Nonionella* sp. T1 regardless it is invasive or not and this is a really important input regarding our understanding of benthic N-Loss in such environments.

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In my opinion, the title should include the regional characteristics including Gullmar Fjord or the North Sea rather than a generalized focus on invasive species' contribution to nitrate uptake. Or the overall discussion of this MS should include more of; what does this mean? This invasive species is increasing in numbers in the region (maybe in other areas too?) which is capable of such contribution to N dynamics and we are expecting to see ... in the future. The observation of its increase in the region is valuable. Nevertheless, I am not sure this is exactly the message of this specific study.

2) Do authors think before the invasion of *Nonionella* sp. T1 benthic denitrification was overall less than their observations in this study or it has been overall the same values, but the other species are simply losing the competition now in the region? Is there any indication or previous study focusing on that? if this is the first time observation on this specific topic in this region, the authors should emphasize it even more.

3) Please provide references for benthic foraminifera taxonomy in supplementary material, considering which publication (maybe even which figure) was used for identification of the species listed in Table S3 and S4.

Abstract: Line 14: there is no flow/connection between the first 2-3 sentences. It would be better to focus on first the importance of invasive species in certain regions or the importance of oxygen, nitrate dynamics in such regions. I think authors should decide how to formulate the most important message of this MS. Line 18: micro-distribution. ... microhabitat instead?. Line 19: worth to mention Gel methodology already here for least confusion of 2D geochemistry concept. The next sentence also needs a reshape giving a broader idea of these contrasting sites. Oxygenated overlying and bottom waters with high nitrate content in porewaters vs hypoxic bottom waters where porewater is nitrate scarce.

Introduction: First sentence: I am confused with nomenclature, unit choice, and conversion of values here. There are many studies focusing on different values for the term hypoxia so I highly recommend citing the publication that the authors followed.

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This is also valid for unit choice, I am familiar with dissolved oxygen concentration units of mL/L and  $\mu\text{mol/kg}$  or  $\mu\text{mol/L}$ . Generally, 2 ml/l is circa 90  $\mu\text{mol/l}$ . Most of the studies concerning benthic foraminifera in low oxygen environments focus on these units. I just wonder which study the authors decided to follow in this case.

Line 33: ...contrasted dissolved O<sub>2</sub> conditions: Over what time interval? a year? different seasons? or different sampling sites? I know this information will be mentioned later but it would be nice to give the information here already.

Line 44: "total denitrification". Overall, denitrification together with anammox is also called N-loss. I recommend authors have a look at some other reviews on marine N cycle: Galloway et al., 2004, Gruber and Sarmiento, 1997; Gruber and Galloway, 2008. Maybe even Sigman et al 2009 (is in the direction of N isotope chemistry but is a nice review). These are reviews that would give a bit more insight and overview of the marine N cycle with perspective to open sea/ocean. There are many publications on coastal systems and while investigation on N<sub>2</sub> loss and its impact on eutrophication I came across to Seitzinger 1988 I think should be included either to the introduction or the discussion to make the findings of this study more pronounced. It is worth mentioning the potential benefit of benthic denitrification to eutrophication already in the introduction giving examples from previous studies.

Line 48: ... nitrification cannot process under low oxygen conditions. How low? Please indicate the values here.

Section 2 Methods Suggestion for site or expedition indicator throughout the text: Instead of 1st and 2nd cruise, authors could use years, e.g., 2017 and 2018.

Line 109: (see previous studies) please indicate references instead.

Line 127: is there a special reason for the choice of 100  $\mu\text{m}$  fraction? Whereas well-accepted fractions are 63, 125, and 150  $\mu\text{m}$ ?

Line 140 and figure 4: Is Figure 4 needed? Is this method described here the first time

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and different from Metzger et al., 2016?

Line 202: I find Table S1 rather important for this MS. What about involving it to the main MS but not only in supplementary information?

4. Discussion: Line 301: I think it should be GF17-1A and 1C in the parenthesis.

Line 309: (our results) data not shown and presented? If so, please mention or indicate where this information comes from. In the same line, it would be better to mention some of the previous studies showing differences too.

I recommend changing the titles for the section 4.2 and 4.3 to "...T1/foraminifera habitat in relation with the nitrate micro-distribution..." since there might be other factors having an impact on the ecology of these species, it would be better to keep the focus on nitrate and oxygen in these sections of the discussion.

Line 395: once again discussion on benthic N loss contribution to eutrophication: I think this needs a broader discussion and requires some references. Moreover, does N<sub>2</sub> flux from sediment promote N<sub>2</sub> fixation, and thus, e.g., cyanobacterial activity? are there studies focusing on N<sub>2</sub> fix vs N loss in Gullmar Fjord or similar settings? I think considering these would improve the discussion significantly.

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