Interactive comment on “Live foraminiferal faunas (Rose Bengal stained) from the northern Arabian Sea: links with bottom-water oxygenation” by C. Caulle et al.

Anonymous Referee #2

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The manuscript presents new data on the species and microhabitat composition of live benthic foraminifera across strong biogeochemical gradients of the OMZ in the Arabian Sea. Major target is to explore the relation of benthic foraminifera to bottom water oxygen concentration and sediment biogeochemistry. Recent oceanographic observations revealed a significant expansion of oxygen minimum zones in the world oceans. This observation has been attributed to a weakening of global deep-water ventilation as response to global climate warming. Quantitative reconstructions based on proxy data are required in order to evaluate this observation in face of the natural ventilation as response to global climate warming. Quantitative reconstructions based on proxy data are required in order to evaluate this observation in face of the natural climate and OMZ variability during the Holocene and to test the significance of model studies. The present study not only contributes to a better understanding of the ecology of deep-sea benthic foraminifers in OMZ ecosystems but also provides the first step for the development of a regional foraminifer-based transfer function for quantitative oxygen reconstructions. The study addresses relevant biogeochemical processes and biological and oceanographic interactions in OMZs. It is well suited for the journal Biogeosciences.

There are, however, several issues that should be considered by the authors prior to submission of the final version. The first issue addresses the present organization of the discussion chapter that appears rather descriptive and not very suitable to highlight the relevant processes. Therefore, I recommend re-organization of the discussion chapter, based on the relevant environmental processes (e.g. oxygenation of bottom and pore water, quality and quantity of food supply, preservation potential of the different faunas etc.). The second issue addresses the statistical investigation of species-environment relationships. In PCA, dependent and independent variables should not be mixed. Instead, canonical correspondence analysis (CCA) or redundancy analysis (RDA) should be applied for quantitative evaluation of the role of different environmental parameters on the species composition. The third issue is that some of the figures contain too much of information. Specifically, it is rather difficult to differentiate between the different colors and shadings in figures 4 and 5.

My specific comments and issues are specified below:

1. Introduction: a) Line 71: you should also mention the influence of outflow waters from the Red Sea and Persian Gulf. b) Line 88: is should read correctly “processes”.

2. Material and Methods 2.2. Foraminiferal analyses a) Line 126: it should read correctly “except”. b) PCA: it appears problematic to include both independent and dependent parameters in a PCA. PCA should be applied in order to group species and/or samples. For evaluation of the species-environment-relationships you should rather use Canonical Correspondence Analysis (CCA) and/or Redundancy Analysis (RDA) according to the nature of the relationships (linear or unimodal). These techniques
allow proper quantitative evaluation of species-environment relations.

3. Results 3.2. Foraminiferal assemblages of the 0-10 cm interval (>125 µm fraction)

3.2.2. Diversity and dominance Line 244-247: when compared with diversities of faunas from other regions, H(S) values of 2.3-2.5 still appear not very low, and values of 3.1-3.2 not particularly high. This should be kept in mind for the discussion chapter. 3.2.3. Distribution patterns of individual species Line 266: “mexicana” instead of “Mexicana”

3.3. Foraminiferal faunas of the 63-125 µm fraction (0-1 cm) 3.3.2. Faunal composition of the >63 µm fraction (0-1 cm level) Lines 328-330: it would be interesting to know which species of Nuttallides you have lumped together here because the different species of this genus exhibit significantly different ecological preferences.

3.4. Foraminiferal assemblages and relation to environmental parameters: principal component analyses (PCA) As mentioned before, PCA is useful to define species and/or sample associations. However, dependent and independent variables should not be mixed. Therefore, PCA is not a proper tool for investigation of species-environment-relationships.

4. Discussion General comments: a) Although the ecological discussion on the species level is correct and up-to-date, I recommend re-organization of this chapter focusing on the relevant environmental processes (“oxygen versus food quality and quantity”) or novel aspects of your study (“implications for the development of a proxy for BWO reconstructions”). Such a re-organization would also help to reduce the more introductory text passages and avoid repetition of results description. b) What do the observed diversities (H(S) between 2.3 and 3.2) tell you in terms of ecosystem stability or stress? How do your values compare to benthic foraminiferal diversities in other deep-sea ecosystems? c) A short subchapter on the preservation potential of your faunas would add relevant information to your study, particularly concerning the applicability of your ideas concerning a proxy for BWO reconstructions.

References Two references appear incomplete: Koho 2008 (lines 816-817), Levin 2003 (lines 838-839).

Figures Fig. 1: overview map in a) appears too small. Bathymetric information is of rather coarse resolution and could be a bit more detailed. Bathymetric legend is missing. Fig. 2: Character size appears too small and should be increased. Reference to Levin et al. (2003) should be given in the figure caption instead in the figure. Fig. 3: Character size should be increased. Reference to Levin et al. (2003) should be given in the figure caption instead in the figure. Fig. 4: Character size should be increased. The multitude of species and assigned colors/patterns plotted makes it difficult to read the figure, especially for taxa with low abundances. Therefore, either the number of displayed taxa should be reduced or information equalized, e.g. by creating an additional figure. Fig. 5: a) The multitude of species and assigned colors/patterns plotted makes it difficult to read the figure, especially concerning taxa with low abundances. Therefore, either the number of displayed taxa should be reduced or information equalized, e.g. by creating an additional figure. Fig. 7: Character and symbol sizes should be increased.

I hope that my comments prove useful to the authors and help to optimize this nice and important study!

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