Biogeosciences Discuss., 10, C6372–C6376, 2013
www.biogeosciences-discuss.net/10/C6372/2013/

Biogeosciences
Discussions
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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

Received and published: 28 November 2013

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 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 63-125μm fraction (0-1 cm) 3.3.2. Faunal composition of the >63μm fraction (0-1cm 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.

4.1. Environmental conditions and their implications to benthic foraminifera This subchapter appears a bit too unspecific and has an introductory character. Therefore, this information would probably be better placed in the introduction chapter.

4.3. Dominance of agglutinated species along the study transect Lines 432-434: please rephrase the two sentences for better comprehensibility Line 442: please rephrase “study setting”

4.4. Species zonation 4.4.1. Taxa dominating the faunas in the core of the OMZ Line 480: shouldn’t it read correctly “A. cretaceus” instead of “A. cretaceous”? Line 505: “species” instead of “specie”

4.4.2. Dominant taxa of the lower OMZ Lines 551-567: you argue that E. trigona may be endemic to the lower part of the OMZ in the Arabian Sea. In the Abstract, you write, however, that E. trigona is a cosmopolitan species. The latter may be correct because it has been reported from a variety of oceans, including the Pacific (Jones 1994, Challenger Foraminifers, Plate 55), Atlantic (Lohmann 1978, JFR 8, 6-34; Mead 1985, Micropal. 31, 221-248; Mackensen et al. 1993, Mar.Mic. 22, 33-69) and SE Indian Ocean (Corliss 1979, Micropal. 25, 1-19). 4.4.3. Taxa dominant at more oxygenated deeper sites Lines 588-589: you may consider here that your OM measurements only reflect a snapshot situation for the time of sampling. The absence of fresh organic matter in your measurements does not exclude the presence of fresh phytodetritus during other times of the year. Your samples have been taken in January but maximum productivity and maximum phytodetritus pulses would be expected during the SW monsoon season in summer and early fall. So the observation of E. exigua may still indicate pulses of fresh phytodetritus even though samples did not contain any fresh OM at time of sampling. Maybe you should add this point to the discussion.

4.5. Vertical distribution First paragraph: this paragraph is mainly a repetition of the description of results. This could be avoided by reorganization of the discussion chapter (see above).

5. Conclusions Lines 664-667: problem of methodology (see above). Line 672: “assemblages.”

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!

Interactive comment on Biogeosciences Discuss., 10, 15257, 2013.