

## Anonymous Referee #2

General Comments: This is a novel investigation of rapid benthic settlement across OMZ gradients, with the addition of phytodetritus as an experimental treatment. The results reveal that rapid settlement of invertebrate communities is strongly impacted by OMZ hydrographic regions. The authors provide the caveat that these results are preliminary, because of the lack of experimental replications. I would agree that the results should be considered as a preliminary view into a potentially rich avenue of research. That being said, the preliminary nature of the investigation, and the lack of replication due to ship time constraints, does not negate the usefulness of the findings. I would argue that the manuscript could be strengthened with clear language regarding the potential for future deoxygenation of the ocean interior in a future of rapid anthropogenic warming. There are a plethora of GCM (General Circulation Model) results that indicate ocean deoxygenation is a fundamental feature of a rapidly warming planet. Therefore, this investigation is not only relevant to modern slope community structure; it is also relevant as a window into future slope settlement processes. Couching the language used in both the introduction and conclusion in a broader conceptual and scientific framework would strengthen this contribution.

**We totally agree with this reviewer that ocean deoxygenation and expanding OMZs create a strong rationale for this study and should receive greater emphasis.**

**Expanding OMZs are already mentioned in the first sentence of the abstract and were discussed in one paragraph within the introduction**

**To provide greater emphasis and to help make this point a motivation of the paper we (1) have added a final sentence to the abstract (referring to experimental results). They may also provide a window into future patterns of settlement on the continental slope as the world's oxygen minimum zones expand. And (2) replaced the original sentence buried in the introduction (Expansion and shoaling of oxygen minimum zones in upwelling regions also raises questions about the influence of declining oxygen on the dynamics of deep-water margin assemblages.).** added text, including a reference to Keeling et al. (2010). This material has been moved to the first paragraph of the introduction, along with the discussion of human disturbance on margins. The relevant section reads:

*There is now recognition that as the planet warms the oxygen content of the world ocean is declining, a phenomenon termed ocean deoxygenation (Keeling et al. 2010). One consequence is that the world's oxygen minimum zones are expanding (Stramma et al. 2008, 2010) and that that upper OMZ boundaries are shoaling (Bograd et al., 2008; McClatchie et al., 2010). This means that increasingly larger areas of the continental margin will experience hypoxia or anoxia. Thus understanding of the influence of oxygen on benthic community structure and function will take on added significance.*

I found a couple instances where it was unclear if the OMZ features discussed were regional characteristics or ubiquitous global characteristics. I think it's important to properly nest these unique properties together, such that you can clearly state what is relevant to global OMZ ecology, and more narrowly about the North Indian Ocean ecology.

**We think the reviewer is referring to the front part of the introduction. Each sentence now specifies the relevant region or global representation of the patterns discussed.**

*Early studies of OMZs revealed distinct **global patterns** in which macrofaunal assemblages were characterized by reduced densities at the lowest oxygen levels and density maxima in the lower OMZ transition zone (reviewed in Levin, 2003). **Worldwide**, OMZs exhibit a high proportion of annelids and low representation of echinoderms (Levin, 2003) with strong diversity shifts linked to oxygen gradients (e.g., Levin et al., 2009). Within the **Indian Ocean**, these patterns have been reported for the Oman (Levin et al., 2000) and Pakistan (Hughes et al., 2009; Levin et al., 2009) margins, as well as on the W. Indian margin (Ingole et al., 2010; Hunter et al., 2011, 2012) and in the Bay of Bengal (Gooday et al., 2010; Raman, unpubl). In the **Arabian Sea** investigations oxygen has been shown to be an important factor limiting the density, body size and taxonomic groups of macrofauna found in OMZs. **On OMZ margins in both the Pacific and Indian Oceans**, macrofaunal species richness exhibits a positive correlation with bottom-water oxygen concentration, although organic carbon content exerts strong control on evenness and dominance (Levin and Gage, 1998; Levin et al. 2009, A. Raman, pers. comm).*

Additionally, I would take time to reformat many of the figures. I would consider the usefulness of color, rather than texture, in distinguishing fauna.

**We are modifying figures with larger font. The handful black and white figures that use texture are readily interpretable and we have some difficulty modifying colors due to the program.**

Specific Comments:

Page 9452, Line 4-6: OMZ impact on slope benthic community structure is studied in every global Eastern Boundary Current. It may be worthwhile to expand this standment to be more broadly inclusive and less regionally specific.

**This has been done. It now says** *The effects of a pronounced oxygen minimum zone (OMZ) on slope benthic community structure have been studied on every major upwelling margin,*

Page 9452, Line 9: You could clarify that these are horizontal transects, rather than vertical transects.

**We agree the transect nomenclature is confusing with respect to the trays.** We now say *To examine the influence of oxygen and phytodetritus on short-term settlement patterns we conducted colonization experiments at 3 depths on the West Indian continental margin.* The next sentence gives the latitudes.

**We introduce the transects for the ‘ambient’ fauna**

*Sediment cores were collected between 535 m and 1140 m from 2 cross- margin transects for analysis of ambient (source) macrofaunal (>300  $\mu$ m) densities and composition.*

Page 9452, Line 15: There may not be an appropriate replacement for the term “background”, i.e. source, macrofauna. However, I find this term distracting. Potentially, you could consider ambient or adjacent?

**We have replaced the term ‘background with ‘ambient’ throughout the manuscript**

Page 9453, Line 12-15: Is this high density at the lower OMZ boundary a regional feature of your study site? If so, stipulate this community structure correlates to the unique hydrographic structure of this regions, rather than a ubiquitous OMZ feature.

**This is a global pattern. The sentence now states this and the citation (Levin 2003) provides supporting data.**

Page 9454, Line 11-13: It would be appropriate to cite publications here that have documented OMZ shoaling hydrographic data, such as Bograd et al., 2008 and McClatchie et al., 2010.

**This section has been expanded, moved to the first paragraph of the paper, and these authors are now cited.** *One consequence is that the world’s oxygen minimum zones are expanding (Stramma et al. 2008, 2010), and that that upper OMZ boundaries are shoaling (Bograd et al., 2008; McClatchie et al., 2010).*

Page 9455, Line 8-11: I would partition these two hypotheses. They are important enough to stand alone, and separating the hypotheses would reflect how the data is subsequently presented and analyzed. **Agreed. We now write:**

*Given the strong influence of oxygen on macrofaunal community structure and trophic functions, we hypothesized that (1) oxygen availability should influence the rate of colonization and (2) oxygen may alter the influence of phytodetritus on colonization and the processing of phytodetritus by colonizers.*

Page 9455, Line 20-22: This sentence needs clarification. State that these are results from colonization trials. **Done. Text now says**

*Early colonization tray experiments in the Atlantic revealed ....*

Page 9456, Line 5: Qualify the term unique. This would be an appropriate place to clearly state what is unique about your study and approach.

**We changed the sentence to say** - *It is the first to document the very first steps of recolonization at different oxygen levels within an OMZ.*

Page 9457, Line 3: The sentence starting with “The 817: : :” is unclear and could be rewritten. **This now states:**

*The 817 and 1147 m sites on Transect 2 had sand content (26.8 and 15.7%) and organic C content (4.04-4.35) that were intermediate between those of the Transect 1 sites (Table 2).*

Page 9465, Line 11-14: It seems more appropriate to cite these manuscripts in the introduction and conclusion, in order to provide context for the motivation behind this research, as well as context for the implications of your findings.

**The Stramma papers are now cited in the first paragraph of the introduction. We have also moved the comments referred to on lines 11-14 to the conclusions. The text states:**

*The type of experimental information generated in this study is highly relevant to understanding consequences for benthic ecosystems exposed to declining oxygen levels. Increased extent of both anthropogenic dead zones (Diaz and Rosenberg 2008; Rabalais et al. 2010) and natural oxygen minimum zones (Stramma et al., 2008; 2010) are exposing more shelf and slope communities to hypoxic conditions*

Page 9466, Line 16-18: This sentence is a key feature of why this manuscript is a unique contribution. I suggest emphasizing this.

**This idea is now the concluding point of the paragraph. I have added a closing sentence to emphasize the point - *Further studies are needed to understand the time scales over which oxygen interacts with other environmental attributes to influence assemblage resilience and recovery potential.***

Page 9466, Line 20-25: First sentence on this line requires a reference. Second sentence is unclear as to what location the statement is referring to.  
**Both sentences have been removed as Menot et al. 2009 was erroneously referred to as describing experiments in areas of low oxygen off W. Africa. This is not the case.**

Page 9472, Line 6-7: OMZ expansion onto new shelf environments will also create scenarios where colonization will occur, a process which is occurring now in the modern ocean and is predicted to dramatically increase in the near future. This should be mentioned here to give context to the relevance of this investigation.

**This point is now mentioned in the conclusion.**  
*Increased extent of both anthropogenic dead zones (Diaz and Rosenberg 2008) and natural oxygen minimum zones (Stramma et al., 2008; 2010) are exposing more shelf and slope communities to hypoxic conditions (Bograd et al. 2008, Chan et al. 2008). Colonization by benthos will occur following hypoxia-induced mortality on shelves.*

Technical Corrections

Page 9455, Line 5: Add comma after "margin". **Done**

Page 9466, Line 3: Extra space within density numbers

**This seems to be a typesetting issue.**

Figure 1. Zoom into the location of the transect for visual clarity, provide a subset map of the larger area. If you zoomed in close enough, could you add the locations of the background faunal collections?

**The Indian government has provided severe restrictions on the bathymetry that can be shown and published. We have asked for permission to show more detailed maps but this request is declined. We have done our best to modify the maps and make them more readable.**

Figure 2. Remove gridlines and lines around figure and key. Superscript M<sup>2</sup>.

**This has been done.**

Figure 3. Some of the points on this figure do not seem to be complete circles. Double check formatting. **Done**

Figure 4, 5 and 6 and 8b. The reviewer has asked us to remove boxes around figures and Change fauna to colors rather than textures. Use the same color scheme across all figures for visual clarity. **We are not able to make these changes readily due to software problems (new computer cannot use the software, it would require extensive time to replot). Because the figures are legible in Black and White and patterns are consistent across figures we have left these as is.**

Figure 7. Remove Bray Curtis text and add that to figure label. Remove stress and add to figure label, or make this text large enough to read.

**We have put this information in the figure labels.**

The point labels are very small, could these be one or two points larger?

**Points and labels are now larger**

Figure 8a. Remove boxes and gridlines. Clarify that the numbers refer to colonization trays. **DONE**

Figure 9: Remove keys from within the figure, you have plenty of space to let the figures stand-alone; this is especially important because the N-15 axis scales are not the same between figures. Make figure key text larger. Remove figure label "Colonizer Isotope Signatures", this text should go in your figure label. Reword figure label: you are showing the same data types here, with different organisms and experimental treatments. Clarify the differences between the plots.

**This figure has been replotted and the requested changes have been made.**

