

**Manuscript number: bg-2023-151**

## **Response to reviewers**

Dear Simon Forster,

I would like to extend my sincere appreciation to the referees for their insightful comments and constructive feedback on this scientific manuscript. Your thoughtful inputs are invaluable and will significantly enhance the overall quality of the research.

Generally, the authors agree with most of the reviewers' comments and will use these inputs to better the quality of the manuscript

Below are the authors' comments on the review in general.

### **Review Summary**

This paper provides new data regarding the benthic communities of oxygen minimum zones (in this case, the Northern Benguella Upwelling System), a generally under-studied habitat, and, as such is within the scope of BG. Unlike most macrofauna studies, the macro-nematodes (>0.5 mm) are included in the macrofauna analyses which provides a novel perspective.

The taxonomic discrimination of the general macrofauna was undertaken to 'major taxa' level whilst the macro-nematodes were identified to genus level. This allows for general comparisons with other studies to be undertaken and key patterns in macrofauna and macro-nematode distribution and hypoxia tolerances to be indicated and discussed.

The fact that the samples were sieved on 0.5 mm mesh precludes the entire nematofauna being considered (the majority of which fall within the 'meiofauna' category). This is, however, acknowledged and the term macro-nematodes is used correctly to distinguish these large species from the nematode community as a whole.

The text is, at times, confusing to the reader unfamiliar with the study and study site, and needs revision to enable an easier read. I have listed comments regarding this below along with any formatting errors/queries I have noticed.

The only significant scientific query I have is regarding the nematode feeding type categories applied to the various genera and, therefore, the conclusions drawn from these. This needs clarification and justification with references.

I think this paper should be published following revision and will complement the 'low-oxygen environments and deoxygenation in open and coastal marine waters' BG special issue.

[Authors' response: Thank you](#)

### **Key Revisions and Clarifications Requested**

- The data analyses undertaken to justify the separation of the sites into the microoxic, dysoxic and oxic zones (i.e. the SPSS) presents a trip-step in the results section. Consideration should be given to stating in the methods that these zone definitions were adopted (following Levin 2003) and removing section 3.2 from the results section. See comment for lines 130-134 and 162-174 below.

Authors' response: Thank you very much for your suggestion, the authors will heed the advice of the reviewer regarding lines 130-134.

- Clarification required regarding the Weiser feeding type allocation with justification of the allocation of Desmolaimus and Halanonchus to Type 2A. If these genera are subsequently considered Type 1B, the results and discussion will need revising accordingly.

Authors' response: Placing Desmolaimus and Halanonchus to type A was a mistake. The authors are really grateful for this and the results and discussions will be revised accordingly.

- Consideration should be given to including a fauna results summary table to include sample/site and community statistics (number of taxa, densities etc) that can be referred to when reading the narrative.

Authors' response: This is well noted and the faunal results summary table will be updated as suggested.

#### **Text and Presentation Comments**

Line 34 – Reference required for hypoxia/SDG statement.

Authors' response: The reference will be inserted.

More detail on the study location required for reader unfamiliar with the Namibian coast and the BUS:

Line 46 – Location details required. E.g. The Benguela upwelling system (BUS) is located off the West African coast extending from.....

Authors' response: The suggestion provided will be adopted by the authors.

Line 62 - Location details required. E.g. ....(namely, Walvis Bay, Namibia (the location of this study), California,.....)

Authors' response: The location details will be inserted as suggested.

Line 74 – Kunene river location details required. Reference to Figure 1 map with Kunene River labelled?

Authors' response: This will be addressed.

Lines 85/86 – reference to Figure 1 map required.

Authors' response: The reference to Figure 1 will be inserted.

Figure 1 – Needs more annotation for readers unfamiliar with the area. Small map needs country boundaries and names. Large map requires additional locations, namely, Luderitz and Kunene River, as these are mentioned in text.

Authors' response: The annotation on the map will be revised to help the reader understand the study area better.

Figure 1 – needs a colour scale bar or key for depth as this is mentioned in the site description (lines 85-89)

Authors' response: The authors will add a scale bar for the depth.

Line 94 – clarify whether 'high surface primary production' is mud surface or ocean surface. Obvious maybe, but avoid ambiguity.

Authors' response: The clarification will be made during the revision.

Line 101 – reference to Figure 1 required after at 90 nm.

Authors' response: Okay, the reference to figure 1 will be put after *..at 90 nm*.

Line 103 - reference to Figure 1 not required. Reference Table 1 instead

Authors' response: The authors agree, that referencing Table 1 rather than Figure 1 will make it easier for the reader to understand

Line 114-118 – please provide details of the level of taxonomy for non-nematode macrofauna taxa. Later, the term 'macrofauna taxa' is used without the reader knowing the definition of 'taxa'.

Authors' response: The details of the level of taxonomy for non-nematode macrofauna will be added during the revision period.

Line 119 – Need to state that feeding types were ascribed to genera following Weiser (1953) and insert reference in ref list.

Authors' response: The authors will state the ascribed feeding types of the nematodes and add the reference to the reference list

Line 130-144 – As above, it is not clear what level of taxonomic discrimination was used for statistical analyses.

Authors' response: As responded above, the authors will clarify the taxonomic classification of non-nematode macrofauna

Line 130-134 – This needs clarifying. Something along the lines of.....

Out of the seven sampled stations, only three had replicates. Therefore, direct statistical comparisons between sampling stations was not possible. To overcome this, the sampling stations were grouped into 'habitat types', based on the measured environmental variable that provided the most significant correlation with the various biotic indices. The communities within these key habitat types were then compared using indices and analyses outlined below.

An alternative approach that may be less complicated would be to state up front in this section that, following the approach of Levin (2003), the samples from microxic, dysoxic and oxic habitats will be compared in order to determine the effects of low DO. It could be further stated that this approach was justified by the application of SPSS that indicated DO was a key determinant associated with the microbenthic community structure. The text from lines 169-174 could be modified for this purpose.

*Authors' response: The authors think that the alternative approach is an excellent suggestion and the authors will implement it during revision.*

Line 134 – New paragraph starting at The data recorded....

*Authors' response: The authors will put a new paragraph at the beginning of line 134 as suggested.*

Line 142 – the various replicates were considered as a single samples. How was this done? If the replicate data were added together it would constitute 3 times the search effort as that for a single sample, therefore, the number of taxa will likely be elevated. Perhaps a more valid approach would be to randomly select a single replica for use in this analysis, rather than combine the three replicates?

*Authors' response: Because the microxic and dysoxic stations had very few taxa and densities, random selection will exclude some taxa which may provide inaccurate results. The authors will consult and deliberate on the best approach to address the reviewer's concerns.*

Line 147 – suggest term inverse relationship in preference to opposite trend.

*Authors' response: This suggestion will be implemented during revision.*

Line 147-150 – not easy to follow. Suggest

Total Organic Matter (%TOM) demonstrated an inverse relationship with depth, with higher organic matter values recorded in the shallower stations. For example, the shallowest stations 20020, 20002, and 23002 had the highest TOM of  $38.6\% \pm 2.16$ ,  $27.5\% \pm 1.55$  and  $23.1\%$ , respectively, whilst the lowest TOM values were found in the most offshore stations, stations 23070 and 26090, with  $9.89\% \pm 1.55$  and  $4.4\%$ , respectively (Table1).

*Authors' response: The authors would like to thank the reviewer for his suggestion. This suggestion will be adopted during revision.*

Line 151 - Similarly, dissolved oxygen values had lower values recorded in the shallower onshore station – According to Table 1, this is not correct; needs clarifying or removing. The OFC transect had

its highest DO at the shallowest site (33 m) and OWB had lowest DO at middle depth site (128 m), as described in the later text.

Authors' response: Thank you for pointing this out, the correction will be done during the review.

Line 158 – New paragraph after (Table 1).

Authors' response: The authors will put a new paragraph as suggested.

Lines 162-174 (3.2 Biotic Factors) – As discussed for Lines 130-134 above, it is suggested that the use of the approach of considering the sampling stations in terms of their DO zones (following Levin, 2003) be stated up front in the methods section. This section is somewhat of a trip-step in the narrative of the results.

Authors' response: The authors will address this when revising the manuscript and implementing the correction as suggested for Lines 130-134.

Line 171 – reference error. Should read (Levin, 2003).

Authors' response: Thank you for pointing this out, the correction will be done.

Line 162 – Section 3.2. As discussed above for Lines 130-134, it may be easier to follow if this narrative is moved to the data analyses methods section 2.4, to justify using the three DO habitat types.

Authors' response: Thank you for the suggestion. The author will move these lines and ideas to the data analysis methods.

Line 175 – 3.3 Macrobenthic assemblages. The term taxa is used with no definition (as mentioned for lines 114-118, above). Presumably, this is the taxonomic groups as listed on Figure 3, although the rarer are combined as others. Maybe list the taxa in a table?

Authors' response: The authors will list the taxa in a table for ease of reference.

Line 176-183 – This paragraph discusses the densities. The references to number of taxa are repeated in the subsequent paragraphs. Suggest the references to number of taxa are removed from this paragraph.

Authors' response: The reference to the numbers will be removed from the paragraph.

Line 215 – Insert reference to Figure 3, i.e. .... zones, respectively (see Figure 3).

Authors' response: Reference to Figure 3 will be inserted as suggested.

Line 216-219 – list of data is probably unnecessary as % abundance data already quoted. If a results summary table was included, this could be referred to instead.

Authors' response: Okay, the data will be removed and a result summary table will be created.

Line 222 – .....their abundance peaking in the Dysoxic station..... Is this relative abundances or total densities. If relative abundance, please state so and reference Figure 6 at the end of sentence.

*Authors' response:* The abundance in the sentence meant total densities. The sentence will further be clarified to enhance its readability and comprehensiveness.

Line 226 - .....recorded significant abundance..... If this is not a reference to statistical significance, please use alternative term, e.g. high abundance, to avoid ambiguity. Similarly, in line 232, please use low abundance unless statistically insignificant.

*Authors' response:* Point noted and the corrections will be done.

Line 230-234 – sentence long and complicated. Need clarifying and/or shortening. Suggest:

For the purposes of graphing the relative abundances, the genera Thoracostomopsis, Anticoma, Cephalanticoma, Trileptium, Mesacanthoides, Terschellingia, and Marylinnia were grouped as 'others' as they were recorded at low abundances (<4%); see Fig. 6.

*Authors' response:* Thank you for the suggestion this suggestion will be added to the revised copy.

Line 235-237 – For clarity, please include the feeding type code after the first mention of the feeding type, e.g. epistratum feeders (type 2A).

*Authors' response:* Thank you for the suggestion this will be added to the revised copy.

Line 239 – Clarification and justification is required regarding the allocation of feeding types. Whilst I appreciate that allocation of Weiser's feeding types is based on the morphology of the buccal cavities and is, therefore, partially subjective, most linhomoeid nematodes (with the exception of Terchellingia) are considered Type 1B (non-selective detritivore). I would classify Desmolaimus as Type 1B due to its unarmed (the cuticular 'arches' are unlikely to act as teeth) and relatively large buccal cavity. Similarly, I have always considered Halanonchus a Type 1B non-selective detritivore as, apart from buccal cuticular thickening, there is no dentition and has a large open mouth. Furthermore, these Genera tend to occur in muds. The results and discussion of feeding type guilds may need reviewing.

*Authors' response:* Thank you very much for pointing out this. The reviewer is right, Desmolaimus and Halanonchus are both 1B (non-selective deposit feeders). The authors will correct, review, and adjust the manuscript appropriately.

Line 256 – ....oxygen correlated significantly with..... Please state significance of correlation (p value?)

*Authors' response:* The p value will be added during revision.

Line 257 – Typographical error. Should read .....into three zones based on.....

*Authors' response:* Thank you for the correction, this will be corrected during revision.

Line 257 – for the benefit of the reader, it would be useful to remind of the three zones. Suggest inserting in parentheses, e.g. ....oxygen levels recorded (microxic zone (<0.1ml l<sup>-1</sup>); dysoxic zone (0.1-1.0 ml l<sup>-1</sup>); oxic zone (>1.0 ml l<sup>-1</sup>)).

Authors' response: Thank you for the suggestion this will be added to the revised copy.

Line 262-264 – It is essential to note.....their relative abundance. Does this mean polychaetes were recorded at their highest density at the microxic sites or they were the most abundant taxa in this zone? I assume the former. Needs clarification to avoid ambiguity.

Authors' response: This is well noted, the sentence will be clarified further.

Line 265 – Please define the core OMZ. OMZ spatial center? Area of lowest DO? Maybe in parentheses.

Authors' response: The core means the area of the lowest DO. The extra information will be added during review.

Line 273-275 – At the microxic zone.....in relative abundance. Meaning unclear. Does it mean, at the microxic sites, the polychaetes were the most abundant taxa in terms of total density, but the average relative abundance was lower than that of cumaceans? (How was the relative abundance of multiple sites calculated?)

Authors' response: Relative abundance was calculated for each core and then averaged. A hypothetical explanation can be for example, if one station had 3 cumacea and 1 polychaete, that means the relative abundance will be 75% and 25% respectively, then another station in the same oxygen zone has 5 polychaetes, 3 nematodes, and 2 cumacea. Polychaetes would have 50%, nematode 30%, and, 20% cumaceans. Hence the average relative abundance for cumacea will be about 47.5% and polychaetes will be 35%, despite polychaetes having 6 individuals while cumacea having only 5.

Line 276 - Were there only 4 specimens found at 23002, i.e. 3 cumaceans (75%) and 1 other taxa (25%)? If so, the 75% relative abundance, whilst correct, gives a misleading impression of the community and, when averaged with the other microxic station could be misinterpreted.

- This paragraph needs reviewing as it is not clear what point is being made and it read more like the results narrative than discussion.

Authors' response: This statement has proven to be problematic to both reviewers and I will therefore have to write it in an easier way for the reader to understand.

Lines 269, 274, 275 – The term cumacean should not be capitalised whereas Cumacea should. Please use terms consistently, either cumaceans or Cumacea wherever possible. Similarly, polychaetes or Polychaeta; nematodes or Nematoda etc. My preference would be polychaetes/nematodes etc when discussing the results, unless referring specifically to the phylum or class as a whole, in which case 'the Nematoda' or 'the Polychaeta' is good.

Authors' response: Thank you for sharing your preference, the terms polychaetes and nematodes will be used in the discussion area in the review.

Line 279 – please use the term macro-Nematoda or macro-nematodes, throughout. The Nematoda includes the meiofaunal size category whereas, this study, considers only those retained on a 500 µm mesh, i.e. the macrofauna size class.

Authors' response: Okay, this is well noted.

Line 286 – Should this read Apart from the increase in nematode size...

Authors' response: Thank you for the correction. The word nematode will be added to the review.

Line 289 – suggest .....coupled with a reduction in predation by larger fauna that are affected adversely by reduced oxygen concentrations.....

Authors' response: Thank you for the suggestion this will be added to the revised copy.

Line 296 – reference should read Gutierrez et al. (2008)

Authors' response: Thank you for the correction.

Line 301 – Once the DO levels to dusoxic levels..... This implies a temporal data set that documented an increase in DO. Suggest At dysoxic sites (DO 0.1 – 1 ml l<sup>-1</sup>), other taxa.....

Authors' response: This suggestion is highly appreciated, the authors will adopt this suggestion.

Line 304 – as above. Suggest At the oxic sites, where DO levels were above 1.0 ml l<sup>-1</sup>, more taxa.....

Authors' response: Thank you for the suggestion this will be added to the revised copy.

Line 308 – Lowest densities, diversity and species of macrofauna taxa or macro-nematodes or both? Please clarify.

Authors' response: This statement refers to general macrofauna taxa. Further edits will be made to minimize ambiguity.

Line 310 – As 301 and 304 above. Suggest At sites with DO above 1 ml l<sup>-1</sup>.....

- Does this refer to your study or Zettler's? Avoid ambiguity, suggest During the present study, at sites with....

Authors' response: The reference in this statement is regarding the current study. The statement will be edited to avoid ambiguity.

Line 314-316 – Most of ..... tolerance/intolerance to hypoxia. Meaning unclear. Suggest: Of these fauna, crustaceans were most abundant. This conforms to the observations of Soto et al. (2017) at oxic sites in an upwelling system in Chile. Conversely, Zettler et al. (2009) recorded amphipod species in low oxygen areas. These contradictory results indicate that, at least amongst the Amphipoda, tolerance/intolerance to hypoxia is species specific.



Authors' response: The authors appreciate this suggestion and they will be implemented during revision.

Line 357 – Suggest: Tolerance to hypoxia is indicated by both the presence and absence of taxa.....

Authors' response: Thank you for the suggestion this will be added into the revised copy.

Line 361 – insert Wieser reference

Authors' response: Wieser reference will be added as suggested.

Line 362-363 – Need consistency of terminology for feeding types in text and Figure 7. Standard definitions are:

Authors' response: Thank you for the clarification, and the consistency of the terminology of feeding types.

Line 363 - Typographical errors – I think it should read .....(2A), with the former dominating the oxic zone.

Authors' response: Thank you for pointing this out, it's definitely a typographic error. It will be corrected when doing revision.

Line 367 – suggest These observations appear to be.....

Authors' response: Thank you for the suggestion, this suggestion will be implemented.

Line 375-376 - The areas around the OMZ have also been observed to contain a high level of diatomaceous mud, which forms a significant component of epistratum feeders' diet, whose abundance was also high in the dysoxic areas.

Is it true that epistratum feeders (2A species) feed on diatomaceous mud? Need reference. 2A species feed on live diatoms whereas diatomaceous mud comprised dead, settled diatoms. Does the surface of the mud support epibenthic diatoms? The shallowest site was 33 m (oxic) whilst the rest of the oxic and dysoxic sites were in excess of 100 m where primary production would be very limited.

Authors' response: The authors will look into this statement and address it appropriately during revision.

Line 377 – Below the OMZ,.... Does this mean offshore from the OMZ, in deeper water?

Authors' response: Yes, below the OMZ means offshore from the OMZ, meaning the OMZ is no longer in contact with the benthic zone.

Line 385 – should this read Ostracoda and Bivalvia observed in limited numbers in the oxic zone.....? (not anoxic?)

Authors' response: From the manuscript, the word used is anoxic which is correct based on the results.

Line 380-391 (5.0 Conclusion) – the conclusion does not mention any thoughts on the macro-nematodes despite the title stating “a macro-nematode perspective”.

Authors' response: Thank you for pointing this out. The authors will revamp the conclusion to include the macro-nematode perspective among other missing information.