Interactive comment on “Food quality determines sediment community responses to marine vs. terrigenous organic matter in a submarine canyon” by W.R. Hunter et al.

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Detailed response to H. de Stitger’s comments.

General Comments

H. de Stitger writes “The motivation given under 4.1 for not quantifying the feeding responses of metazoan meiofauna and foraminifera – both representing important components of deep-sea communities –sounds less convincing, however. Uncertainty about the quantity of labelled C and N incorporated by these groups and in the dissolved inorganic carbon, makes inferences about macrofauna-bacteria interactions appear less conclusive.”

Response: The primary focus of the study was to investigate the feeding responses of both the bacteria and metazoan macrofauna to marine and terrigenous OM deposition., using stable-isotope labelling methods. Our decision to exclude meiofauna and forams from the analysis does not reflect the ecological importance of these taxa. Rather it was determined by the methodological limitations of in situ pulse-chase experiments, where previous studies have found uptake of the ^{13}C and ^{15}N labels by the meiofauna and forams to be low over the time frame of the present study (e.g. Witte et al., 2003a; 2003b; Nomaki et al., 2006; Gontikaki et al., 2011). Likewise it was not feasible to quantify DIC production using the Oceanlab Spreader mesocosms. We accept that this results in uncertainty in interpreting potential interactions between the macrofauna and bacteria, and so the present study can do little more than generate hypotheses about these potentially important linkages within the sediment ecosystems of the Whittard canyon.

H. de Stitger writes “References to studies on submarine canyons are more general, and not specifically addressing the processes that are likely occurring in the Whittard Canyon. The authors should be aware that sediment transport in submarine canyons is not only about episodic events, but that tidal forcing often ensures continuous sediment resuspension and transport”

Response: the revised manuscript makes specific reference to tidal forcing and the potential impacts of storm-induced gravity flows, as routes for sediment resuspension and transport in submarine canyons.

H. de Stitger writes “Surprisingly for a study addressing submarine canyon processes, no mention is made of sedimentary characteristics that might be indicative of sediment gravity transport…”

Response: We include descriptive information about the sediment characteristics at each station within sections 2.1 and 3.1 of the revised manuscript, including reference to the sediment descriptions of Otto and Balzer (1998); and Duros et al., (2011).

H. de Stitger writes “the title of the paper suggests a broader scope study, where among a number of factors, food quality was found to be the principle factor determining community response… Not investigated, but probably relevant in terms of community response are the different physical processes associated with delivery of marine or terrigenous organic matter…. In short, the title without “food quality determines” might be more accurately representing the content of the paper.”

Response: As we have previously stated we accept Prof de Stitger’s critique of the title to be valid. Accordingly the title of the revised manuscript is “Sediment community responses to marine vs. terrigenous organic matter in a submarine canyon.”

Specific Comments

Regarding the effect of macrofaunal activity upon bacterial biomass we do not propose a direct causative link between bacterial biomass and faunal feeding activity. We accept this is beyond the scope of the present study. However, data-exploration and the negative correlation between faunal feeding responses and bacterial biomass provide an opportunity to propose data-driven hypotheses for future research. Bacterial biomass may decrease for a number of reasons following OM deposition including physical disturbance of the sediment (e.g. Kristensen and Holmer, 2001), bactivory (e.g. Pascal et al. 2008), or the stimulation of an infectious stage in phage lifecycles mediating enhanced bacterial lysis (e.g. Danovaro et al., 2008; Gregory et al., 2010) . It is important that we highlight the potential interactions, which underlie sediment community responses to OM deposition, and propose these as a future research direction to understand ecosystem processes in deep-sea sediments.

We accept that the reference to climate change leading to shelf water cascading, in the introduction, is unclear. We have revised this passage to highlight the potential importance of storm-induced gravity flows as a source of disturbance and OM input in the Whittard and other ne Atlantic canyons.

Technical Corrections

Page 11338, Line 4 (Section 2.3). The typo regarding POM inputs in the bathyal and abyssal NE Atlantic will be corrected – from g C m^{-2} to mg C m^{-2}.

Figure 7: The legend now specifically states that the horizontal dashed lines at 4.06 and 22.80 represent the C:N ratios of diatom and wheat phytodetritus.

Detailed response to T. Tesi's comments.

1) The material that reaches deep sediments is everything but matrix-free terrigenous material as the one used in this study (i.e., Triticum aestivum). The only regions in the ocean where you have significant contribution of plant detritus are probably shallow deltaic environments. By contrast, the terrigenous material in deep sea sediments is exclusively associated and protected by the mineral matrix forming organo-mineral complexes. Also terrigenous OC that accumulates along slopes is extensively aged and degraded (see for example the difference in composition between lateral advection and passive sinking of marine phytodetritus in the Adriatic submarine canyons, Tesi et al, 2008. Deep Sea Research I 55 (2008) 813–831). Therefore I am expecting that the "real" land-derived material is even less reactive than the terrestrial phytodetritus used in the study. The authors should be aware of this and maybe it would be appropriate to state this somewhere in the text. Indeed, it would be interesting to see if by using soil OC the conclusions would be the same. Considering the low reactivity of matrix-protected OC maybe the difference in phytodetritus use would be even more pronounced.

Response: We fully accept Prof. Tesi's comment. The use of *Triticum aestivum* in the present study represents a model terrigenous OM source. Much of the terrigenous OM reaching the deep-sea will be highly degraded or bound in mineral-organic complexes, and so may be even more resistant to biological degradation. The revised manuscript explicitly states this caveat.

With regard to organo-mineral complexes and matrix protected OM we agree that this opens up questions for further study. It would be interesting to test how soil-bound OM particles, and flocculant particles from the water column are degraded in deep-sea sediments to provide and how these processes seek affect OM processing and burial. This presents an important direction for future studies to test.

2) I think the methods can be improved by providing a brief explanation for each index used. In the methods the authors presented only formulas that I found it

a bit sparse on details. However, the reader would benefit from a few comments about what high and low values means and what kind of information a certain index, say $I_{bacteria}$, can give you.

Response: The calculations displayed in the Methods section are not indices, but rather the stages by which we calculate the uptake of carbon (^{13}C) and nitrogen (^{15}N) by the fauna and bacteria within our stable-isotope labeling experiments. These follow the methodology published by Middelburg et al. (2000) and Boschker and Middelburg (2002) and used in many subsequent papers (Witte et al., 2003a; 2003b; Buhring et al., 2006; 2006b; Hunter et al., 2012a; 2012b; Mayor et al., 2012). Consequently, $I_{bacteria}$ represents either bacterial biomass or ^{13}C uptake, derived from concentrations of bacterially derived polar-lipid fatty acids within the sediments.

3) Fig 1. Those dots are a way too small, so the labels

Response: We have increased the size of the markers and labels in this figure.

4) Fig 2. It would be interesting to see the down core profiles of nitrogen and carbon stable isotopes next to or on top of these plots.

Response: It is unclear to us what additional information the inclusion of profiles for isotopic natural abundance would make in these graphs. Each graph plots the change in delta-delta units and so shows the isotopic-enrichment of the sediment POC and TN within the experimental incubations, where background values would equate to 0. This can easily be compared with the distributions of macrofaunal abundance displayed in Fig. 3.

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