

Interactive comment on “Stable carbon isotope deviations in benthic foraminifera as proxy for organic carbon fluxes in the Mediterranean Sea” by Marc Theodor et al.

Marc Theodor et al.

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Response to interactive comment by anonymous referee #2

We acknowledge the comments by the reviewer, which helped to improve and to complete our manuscript. Below we respond to all comments raised by the reviewer.

General comment: Theodor et al. are utilizing stable carbon isotope gradients between epifaunal and shallow infaunal foraminifera as a proxy for organic matter flux rates to the sediments in the Mediterranean Sea. Their work is novel; being able to predict/measure organic carbon fluxes to sediment in the past is a big unknown in Paleoceanography. The work clearly outlines caveats and limitations, and I recommend

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publication after some minor corrections. Specifically the abstract should reflect the main text better (e.g. in the discussion the authors make it clear that *Cibicides* likely occupies a very shallow infaunal habitat and that its $\delta^{13}\text{C}$ has a pore-water influence, which is also reiterated in the conclusions). Please also check your figures and captions and provide details of how certain values ($\delta^{13}\text{C}$ DIC bottom water, Fig. 2) were calculated/estimated.

Response: Thank you very much for this positive assessment and the specific comments. We followed the suggestions and changed the abstract, text and figure captions accordingly.

Specific comments:

Comment: Abstract: Lines 29-30 'Because...evaluation.' place before line 27-29 'The...sites.'. Response: done

Comment: Lines 38-39 change 'considering' to taking into account? Response: done

Comment: Introduction: Correction for ontogenetic effects (line 123-124)? Restricting to measurements from the size fraction $>600\ \mu\text{m}$ is not really a correction procedure. Response: This is true; we have changed the wording of this sentence.

Comment: Material and methods: Line 159 'with a micrometer of an accuracy of $10\ \mu\text{m}$?' not sure what this is meant to say. Response: We have changed the wording of this sentence to be more precise.

Comment: Discussion: Lines 242-245. Strange way of putting it as a fact and then dismissing this claim later? Response: We agree. We have changed the first sentence to express the preferred assumption of the isotopic composition of epifaunal species and their actual much greater variability.

Comment: Lines 245 - 247. Why are these data not plotted in the Figures? Response: Also referring to the previous comment on Fig. 2, the isotopic compositions of Mediterranean water masses were added to the figure.

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Comment: Line 262 change 'on' to 'at'. Response: done

Comment: Lines 404-405: Lateral input of organic matter through submarine canyons. could such process also bring in juvenile benthic foraminifera from different water depth/environment and be a suitable explanation for lines 354 and onwards? Response: Although relocation of living foraminifera has been reported from different environments (e.g. from prodelta systems) it appears highly improbable that this effect is the reason for lower $\delta^{13}\text{C}_{\text{Umed}}$ values in smaller tests since this signal is consistently observed at all studied sites. However, relocation of dead specimens may be problematic for the application of the transfer function to fossil data sets. We have discussed this problem in some detail in chapter 4.3. It appears important to note that in our study this problem occurred at sites with reduced lateral organic matter transport (including the Strait of Sicily and the Mallorca Channel), while the sites with a strong lateral component seemed to be less affected by reworked and displaced tests.

Comment: Conclusion: Line 456 allochthonous tests? This should be discussed much more thoroughly in the discussion and not appear as a slight statement at the end in the conclusions (e.g. see comment above for lines 404-405 etc). Response: We agree and extended the discussion on this issue. See also response to the previous comment.

Comment: Figures Figure 2: Is estimated $\delta^{13}\text{C}_{\text{epi}}$ the same as approx. DIC bottom water? If so please use the same terminology to avoid confusion. Response: Yes it is; we have modified the figure using consistent terminology.

Comment: Provide details of how the estimated $\delta^{13}\text{C}_{\text{epi}}$ / approx. DIC bottom water values are calculated? Response: The explanation was extended. We have chosen the $\delta^{13}\text{C}$ values of *P. ariminensis* as the best bottom water reference. If no specimens of *P. ariminensis* were available, we had to substitute the bottom water signal by the other measured epifaunal species or interpolate the value from nearby sites. We have specified the description for the estimation of $\delta^{13}\text{C}_{\text{epi}}$ in the revised manuscript and

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discussed the possible uncertainties for the sites where no tests of *P. ariminensis* could be measured.

Comment: It is not possible to decipher different symbol sizes from a (they all look the same size), so please remove Line 889 about symbol sizes indicating different test sizes. Response: done

Comment: Put Mediterranean water mass endmember $\delta^{13}\text{C}$ DIC values in 2b. Response: The measured data of Pierre (1999) for the depth distributions of $\delta^{13}\text{C}_{\Sigma\text{CO}_2}$ from different regions of the Mediterranean Sea were added to this figure for a better comparison.

Comment: Figure 3: I presume this Figure shows the $\delta^{13}\text{C}$ difference between the $\delta^{13}\text{C}_{\text{Cepi/approx. DIC bottom water and U. mediterranea}$, and does not include *C. pachyderma* $\delta^{13}\text{C}$? Please make this clear in the Figure caption. Figure 4: Same as 3. Response: Both figures have been modified including a more detailed description.

Comment: Why do only some stations have uncertainties plotted for their Median Living Depth? Do you know uncertainties relating to the other parameters (redox boundary depth, export)? Response: Unfortunately, uncertainties for other parameters cannot be provided due to single measurements. MLD uncertainties refer to seasonal contrasts of the living depth of foraminifera in the Gulf of Lions sites (Canyon and Slope), which were sampled in spring and late summer (Schmiedl et al., 2000). This was additionally mentioned in the figure caption.

Cited references: Pierre, C. 1999. The oxygen and carbon isotope distribution in the Mediterranean water masses, *Mar. Geol.*, 153, 41-55. Schmiedl, G., de Bovée, F., Buscail, R., Charrière, B., Hemleben, C., Medernach, L., and Picon, P. 2000. Trophic control of benthic foraminiferal abundance and microhabitat in the bathyal Gulf of Lions, western Mediterranean Sea, *Mar. Micropaleontol.*, 40, 167 -188.

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