

Interactive comment on “Variation in stable carbon and oxygen isotopes of individual benthic foraminifera: tracers for quantifying the vital effect” by T. Ishimura et al.

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The paper entitled “Variation in stable carbon and oxygen isotopes of individual benthic foraminifera: tracers for quantifying the vital effect” by Ishimura San et al. deals with the applicability of inter-individual $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ distributions (Standard Deviation within species) to reconstruct the bottom water isotopic signatures. This work is based on live and dead (assumed as modern) foraminifera that were sampled at 4 deep-sea sites, off Japan. Different species and genera, with different individual weights (i.e. size), were analyzed individually and their isotope signatures were compared with bottom water $\delta^{13}\text{C}_{\text{DIC}}$ and $\delta^{18}\text{O}_{\text{e.c.}}$. Within a species, lower $\delta^{13}\text{C}$ and

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$\delta^{18}\text{O}$ values are recorded for smaller individuals. This is in agreement with other published works. Both $\text{D}\delta^{13}\text{C}$ and $\text{D}\delta^{18}\text{O}$ vary between taxa, what is also consistent with other publications. Finally, the authors show that the average intra-individual $\delta^{13}\text{C}$ calculated for each species is correlated to the related Standard Deviation – when all species from a same area are plotted on the same graph, a simple equation ($a \times \text{SD}\delta^{13}\text{C}_{\text{foram}} + b = \delta^{13}\text{C}_{\text{foram}}$) can be determined by a linear regression. Then, the authors observe that when $\text{SD} = 0$, the $\delta^{13}\text{C}_{\text{DIC}}$ ($= b$) is close to the bottom water $\delta^{13}\text{C}_{\text{DIC}}$. Therefore, they propose that the average intra-individual $\delta^{13}\text{C}$ and the related Standard Deviation may be relevant and reliable proxy to calculate bottom water $\delta^{13}\text{C}_{\text{DIC}}$.

General comments

This paper is well written and well illustrated. It is based on a large data set of isotopic measurements that should be published in a peer-review journal. Those high-quality analyses were done on single individuals belonging to taxa which are quite common along the Pacific margin. As a modest taxonomist, I would recommend the authors to provide an appendix with taxonomic references for all taxa which were analyzed in this study. SEM pictures for all taxa would be also necessary for readers who would like to use related taxa for their own investigations.

Now, when I deal with some interpretations proposed by the authors, I have got some concerns that should be clarified by the authors. For instance, it seems that the authors have forgotten to use isotopes data of some species (*Nonionella globosa*, *Nonionella labradorica*) in figure 5 (in which interpretative linear regressions were drawn). According to me (I may be wrong!), adding those data (with low SD values) would change a large part of the interpretative story. Moreover, in some cases, the authors have measured isotopes at a genus level (*Rutherfordoides* and *Stainforthia*) without considering the potential inter-specific variability. Such a point should be addressed somewhere. Furthermore, the linear regressions which are proposed by the authors should be tested for their r -value and their p -level significance. Finally, I wonder whether this

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approach may be relevant and reliable in oligotrophic settings where only few fossilizing shallow infaunal species thrive. For instance, do the authors think that they may rebuild bottom water $\delta^{13}\text{CDIC}$ with long fossil records where only *Epistominella exigua* would be the taxon present along the overall archive? It sounds like a question picked up from the Pandora's Box...so?

More generally (and as a response to the previous question), the authors focus their discussion on the applicability of isotopes to reconstruct bottom water signals. But, for most infaunal foraminiferal species, it seems that the (average) $\delta^{13}\text{C}$ is strongly constrained by in-sediment processes affecting pore water $\delta^{13}\text{CDIC}$ (exported productivity, in-sediment organic matter mineralization, cold seeps...) (many publications as references). For instance, the authors should discuss the overall role of micro-habitat on the specific (average value) $\delta^{13}\text{C}$, before dealing in detail with the inter-individual isotopic variations. They could do so for the 1208-m depth station where they have pore water data. Indeed, the $\delta^{13}\text{C}$ of some taxa is sometimes proposed as relevant proxies of environmental parameters (redox conditions in the sediment, exported organic matter flux) that are partly disconnected from bottom water signature.

Specific and technical Comments:

p. 6194, line 10. The Nankai Trough and the Sagami Bay are not located in "marginal seas", are they? The authors should correct this sentence.

p. 6194, line 23. "Multicorer" is better than "multiple corers".

p. 6195, lines 7-10. This paragraph is unclear and should be reformulated. For instance, did the authors use either ethanol or formaldehyde (with Rose Bengal solution) to store sediments before sieving?

p. 6195, line 11. The authors should precise that they have also analyzed *N. labradorica* and *N. globosa*.

p. 6195, lines 11-19. As explained in my comments for the figure 2, many taxa that are

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analyzed in this draft are complex in terms of taxonomic identification. For instance, *Nonionella labradorica* (name used in this paper) is generally described as *Nonionella labradorica* (in most "Japanese" papers that I know). What is the difference between both taxa according to the authors? *Nonionella globosa* is very close to *Nonionella stella*, isn't it? But few taxonomic plates exist as relevant illustration of what a *Nonionella globosa* looks like. Furthermore, *Rutherfordoides* and *Stainforthia* are both tricky genera the species of which may be easily confused. Maybe the authors should be more precise concerning the related species? *Rutherfordoides cornuta*? *Rutherfordoides rotundata*? *Stainforthia fusiformis*? (...) *Globobulimina* presents different species that are very close in terms of morphology (*Globobulimina affinis*, *Globobulimina auriculata*, *Globobulimina hoeglundi*...). (...) Finally, the authors should add an appendix with taxonomic references for all taxa which were analyzed in this study. If possible, they should precise the species of *Rutherfordoides* and *Stainforthia*. SEM pictures for all taxa are necessary for readers who would like to use related taxa for their own investigations.

p. 6197, line 21. "Authigenic" instead of "authentic".

p. 6197, lines 22-25. Can the authors provide the data (with values and graphs) confirming that "interspecies differences in average isotopic values were not due to the reduced sample size?"

p. 6199, lines 13-16. If I look carefully at the table 2 and at the figure 3, a part of the large inter-individual deviation for *Brizalina pacifica* (MR) and *Stainforthia* sp. is pulled by measurements performed on very small and dead individuals. Can you trust those values as reliable for primary calcite signals? Don't the authors think that a part of very low $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ signatures recorded for both taxa may be influenced by secondary calcite (more or less related to cold seeps, for instance)? Moreover, the authors have worked with *Stainforthia* at the genus rank (i.e. without discrimination between different species). In other words, a part of "inter-individual" variability may be related to "inter-species" variability. Right or wrong? If so, related values should be

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considered with utmost cares and not used for calibration (and regression).

Authors' interpretations on the relationship between the $\delta^{18}\text{O}_{\text{e.c.}}$ and foraminiferal signatures are certainly right. However, I don't think that "species with low inter-individual deviations in (carbon) isotopic composition are more suitable as direct proxies of the bottom water environment". Indeed, for 90% of taxa there is clear shifts compared to the equilibrium line (bottom water signature) (Fig. 3) ... and it is well-known that those shifts (>1 permille in this study) are not constant for one species and varies in function of in-sediment parameters (organic matter mineralization in the sediment, pore-water oxygenation, alkalinity, methane seepages...) (McCorkle et al., 1990, 1997; Schmiedl et al., 2004; Fontanier et al., 2006, ...). That's why the $\delta^{13}\text{C}$ of some taxa is sometimes proposed as relevant proxies of environmental parameters (redox conditions in the sediment, exported organic matter flux) that are either partly or totally disconnected from bottom water signature.

p. 6199-6200. The paragraph 3.2 and the related illustrations (Figure 5 and Table 3) are slightly confusing. To be honest, I have got some doubts on the related conclusions (i.e. the applicability of inter-individual distributions (SD within species) to reconstruct the bottom water $\delta^{13}\text{C}_{\text{DIC}}$). Why?

(1) I don't trust in the isotopes values related to either *Stainforthia* or *Rutherfordoides* without specific determination. If you consider *Uvigerinids* for instance, signatures are totally different between *U. mediterranea*, *U. peregrina* and *U. elongatastriata* and they belong all to *Uvigerina* genus. (2) The authors have forgotten to add isotopes data of *Nonionella globosa*, *Nonionella labradorica* and *Takayanagia delicata* for the Sea of Okhotsk in the figure 5. Am I right? If you add those average values (and related SD), it seems that mathematical regressions are suddenly much less convincing for this station. I may be wrong but the authors should discuss this point! (3) If the authors want to draw a convincing regression line, they should have provided the same quality of data for each species at each site (equal number of measurements per species at one site, only living foraminifera). It is not the case in the present study. (4) Coefficients

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of Determination (R^2) are high but it does not mean that the correlation coefficient (r) is statistically significant. The authors should calculate the r -value and the p -level of significance.

p. 6200-6201. Now again, and as explained above, the lower $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ recorded for the smaller and dead individuals belonging to *Brizalina pacifica* (MR) and *Stainforthia* sp. might be related to secondary calcite. Have the authors investigate the possibility of authigenic carbonate precipitation that may be related to cold seeps?

Figure 1. According to the caption, the location of both stations A and B in the related map seems wrong and should be checked.

Figure 2. *Rutherfordoides* sp., *Globobulimina affinis* (from Sagami Bay), *Bulimina aculeata* (from Nankai Trough), *Stainforthia* sp., *Nonionella globosa* and *Nonionella labradorica* (from Okhotsk Sea) should be pictured. Indeed, most of these species/genus are quite complex in terms of taxonomic identification. Therefore, some complementary illustrations would be very useful for readers interested in the related study areas. Moreover, SEM pictures for all taxa (with different views) would be more relevant than normal photographs. Please, don't use "sp." in italics for *Rutherfordoides* sp.

Figure 3. Where are data for *N. globosa* and *N. labradorica*?

Figure 4. Where are data for *N. globosa* and *N. labradorica*? " R^2 " is not sufficient. " r " is required with the p -level of statistical significance.

Table 1. The presentation of sediment intervals used for pore water analyses is awkward. For instance, what is the meaning of "2"? Is it the sediment interval 1-3 cm? or the sediment interval 0-2 cm? What is the meaning of bottom water?

Table 2a-c. Please, precise in the caption the meaning of "cmbsf", and also the meaning of "*" used for *B. aculeata*.

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The end***

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