Biogeosciences

Discussions

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Interactive comment on "Factors Influencing Porosity in Planktonic Foraminifera" *by* Janet E. Burke et al.

Anonymous Referee #2

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General comments

The manuscript entitled "Factors Influencing Porosity in Planktonic Foraminifera" by Burke et al. examined determinant factors of porosity of planktic foraminifers from core top samples using random forest models, considering environmental, biological, and taxonomic factors. They also conducted culture experiment to test the findings derived from the random forest models. They concluded that porosity is determined primarily by size and temperature that would be involved with metabolic rates. This study has fundamental importance on understanding the function of pores, application of porosity to reconstruct paleoecology, and interpretation of test geochemistry. The manuscript is well-written, and overall carefully discussed with statistical supports. However, there are some uncertainties that should be specified in the text, tables, and figures es-

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[Discussion paper]

pecially for the general terms like "size" and "porosity", and their units. In addition, discussion on temperature coefficient Q10 of porosity needs further consideration in terms of its calculation, interpretation, and the terminology as well. The paper would be more improved if the above points are considered.

Major points

1. Unit of "pore size"

In Figure 2, "average pore size" seems to have a unit of μm, so I thought it means pore diameter. However, when I carefully checked the dataset presented in the Supplementary Table 4 (I also downloaded some SEM images from YPM collections, and measured the pore diameter by myself), I found that the "pore size" values in the table seem to have a unit of μm2. Am I right? If so, I think "size" is not an appropriate term to represent an area of a pore (when we say test size, for instance, it usually indicates test diameter, not area). I also found that in Supplemental Figure 3b, "average pore size" is associated with a unit of μm, but in Figure 4 and in Supplementary Figure 6, "Pore size" is with μm2. Which is correct? Please clarify the definition of the parameter together with its unit. It is the same for "pore density". Perhaps it has a unit of "number μm-2", but please specify it as well.

2. Interpretation of Q10 of porosity

In the discussion part, Q10 of porosity is used to test if porosity increases with temperature at the same rate as respiration. The authors concluded that the Q10 of porosity ranging from 1.3 - 2.4 is close to that of respiration of 3.18 (Lombard et al. 2009), and it indicates the relation in respiration and porosity. In my understanding, however, these values can be said different. Since a Q10 value is a rate of change, 2-fold increase and 3-fold increase eventually cause a large difference. I agree that the porosity increases as temperature increases since the Q10 values are larger than 1 (except for G. inflata). However, the difference in Q10 of respiration and that of porosity is rather large. So, I would say the rate of respiration increase due to temperature rise is faster than the

increase of porosity. If the porosity and respiratory gas-exchange are related, it means that the gas-exchange becomes less efficient at a higher temperature (it might indicate that the porosity increase alone cannot meet the increasing respiratory gas-exchange). Maybe, for example, the presence of symbionts is involved with the efficient scavenging of respiratory gas... Anyway, please consider this point (i.e., the difference in Q10 of respiration and porosity) and add a bit more discussion in this part. In addition, according to the values shown in Table 3, the correct range of Q10 of porosity is "1.3 to 2.8", I suppose. Please reconfirm it.

3. Q10 calculation based on SST

I failed to understand why the authors chose SST to calculate Q10 of porosity instead of ambient temperature that directly affects physiological rates. SST can be an indicator of overall categorization of foraminiferal biomes, but it seems inappropriate to use it to calculate temperature sensitivity (i.e., Q10) of species. Especially, respiration of G. truncatulinoides that lives in deeper water mass won't be affected by SST. Would you please clarify this point, or is it possible to recalculate the Q10 of porosity based on the ambient temperature?

4. Use of the term Q10

In the first place, I wonder if it is appropriate to use the term Q10 for the case like porosity which is not a physiological or chemical reaction rate. In general, Q10 is used to show temperature sensitivity of biological (physiological) or chemical reaction rate. Q10 of porosity is understandable to me, but may not be a suitable terminology, simply because porosity is not a physiological rate. Please check the general usage of this terminology carefully.

5. "Size" of cultured specimens

The authors often mention on "body size" in Section 3.2 (e.g., L236, L420), but what this term indicates is not clear without very careful reading (I could understand that it

means the area, not the body mass or the test diameter, only after I reached L234). In the method part, please define the term. I recommend not to use "size" to indicate "area".

6. Size-normalized porosity

I failed to understand how the size-normalized porosity is calculated. Why the values with a unit of % have negative values (e.g., as represented in Figure 5b)? Would you please explain these values and how you calculated them in the method section or the supplementary text?

Minor points

L43, L45: Hemleben et al., 2012 —> Isn't it "Hemleben et al., 1989"? The book was firstly published in 1989, and later released as an e-book in 2012, I suppose.

L81: . . .including respiration and photosynthesis —> I did not see any discussion on porosity and photosynthesis in the text. If so, please delete "and photosynthesis". Meanwhile, I think it is good to add discussion on photosynthesis and porosity, if possible. Please see the abovementioned comment on Q10 of porosity.

L95-96: Supplemental Discussion —> I could not find "Supplemental Discussion" in supplementary materials. Perhaps you mean "Supplemental Text"?

L143: 32.35942N —> ° is missing.

L166: Random Forest —> Random forest

L245–247: "The groups were all statistically . . ..., but . . .." —> The wording sounds strange. Since one-way ANOVA is a method that evaluates whether the group means are drawn from populations with the same mean values or not, your one-way ANOVA result just shows there is a significant difference somewhere. It does not tell you that "the groups were all statistically different". Then, the post-hoc Tukey's HSD, a test to check where the difference exists, revealed that the significant difference exists be-

tween high- and low-temperature groups. So, the sentence should be "The groups were statistically different . . ., and a pairwise Tukey's . . ..".

L248: p>0.335 —> p=0.335?

L261: . . .test size (specifically surface area) —> How about just saying "surface area" since "test size" usually represents test diameter.

L624: Buma, J. —> Bijma, J.

Through the text: The number of decimal places is sometimes inconsistent among the same parameters (e.g., L216: 71.81% —> 71.8%, L228: p=0.52, 0.171, 1 —> 0.52, 0.71, 1.00(?), Table 3).

Through the text: "Supplemental Figure XX" or "Supplementary Figure XX"? Please use a consistent term.

Through the text: It seems that the term "porosity" is sometimes used in an expanded sense, not for the specific variable indicating the total percent area occupied by pores. In such cases, how about using "pore characteristics" instead? Otherwise, it is quite confusing.

Through the text: morphogroups or morphotype: In the text, both are used. If both represent the same categorization, please unify them to either one. In addition, the authors say "morphogroups were . . . as per Bé (1968)" in L136, but on the other hand, in the caption of Supplemental Figure 4, they say ". . .morphotype as described in Bé (1960)". Perhaps the latter should be Bé (1968)? Another concern relating to this is that morphogroups by Bé (1968) are based on test microstructure of species, including characteristics of perforation. Therefore, using this categorization to examine the effect of morphogroups on porosity seems to have a problem (maybe a kind of circular reasoning). Considering this point, the categorization of species should be solely based on, for example, genetic phylogeny (which is constructed independently from pore characteristics) in order to take into account for the evolutionary relationship. In fact, it will

not be a big problem because the categorization of morphogroups in this manuscript (i.e., globigeinoid, globigerinid, globoquadrinid, and globorotalid) are usually consistent to the other species categorization which is independent from pore characteristics.

Table 3: ΔPorosity —> Does it mean Q10 of porosity? Please use the consistent term as appears in the text.

Table 3: Please use consistent genus names. If you use the naming convention in Schiebel and Hemleben (2017) as you declared in the text, Trilobatus should be Globigerinoides, Truncorotaria and Globoconella should be Globorotalia. It is the same for Supplemental Figure 4a, 4b, and 4c.

Figure 1: Please indicate longitude and latitude at least at the four end of the represented area.

Figure 4: The symbol for Globorotalia in the legend is not identical to the ones in the plot, strictly speaking. In addition, um2 should be μm2.

Figure 5, caption: Body size and porosity of…. —> Does "body size" mean "ΔArea (mm2)" in Figure 5a? If so, I think the term is misleading, and needs to be corrected. In addition, more detailed explanation is needed in the caption as this is the only figure showing the results of cultured specimens except for supplementary figures.

Supplemental Figure 5: The colored bars are not easy to read especially in (b), and they are not so informative. I think it's okay without them. Alternatively, how about rearrange the panels to align each treatment group as a column (transpose columns and rows)? It will make it easy to compare different temperature treatments.

Supplemental Figure 6: What does the vertical axis mean? The caption says "size normalized porosity (%)", but in the figure, the axis is "Porosity residual".