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Biogeosciences Discussions

Interactive comment on "The unique skeleton of siliceous sponges (Porifera; Hexactinellida and Demospongiae) that evolved first from the Urmetazoa during the Proterozoic: a review" *by* W. E. G. Müller et al.

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- p. 389, l. 4 This statement is completely redundant. Metazoan monophyly is well supported and was well supported before molecular data became available (see above). So, by definition all metazoans emerged from their most recent common ancestor.

Answer: I ask the reader to give me a valid publication where this is outlined unambiguously. I refer to the article of Rodrigo et al (Are sponges animals? An investigation into the vagaries of phylogenetic inference). In: Sponges in Time and Space

(1994).

Reply: Maybe I should have dropped the "and was well supported before..."-part of the sentence, because this is not the key point of my critique here. The point is that metazoan monophyly is well supported from several lines of evidence and today nobody seriously doubts it. If a group is known to be monophyletic, it is redundant to mention that all of its members are derived from its hypothetical ancestor (they are so by definition). By the way, "ancestor" is singular, so if Prof. Müller insists on his "Urmetazoa" he should at least change it to "Urmetazoon" in this sentence.

- p. 389, l. 10-11 First, it should read "metazoan phylum" or "animal phylum". Second, other animal phyla were certainly already around at the Neoproterozoic/Cambrian boundary. The authors should not simply claim that sponges were dominant or even the sole phylum at that time, but discuss this in more detail and provide references.

Answer: We will include “metazoan phylum” and will outline that sponges had been the sole phylum with a hard skeleton.

Reply: Demosponges of the late Proterozoic of S-Namibia are associated with the organism Cloudina, which is represented by calcareous tubes and probably has affinities to annelids (see chapter by Reitner and Wörheide in Systema Porifera), so it is not true that sponges were the only phylum with a hard skeleton during that time.

- p. 389, l. 12 Sponges are not "living fossils". Most researchers would define a living fossil as a relict taxon that is still alive today whereas all of its close relatives (members of the same ancient radiation) went extinct long time ago. Perhaps the term should be avoided altogether in a rigorous scientific context. In any case, sponges are very widespread and diverse today and play major ecological roles, so they are certainly not relicts of an ancient radiation. Therefore, the term "living fossil" does not apply to them.

Answer: Sponges as "living fossils". I will stick to this term, since it is also used in the group of the reader: “Jahn, T., König, G.M., Wright, A.D., Wörheide, G. Reitner,

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J. (1997): Manzacidin D: An Unprecedented Secondary Metabolite from the? DLiving Fossil“ sponge Astrosclera willeyana.- Tetrahedron Letters, 38: 3883-3884.”.

Reply: First of all I find the argumentation to insist on the term because members of my department/group have also used it a bit dubious. Please also note that I have joined the group in 2004, so I had nothing to do with that paper. More importantly, however, the term "living fossil" as I have defined it in my original comment does apply to Astrosclera (and other extant "coralline sponges" such as Vaceletia), but not to sponges as a whole.

- p. 390, l. 4-5, l. 22 ff.; p. 391, l. 11 ff. Demosponge fossils have been found in 750 my old strata of Nevada (Reitner and Wörheide, 2002), so demosponges predate hexactinellids in the known fossil record.

Answer: The reader perhaps refers to: Reitner, J. & Wörheide, G. (2002): Non-Lithistid fossil Demospongiae - Origins of their Palaeobiodiversity and Highlights in History of Preservation.- In: Hooper, J.N.A. & Van Soest, R. (eds.), Systema Porifera: A Guide to the Classification of Sponges. 52-68 (Kluwer) New York. If I see it correctly, this review only states the existence of those sponges, without giving photos or any other detailed data. If so, the evidence is not enough for me.

Reply: I do refer to that reference (I put a reference list at the end of my original comment), and it is true that these findings are not documented there, but the possibility that the interpretation is correct should nevertheless be discussed. However, even if we assume that Prof. Reitner’s interpretation of these fossils and/or age of strata is not correct, fossils with demosponge affinities have also been found in Ediacaran age (555 mya) strata in Namibia (see Figure 1A in the same reference), and the demosponges described in Li et al. (1998): Science 279:879 are also of Vendian age (ca. 580 mya). As far as I see it, there is currently no convincing evidence that hexactinellids predate demosponges in the fossil record. If they are each closest living relatives it should be expected that they are of the same age anyway.

- p. 391, l. 7-10 What relevance does the age of freshwater sponges have to the issues

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addressed in this review?

Answer: It should highlight that the freshwater sponges evolved later. This appears not to be necessary - however I want to refer to the hot discussion about the origin of the endemic sponges in the Lake Baikal.

Reply: This is certainly an interesting topic, but it has nothing to do with the evolution of siliceous skeletons during the Proterozoic.

- p. 392, l. 15-18 The authors do not explain why soluble silicate should have provided a basis for survival and diversification. Evidence and/or references are missing.

Answer: Please see: Müller WEG, Schröder HC, Wrede P, Kaluzhnaya OV, Belikov SI (2006) Speciation of sponges in Baikal-Tuva region (an outline). J. Zool. Syst. Evol. Research 44: 105-117. There we outlined that silicatein, the basic protein which produces silica in sponges, diversified in freshwater sponges and might be highly correlated with the evolution of the Lake Baikal sponges.

Reply: Even if the diversification of silicatein is highly correlated with the evolution of these freshwater sponges, one cannot extrapolate this finding to early sponges in the Neoproterozoic ocean. Although it could be true, this is pure speculation and should be indicated as such.

- p. 392, l. 25-29 This section is unclearly written, and references are missing. What does "genetic toolkit for all deriving metazoans" mean? What are "deriving metazoans" anyway? Why does the genetic repertoire of sponges "gives the frame" etc. of the body plan construction seen in "higher groups" ("crown groups" is wrong; see above)? If at all, it is the genetic repertoire of the common ancestor of sponges and eumetazoans that set the limits of animal body plan construction.

Answer: If I understand the reader correctly wants that I give as a reference to that paragraph the citation of: “Pilcher, H.: Back to our roots, Nature, 435, 1022-1023, 2005.”. There, these terms are outlined and also the term “Urmetazoa” has been high-

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lighted.

Reply: I would not recommend to include this citation. I think I know what the authors are trying to express in this paragraph. My critique is that it is unconcisely written and not to the point. Besides, I think it should be "derived", not "deriving".

- p. 393, l. 2-5 I think science should not be a matter of postulating things but testing hypotheses in the light of observations. What does "entropy" mean in an evolutionary context? "Complexity" is also a rather vague term, and besides it is well known that simplifications have occurred during the course of evolution. The term "perfection" should be avoided in an evolutionary context since it implies an underlying "plan", which puts things in the realm of creationism. Anyway, it is not clear to me what this sentence is supposed to mean. Why should increased complexity be detrimental to the survival of younger species? What species are the authors referring to, and younger than what are these species supposed to be?

Answer: In a review it is allowed to speculate in order to provide the ground for further scientific contributions. I refer to our paper (Müller WEG, Müller IM (2003) Analysis of the sponge [porifera] gene repertoire: Implications for the evolution of the metazoan body plan. In: Marine Molecular Biotechnology (Müller WEG, ed.) Springer-Press, Berlin, pp. 1-33) in which we also provide data that sponges have over 100,000 gene in contrast to the 34,000 genes in human. If they are expressed - which must be checked - then the diversity of transcripts might be higher in sponges than in humans. How to explain that? - only by redundancy? Perhaps I will exchange "entropy" by “redundancy”.

Reply: I read these two sentences over and over again, but I still don’t get what they are supposed to mean. Prof. Müllers answer did not add anything to my understanding. The authors should express themselves more concisely.

- p. 393, l. 24-26 As stated above, there are also sponges without spicules, and they have a body plan, too. Besides, spicules and sclerocytes are not the same: the former

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are products of the latter, and sclerocytes as such do not stabilize the sponge body.

Answer: I cannot follow the argumentation of the reader. Please find in the article of “Reitner, J. & Wörheide, G. (2002) [see above]” the outline: “The origin of the sponge bodyplan is probably related to the development of special stromatolite-forming biofilmsE? .”. Is this what the reader means with bodyplan?

Reply: No. I am not convinced of Prof. Reitner’s biofilm hypothesis (see above). As stated earlier, for me "body plan" is a very general term - every multicellular organism has some sort of body plan. Since this includes spicule-lacking sponges, I could not follow the author’s argumentation. However, if Prof. Müller has a more specific definition of "body plan" it would be appropriate to give this definition in the article.

Figure 2 First, see comment on "Urmetazoa" above. Second, what is the difference between the light blue bars and the dark blue bars and what does the height of the bars mean (i.e., how is the y-axis scaled?). Third, it should be "years before present", not "Years". Fourth, according to the figure, metazoans evolved about 900 my ago (and the socalled "Urmetazoa" even earlier), whereas in the figure caption it is stated that they evolved between 600 and 800 my ago. Finally, the Neoproterozoic does not continue up to the present day (0 years) as implied by the figure (what happened to the Phanerozoic?).

Answer: We will give a more comprehensive description in this review, even though we gave the reference “(Hoffmann and Schrag, 2002)”, where everything is described in details.

Reply: First, a figure should always be fully described, no matter if it is original or adapted from a reference. Second, I hope that the figure will be changed so that the scaling of the x-axis, the rest of the figure, and the figure caption are in agreement with each other.

Figure 3. Second, the phylogenetic position of Archaeocyatha is still being debated;

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certainly they are not the sister group of Eumetazoa, as implied by this tree.

Answer: We will make on this line a Question mark.

Reply: This would still indicate that this hypothesis has been proposed, which I am not aware of.

Third, the "silicic acid skeleton" is very likely an autapomorphy of siliceous sponges (and not of Metazoa as the figure implies); the "Ca-carbonate skeleton" (spicules to be precise; see below) is an autapomorphy of Calcarea (not of Calcarea+Eumetazoa), "oral/aboral axis" and "radial symmetry" are probably autapomorphies of Cnidaria (not of Eumetazoa), and "biradial symmetry" certainly is an autapomorphy of Ctenophora (not of Ctenophora+Bilateria).

Answer: We can follow the reader.

Reply: Then you can change the figure accordingly.

Fourth, a number of demosponge groups are also capable of secreting Ca carbonate skeletons, whereas Ca carbonate spicules only occur in Calcarea.

Answer: We have here submitted a review. I think this is debatable and should not be included in the paper the occurrence of calcite and silica in one sponge - biochemical data are absent.

Reply: I do agree that siliceous and calcareous spicules do never occur together in one sponge. However, it is a fact that certain demosponges (e.g., Astrosclera) secrete Ca-carbonate basal skeletons.

Also, sponge paraphyly is still being debated.

Answer: I am happy about the statement of the reader.

Reply: The point is that it should be mentioned in the article.

Third, I am not aware of any study that recovered Calcarea as "a sister group of the

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Cnidaria" (l. 8); the current working hypothesis in the molecular phylogenetics community appears to be that Calcarea is the sister group of Eumetazoa.

Answer: Yes - I know, we published this first. See: “Schütze J, Custodio MR, Efremova SM, Müller IM, Müller WEG (1999) Evolutionary relationship of metazoa within the eukaryotes based on molecular data from porifera. Proc. Royal Society Lond. B 266: 63-73”.

Reply: First, it had been published before the mentioned paper (see Cavalier-Smith et al. 1996. Can. J. Zoolog. 74:2031; Collins 1998. PNAS 95:15458; Zrzavy 1998. Cladistics 14:249). Second, it is not clear to me why the author claims a sister group relationship of Calcarea and Cnidaria when he knows that it is not true.

Fourth, ctenophorans did certainly not "evolve from" cnidarians (l. 8-9). This would imply that Cnidaria is paraphyletic, which is very unlikely. Ctenophora is either the sister group of Bilateria, of Cnidaria, or of Cnidaria+Bilateria; there is currently no consensus regarding these three hypotheses.

Answer: The line to the Ctenophora will be marked with a question mark.

Reply: My point is that the expression "evolve from" is wrong. Putting a question mark on the line does not change this.

Finally, it is not explained what the green triangles in the figure mean.

Answer: That is easy - and I hope self-explainable: these are the borders of the respective ice periods.

Reply: I know that. But why two triangles in differently shaded green that point in different directions?

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