Peer Community In Zoology

# Future oceanic conditions could leave sponge holobionts breathless – but they won't let that stop them

***Loïc N. Michel*** *based on peer reviews by* ***Maria Lopez Acosta*** *and 2 anonymous reviewers*

Brian W Strehlow, Astrid Schuster, Warren R Francis, Lisa Eckford-Soper, Beate Kraft, Rob McAllen, Ronni Nielsen, Susanne Mandrup, Donald E Canfield (2023) Transcriptomic responses of sponge holobionts to in situ, seasonal anoxia and hypoxia. bioRxiv, ver. 4, peer-reviewed and recommended by Peer Community in Zoology.
https://doi.org/10.1101/2023.02.27.530229

Submitted: 16 May 2023, Recommended: 14 December 2023

**Cite this recommendation as:**
Michel, L. (2023) Future oceanic conditions could leave sponge holobionts breathless – but they won't let that stop them. *Peer Community in Zoology*, 100211. 10.24072/pci.zool.100211

Published: 14 December 2023


---

It is now widely accepted that anthropogenic climate change is a severe threat to biodiversity, ecosystem function and associated ecosystem services. Assessing the vulnerability of species and predicting their response to future changes has become a priority for environmental biology (Williams *et al.* 2020).

Over the last few decades, oxygen concentrations in both the open ocean and coastal waters have been declining steadily as the result of multiple anthropogenic activities. This global trends towards hypoxia is expected to continue in the future, causing a host of negative effects on marine ecosystems. Oxygen is indeed crucial to many biological processes in the ocean, and its decrease could have strong impacts on biogeochemical cycles, and therefore on marine productivity and biodiversity (Breitburg *et al.* 2018).

Whenever facing such drastic environmental changes, all organisms are expected to have some intrinsic ability to adapt. At shorter than evolutionary timescales, ecological plasticity and the eco-physiological processes that sustain it could constitute important adaptive mechanisms (Williams *et al.* 2020)

Marine sponges seem particularly well-adapted to oxygen deficiency, as some species can survive seasonal anoxia for several months. This paper by Strehlow *et al.* (2023) examines the mechanisms allowing this exceptional tolerance. Focusing on two species of sponges, they used transcriptomics to assess how gene expression by sponges, by their mitochondria, or by their unique and species-specific microbiome could facilitate this trait. Their results suggest that sponge holobionts maintain metabolic activity under anoxic conditions while displaying shock response, therefore not supporting the hypothesis of sponge dormancy.

Furthermore, hypoxia and anoxia seemed to influence gene expression in different ways, highlighting the complexity of sponge response to deoxygenation. As often, their exciting results raise as many questions as they provide answers and pave the way for more research regarding how anoxia tolerance in marine sponges could give them an advantage in future oceanic environmental conditions.

***References:***


Breitburg *et al.* (2018): Declining oxygen in the global ocean and coastal waters. *Science* 359, eaam7240. https://doi.org/10.1126/science.aam7240

Strehlow *et al.* (2023): Transcriptomic responses of sponge holobionts to in situ, seasonal anoxia and hypoxia. bioRxiv, 2023.02.27.530229, ver. 4 peer-reviewed and recommended by Peer Community in Zoology. https://doi.org/10.1101/2023.02.27.530229

Williams *et al.* (2008) Towards an Integrated Framework for Assessing the Vulnerability of Species to Climate Change. *PLOS Biology* 6(12): e325. https://doi.org/10.1371/journal.pbio.0060325

Williams *et al.* (2020): Research priorities for natural ecosystems in a changing global climate. *Global Change Biology* 26: 410–416. https://doi.org/10.1111/gcb.14856


# Reviews

## Evaluation round #3

### Reviewed by Maria Lopez Acosta, 11 December 2023

The authors have made the requested changes and I now consider the paper ready to be recommended by PCI Zoology. I think this is a good manuscript that will serve as a basis for future (and hopefully numerous) studies on the tolerance and adaptations of sponges to oxygen limitation, a major issue in an ocean undergoing rapid and significant changes due to climate change.

## Evaluation round #2

DOI or URL of the preprint: https://doi.org/10.1101/2023.02.27.530229
Version of the preprint: 3

### Authors' reply, 06 December 2023

**Download author's reply**
**Download tracked changes file**

### Decision by Loïc N. Michel, posted 23 November 2023, validated 24 November 2023

**2nd revision necessary**

Dear Brian et al.,

Your preprint has now undergone a second round of revision. One of the two original reviewers is pleased with your edits and has no further comments. The other original reviewer was unfortunately not available, and the paper therefore has been sent to a third reviewer. As you will see they are very enthusiastic about the

draft, but suggest a number of modifications. They provided a very comprehensive list of minor or moderate suggestions in their review, and I'm confident that you will be able to accomodate them efficiently.

All the best,

Loïc Michel

### Reviewed by anonymous reviewer 1, 06 November 2023

The authors made the requested changes: their revisions have answered/addressed all of my questions and concerns from the original submission. I consider the paper ready to be recommended in PCI Zoology.

### Reviewed by Maria Lopez Acosta, 22 November 2023

**Download the review**

## Evaluation round #1

DOI or URL of the preprint: https://doi.org/10.1101/2023.02.27.530229

Version of the preprint: 2

### Authors' reply, 27 October 2023

**Download author's reply**

**Download tracked changes file**

### Decision by Loïc N. Michel, posted 21 August 2023, validated 28 August 2023

Dear authors,

First of all, I would like to apologize for the long silence since you submitted this preprint. Not only has it been hard to find reviewers despite your suggestions, but a busy period regarding cruises, conferences and summer breaks has complicated the process.

I have now received the reports of two reviewers. Both made positive assessments of your pre-print and I agree with them. Nevertheless, they also made multiple suggestions that, in my opinion, would improve your manuscript before recommendation. Both reviewers notably noted the very important amount of presented results, which tends to dilute the main message of the paper. Both of them suggested to provide a synthetic overview of the results, either in a summary paragraph or in a conceptual diagram at the end of the paper. Please revise your manuscript taking this suggestion into account, and addressing each of the reviewers' comments in your response.

I look forward to receiving a revised version of your preprint.

All the best,

Loïc N. Michel

### Reviewed by anonymous reviewer 1, 12 August 2023

**Download the review**

### Reviewed by anonymous reviewer 2, 04 August 2023

Review of the paper " Transcriptomic responses of sponge holobionts to in situ, seasonal anoxia and hypoxia " by Brian Strehlow and collaborators

This article reports on a study of the transcriptomic response of two sponge species to hypoxic and anoxic conditions. The study focused on the transcriptome of the sponges themselves, but also of their mitochondria and the associated microbiome (mainly the two dominant microbes: an archaea and a gammaproteobacterium).

This article deals with a very interesting subject and poses particularly interesting questions on the mechanisms that enable these organisms to tolerate a reduction in the quantity of oxygen in the environment, particularly in the current context of possible deoxygenation of the oceans.

The title clearly reflects the content of the article.

The introduction seems (as far as I can judge, not being a specialist in the subject) to correctly put the study into context and the literature on the effect of hypoxia or anoxia on sponges or other invertebrates on which data are available. I think it would be interesting to develop the paragraph on the missing HIF (hypoxia inducible factor) pathways in sponges and the vital functions that the microbiome can play, which remains very evasive (lines 115 to 118). It would also be interesting to describe the host-microbiome relationship (i.e. location of microbes in/on host tissues, quantity, diversity, interactions with the host) if this information is known.

The stated aim of the study is to understand the mechanisms that enable tolerance to hypoxia and anoxia, and survival in prolonged anoxia. While a number of clues are given, overall we are left wanting to know what mechanisms are at work to explain such tolerance (no doubt due to the sheer volume of data, which is a bit confusing, see below).

Regarding Materials and methods, I lack expertise in molecular approaches and am not in a position to judge the choice of techniques and analyses used. On the other hand, I would suggest indicating the depths and temperatures of the sampling sites, if available.

My main concern with this article is that the study provides an enormous amount of data, which dilutes and obscures the important messages. The summary also reflects the complexity of having so much data to summarise.

For example, some phrases that can be a bit confusing, such as:

- Line 799: These results might indicate that glycolysis rates increased under anoxia and hypoxia in both species. Due to the consistency in gene expression of the other ~70 genes associated with glycolysis; however, it is more likely that glycolysis continued under anoxia and hypoxia at normal rates in both species.

- Line 946: These species-specific responses within the symbionts could result from phylogenetic differences between the two symbionts. And in the next sentence: these taxonomically similar symbionts between two sponge species might have similar functional roles.

The discussion is very long and sometimes hard to follow. It's not easy to know what's important in the long list of genes/groups of genes up- or down-regulated in the different compartments or the different treatments. The publication would be clearer if only the take home messages were kept and not the differences observed at the margins, which in the final analysis are not significant in answering the question of tolerance.

A summary paragraph clearly indicating what the study explains (or can not explain) about the mechanisms involved in resistance to hypoxia would be very useful.

Links between the different data would also be interesting: for example, if I've understood correctly, there could be dormancy in hypoxia in Eurypon sp. 2, how could that be correlated with the increase in ATP production?