Dear Dr Brandl,  
  
Thank you again for submitting your manuscript "Organismal responses to extreme temperatures reduce coral reef biodiversity and functioning" to Nature Communications. We have now received reports from three reviewers and, on the basis of their comments, we have decided to invite a revision of your work for further consideration in our journal. Your revision should address all the points raised by our reviewers (see their reports below). Although we are overruling Reviewer 1 on the point about the work lacking replication at the level of "gulf", we do expect significant toning down and re-framing about the role of temperature in driving the patterns presented.   
  
When resubmitting, you must provide a point-by-point response to the reviewers’ comments. Please show all changes in the manuscript text file with track changes or colour highlighting. If you are unable to address specific reviewer requests or find any points invalid, please explain why in the point-by-point response.  
  
In addition to the above, you must comply with the following editorial requests; failure to do so will cause delays upon resubmission.  
  
Best regards,  
  
Alexa  
  
Alexa McKay, PhD  
Senior Editor  
Nature Communications

*Our response:*

*Dear Dr. McKay,*

*Thank you for your time and effort in handling our manuscript. We are very pleased to have the opportunity to submit a revised manuscript. In our revised paper, we have de-emphasized the causal role of temperature in driving the observed patterns and instead keep a broader perspective on the environmental extremes imposed by the Arabian Gulf. This is reflected in the title, abstract, introduction, and discussion of our results. Furthermore, we provide additional information on the temperature profiles and other environmental conditions in the two locations.*

*Please find our specific answers to each of the Reviewers’ comments below.*

*Best wishes,*

*Simon Brandl (on behalf of the authors)*

**REVIEWER COMMENTS**  
  
Reviewer #1 (Remarks to the Author):  
  
This study makes comparisons of fish communities between two gulfs and finds them to be different. It then inappropriately attributes these differences to differences in temperature regimes between the two locations. Two communities can differ for any number of reasons, temperature is just one. To conclude, on the basis of comparing just two sites, that temperature is the principal driver (from the Abstract: "Rather, impoverished body conditions of 35 populations in the Arabian Gulf point toward an increased energetic costs of growth and 36 homeostasis at higher temperatures). The scale at which the factor of interest varies here is "Gulf", consequently the unit of replication to make valid inferences is also "Gulf". The study does not replicate at that scale and so none of the inferences are supported. I recognise that replicating at that scale would be challenging but consider that that the statement that the authors is making is substantial - that temperature is the most  
important driver of differences among gulf - to make a substantive statement requires substantive evidence.   
There is vast literature on making comparisons across large spatial scales such as the one proposed here, particularly protected area studies on both land and sea. Likewise, there is a large body of work on local adaptation of physiology (Conover in fish is a good exemplar). This work does not approach this problem at the appropriate scale and does no provide sufficient support for any of the key inferences.   
I'm sorry I cannot be more positive but for work to be published in a high impact journal, best practice in terms of experimental design is essential.  
  
  
Reviewer #2 (Remarks to the Author):  
  
This study compares cryptobenthic reef fish communities and their ecological processes from the Gulf of Oman and the Arabian Gulf. The Arabian Gulf is an extreme environment and this study investigating how this influences these fish in the context of future climate change. Through standardized collections and aquaria trials, the authors explored differences in, critical thermal maximum and minimum tolerances, gut content using DNA barcoding, and length weight relationships for a subset of species. They also modeled growth, mortality, and biomass turnover for each region at the community level. Through these analysis, the authors conclude that there are ecological differences between the fish in the Arabian Gulf and Gulf of Oman reefs driven by extreme temperature after coral cover and composition are dismissed, with the extreme temperatures in the Arabian Gulf having a detrimental effect on fish communities and function.  
  
Firstly, I would like to acknowledge the significant among of field, laboratory, and aquaria work to address these questions. There is a considerable amount of effort gone into to executing this study in a region that is greatly understudied and challenging to work in. This study is excellently communicated, analyses, and presented. Furthermore, the majority of this data is collected from the natural environment in natural conditions which is rare, However, this does reduce the ability to account and control for other variables. They have done a great job comparing the two regions, however I caution the strong narrative that focuses on temperature as the main driver.   
  
The authors propose that the higher temperatures in the Arabian Gulf is the main driving difference between the two regions after the benthos is excluded. This is a focus of the manuscript and made clear in the title and throughout the manuscript (L130-140, Fig 1). While temperature profiles are clearly different and a driver of organism response, there appears to be no inclusion and little discussion around other environmental variables that differ greatly between regions that could factor into these findings (e.g., salinity and productivity).   
  
The authors do test and dismiss benthic community composition and coral cover after finding no significant differences between regions based on the sample sites. Given the broad resolution of the benthic composition data, these differences might be difficult to detect. Resolution (benthic species, caves, complexity) could be important give the close relationship between fish and benthos for shelter, feeding and reproduction. Benthic profiling (5 x 20x20cm quadrates) over a ~4.6m2 area with broad groups might not captured enough of the variation to detect differences in benthic composition and coral cover in addition to the assumption of the reef surface area (L657), and therefore dismiss the benthos as an additional driver. Given the extreme environment in the Arabian Gulf and the bleaching events in the previous years (L448) it is surprising that they are similar (see Burt et al. 2019 CR).   
  
Sampling and collections were conducted at the end of April and May, the end of the cooler season. If the model species in this study only live weeks to months (Lines 99 onwards: 7.4 generations per year, high mortality) and you collected them at the end of the winter, would it not be the winter temperatures that are influencing body mass per unit length, growth rates, and biomass production?   
  
Minor comments  
  
L130  
Here you are presenting a maximum and minimum sea surface temperature from a 10 year period (2008 - 2018). While this presents the extremes for each region from a decade, some additional information about the two regions would be useful. Either here, or in the methods (L475), can you provide some additional details around the thermal regimes: i.e., how long do these max. and min. temps persist for, are these temps observed most years, and what is the average temperature for each of the two regions?   
  
L154  
It would be informative to include some values for species richness and density within this section. Also, the graph has “richness”, the caption has “density”, and the text has “diversity”.   
  
L198  
Please provide the values for each region or the difference in heat tolerance for E. pulcher   
  
L327   
This is a strong statement considering only one species increased max thermal tolerance and one species increased min thermal tolerance.   
  
L324  
While statistically significant, how ecologically relevant are the differences in body condition for E. ventermaculus (very small weights) and C. anomolus (for the given size comparisons)?   
  
L330 – 333  
Poor body condition suggests a response to temperature and other environmental variables, - what about the recorded differences in diet composition (as a result of the temperature and other environmental variables) also producing poor body condition?   
  
L338 – 342 and L423 - 426  
How does the difference in produced biomass between regions related to the observed standing biomass that was similar between the two regions?   
  
L350, L352  
If there is significant self-recruitment back to these thermal hotspots.   
  
L382  
Maybe add that DNA metabarcoding cannot accurately assess quantity of prey types in the diet.   
  
L408  
Your length body rate relationships are potential from winter months (if their life span is ~3 months). Therefore the response could be to cooler water not warmer water, or the temperature envelope if the they live longer than a year. Would you expect these differences to be even more pronounced if they were collected at the end of the summer period? What is the average life span of these 3 species that you tested?   
  
L485   
What was the local water temperatures for each region at the time of the collections?   
  
L517-520  
Please provide sample size for each species   
  
L554 - 557  
Please include what the temperature and salinity for the holding tanks and trial chambers, and was this the same for species from each region?   
  
L565  
Can you please provide the specific replication for each species from each region for each thermal trial (max and min).   
  
L657   
“assumption that outcrops are hemispherical… “ This seem like a big assumption, and assumes that all outcrops were of similar shape (and height?). Given the collection tarpaulin was standardized and used in this equation, it would appear that surface area would be similar among sites. This can obviously influence benthic groups % cover, in addition to calculating abundance, diversity, and biomass of fish based on the area of this calculation.   
  
L671   
Please include if the data was transformed for any of the ordination analysis?   
  
L680   
Please include if this is proportion or percentage.   
  
L682  
Please define if these “3 records” were per quadrate, outcrop, or region?  
  
L694  
Did you account for the effect of individual size?  
  
Fig 1 and 2  
It is difficult to distinguish among symbols.   
  
Fig 2  
Should the % coral cover in the bottom right be proportion? 0.2% to 0.6% seem extremely low  
  
Fig 3   
Check that 11.9oC is correct in the caption.   
  
  
  
Reviewer #3 (Remarks to the Author):  
  
The manuscript titled ‘Organismal responses to extreme temperature reduce coral reef biodiversity and functioning’ is study on differences in cryptobenthic fish communities among two reefs with different environmental conditions. The aim here is to understand how and why a community might look like in the light of increasing temperature due to climate change.  
General comments:  
What a lovely manuscript to review. The authors have done a great job at finding a good ‘natural laboratory’ to answer some of these really important questions. The study has been thoroughly performed and addresses many aspects of why fish might be different among both sites.   
I only have one more general comment, which I can see in the discussion that the authors are already aware of. Although benthic communities might be similar, much other than temperature will vary among the ‘two’ locations. Especially the introduction is heavily focused on temperature. I think it is worth already at the start to acknowledge that there is more than just temperature that differs between these sites. It is obviously impossible to find two sites with only one variable of change of course, but here temperature is the only variable presented.   
Specific comments:  
As mentioned to the editor, some of your study does not fall into my field of expertise, nevertheless it would be good to clarify some of these questions I stumbled across.  
Line 187-190: I had to read this over and over again. It’s a nicely compact sentence, but hard to follow, especially at this point it is the first time the reader hears of CTmax  
In the next paragraphs it is not 100% clear if these species are found in both sites or just at one or the other (unless stated in brackets).   
The issue with having a methods part after the results – according to your figure 3 – you measured two species that occur in both locations, one that is AG only and three GoO only? Maybe clarify this in the text (as it took me a while to figure out) and the ‘all species’ in line 191 might be misleading – it is all species which you tested (correct?).   
Line 284: Is the fact that you only found large individuals of C. anomalus in the AG a collection bias or are there no large sized fish?  
Line 335: Is there a chance that the fish at AG feed on restricted food – not just because there is less available - but possibly the food they choose to eat is of higher ‘quality’(and hence less diverse)? (ok, saw that you did discuss this a few paragraphs later)  
Line 329: very cool result.  
Line 352: what about rapid evolution? Kind of curious to see if these are still the same species or there is some population structuring and local adaptation happening (but of course out of the scope of this paper).  
  
Figure 1: Would it be possible to zoom into sites ( as in the end the whole AG temp profile isn’t really that important here)?  
Figure 2: It is hard to identify the sites as the symbols are too small.  
  
  
  
  
  
  
  
\*\* See Nature Research’s author and referees' website at [www.nature.com/authors](http://www.nature.com/authors) for information about policies, services and author benefits.  
  
  
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