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Dr. Elisa De Ranieri
Editor-in-Chief
Nature Communications

Dear Dr. De Ranieri,

We wish to submit our manuscript "**Organismal responses to extreme temperatures reduce coral reef biodiversity and functioning**" for consideration as an Article in *Nature Communications.*

In an era of intensifying human impact, understanding nature's responses to changing conditions is critical. Altered abiotic conditions primarily affect organismal physiology. Yet, this may cascade through levels of biological organization to shape community assembly and ecosystem functioning.

Coral reefs supply services to more than 500 million people worldwide. While reef-building corals are highly susceptible to rising temperatures, recent research has suggested that reef fishes, the primary fisheries resource provided by reefs, may be able to cope with warmer oceans through transgenerational adaptation. Instead, loss of live coral habitat is cited as a primary process that may deplete reef fish communities.

Here, we show that cryptobenthic reef fishes, the ocean's smallest vertebrates and a critical functional group on reefs, cannot cope with energetic demands of extreme temperatures, jeopardizing the productivity of coral reef fish assemblages in warming oceans.

Specifically, we combined field surveys of cryptobenthic reef fish communities from the southeastern Arabian Gulf (the hottest reefs on Earth) and the nearby thermally benign Gulf of Oman with organismal physiology, gut content DNA metabarcoding, and population modeling to show that:

1) Cryptobenthic reef fish assemblages from the Arabian Gulf are highly depauperate, merely including **half of the species and less than 25% of the individuals** in the Gulf of Oman, despite comparable availability of live coral substrate.

2) This pattern is not driven by species-specific critical thermal tolerances; species present in both locations **are able to withstand short-term exposure to temperatures** well beyond the extremes reached in the southeastern Arabian Gulf.

3) Instead, stark intraspecific differences in body condition and diet between populations in the two locations suggest **an energetic double jeopardy that precludes the persistence of most cryptobenthic species**: extreme temperatures increase the costs of growth and homeostasis, while a different and narrower suite of dietary resources exacerbates the satisfaction of these increased energetic demands.

4) This "energetic filtering effect" of high temperature reefs **stymies the production, transfer, and renewal of cryptobenthic fish biomass**, suggesting that climate change may erode a critical building block of the fast-paced dynamics that underpin coral reef ecosystems and their services to humanity.

By integrating research across the organismal, population, community, and ecosystem levels, our findings offer a new perspective on the effects of rising temperatures on coral reefs. Recent research has suggested that reef fishes will be resilient to the direct and indirect effects of climate change, thus providing a sustained resource for humanity on rapidly changing reefs. Our results challenge this assumption by revealing the far-reaching effects of extreme temperatures on the energy budgets of the smallest, most-diverse, and shortest-lived marine vertebrates. For these species, small body size and high mass-specific metabolisms may set a hard, insurmountable boundary on their ability to adapt to changing conditions, possibly leading to losses in coral reef biodiversity and functioning.

Our unique approach to trace the effects of extreme temperatures from individuals to ecosystems was made possible by the combination of field-surveys, physiological trials, molecular dietary analyses, and theoretical modeling. As such, our paper provides not only critical insights into ecological dynamics on warming reefs, but it also offers a blueprint for rigorous integrative ecology to tackle the challenges of rapid environmental change. Therefore, we believe that our manuscript is ideally suited for the prime exposure and broad reach afforded by *Nature Communications*. We hope you agree.

All raw data and code necessary to reproduce our results are included with our submission. We provide a list of potential reviewers for our manuscript below. We declare no conflict of interest. Please note that first authorship is shared between me and Dr. Jacob L. Johansen.

Thank you for your consideration.

Sincerely,

Dr. Simon J. Brandl (on behalf of all authors)

Suggested reviewers:

1. Moises Bernal, Auburn University: mab0205@auburn.edu
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