Transcriptome analysis provides a blueprint of coral egg and sperm functions

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Reef-building corals structurally support marine ecosystems by serving as a place for organisms to live, feed, and reproduce as well as form a physical barrier to hinder damaging wave energy from hitting coastlines. Corals are animals and in their cells they house algae that convert light energy from the sun to chemical energy in the form of sugar that the coral can use to produce energy for its own tissues while also providing a safe environment for these algae to live and reproduce (this relationship is an example of symbiosis, an ecological association where two different organisms receive a benefit from living together). When conditions in the water column become unfavorable for maintaining this symbiotic relationship, these algae abandon the coral. This process is called "bleaching" and it is a very serious problem worldwide which has led to huge coral die-offs with many negative cascading effects on the broader ecosystem. Bleaching can be caused by warmer temperatures and lower pH (higher acidity) in the ocean which are both consequences of climate change.

In our lab, we study a stony coral species native to Hawaii called *Montipora capitata* which has been shown in previous studies to be rather resilient in responding to environmental stressors. This makes *M. capitata* an interesting model system because we can gain insights into how this coral functions in its changing environment based on its genes and gene expression and use those insights to form conclusions about how it is able to survive. RNA sequencing is a technique where we get a profile of which genes are expressed under certain conditions by obtaining sequences of mRNA transcripts at various times under established experimental conditions (like hot vs. ambient temperature, for example). mRNA is the intermediate molecule between genes, which contain the genetic code related to some sort of process, and proteins, which are functional molecules that carry out those processes within cells. *Montipora* is a broadcast-spawning coral which means that it releases its gametes (sperm and eggs) into the water when it is time to reproduce and these cells must survive long enough to achieve fertilization (when a sperm and egg of the same species unite and produce an embryo) and ultimately develop into a coral polyp which is the individual coral unit that colonizes and builds reefs.

Other studies have focused on the gene expression of adult *M. capitata* colonies but there are currently no other studies that have sought to understand the gene expression of gametes which must also overcome environmental challenges like those related to climate change in order to survive. In this paper, we compared sperm gene expression and egg gene expression each to previously generated data for adult gene expression to identify differences so that we can understand what process and their degree of expression make sperm or egg physiology different from adult physiology. We found that while each gamete differed considerably from the adult counterpart, that it seemed like sperm and eggs were taking part in the same major processes. We then compared sperm gene expression data to egg gene expression data in order to validate this finding and found that very few differences in gene expression between sperm and eggs, confirming the hypothesis generated from the gamete vs. adult data. Overall, we found that sperm and eggs transcribe far fewer genes than adults (i.e. have overall lower gene expression) which aligns with what we already know about gametes in general—that they are specialized cells focused on one thing: reproduction. We were also able to identify some genes that may play a role in how sperm and egg cells recognize each other in the water column in order to fertilize, despite many other gametes from many other organisms being released into the same space at the same time. All of our findings are based on statistical tests done with the data from our gene expression experiments and they yield some interesting findings that will form the basis for future experiments on coral gamete biology, a topical endeavor due to the accelerating state of climate change and the rapid decline of coral reefs.

Additional summary info can be found here: https://phys.org/news/2020-08-coral-spawning-features-revealed.html