Evolutionary alterations to circadian rhythm genes help reef fish adapt to the higher levels of carbon dioxide

August 1 2016

Credit: Tiago Fioreze / Wikipedia

Much of the excess carbon dioxide (CO_2) in our atmosphere, released from burning fossil fuels, is taken up by the oceans. Yet the dissolved CO_2 increases the acidity of the water, with inevitable impacts on fragile marine ecosystems such as coral reefs. Researchers at KAUST are conducting genomic experiments on generations of reef fish to determine how they might adapt to rapidly changing conditions.

Fish rely on certain behaviors to avoid predation and ensure their populations are replenished. Scientists have noticed that, under higher CO_2 conditions, young fish lose the ability to respond to cues from other fish, leaving them vulnerable to predation. Such behavioral changes are detrimental to the fish population; if they are to survive in altered environments then they need to be able to adapt.

Tracking changes in the genome in subsequent generations provides insights into how such adaptations occur. Timothy Ravasi, his postdoc Celia Schunter and co-workers from the Biological and Environmental Science and Engineering Division analyzed genetic data from parent and juvenile damselfish (*Acanthochromis polyacanthus*) to see how the fish reacted to ocean acidification.

"We developed a unique fish-rearing experiment that allowed us to measure the effects of ocean acidification across generations," says Ravasi. "By combining data from the genome with information about RNA and protein expression, we were able to uncover the transgenerational molecular responses of the fish's brains."

After rearing wild-type damselfish in captivity, the team separated adult fish into two groups; those that were naturally tolerant of high CO_2, and those that were sensitive to it. Their offspring were raised in the same CO_2 conditions as their parents—either at current pH levels or at near-future levels with higher CO_2.

The immense amount of sequencing data generated in the project was unprecedented for a wild-type organism, and took the team considerable time to analyze.

The researchers found many molecular differences between the tolerant and sensitive offspring, including alterations to both genes and protein expression. Significantly, the main differences involved changes to the circadian rhythm genes in the tolerant offspring, a finding that Ravasi had not anticipated.

"In all coral reefs, CO_2 levels naturally fluctuate between day and night due to coral symbiont photosynthesis," explained Ravasi "Reef fish adjust their bodies to compensate for elevated night-time CO_2, and of course, this is controlled by circadian rhythm. It seems the tolerant offspring may have adjusted their circadian clocks as if it was always night!"

Ravasi's team was recently awarded a grant for expansion of their project to investigate the mechanisms behind these findings.

More information: Celia Schunter et al, Molecular signatures of transgenerational response to ocean acidification in a species of reef fish, *Nature Climate Change* (2016). DOI: 10.1038/nclimate3087

Provided by King Abdullah University of Science and Technology