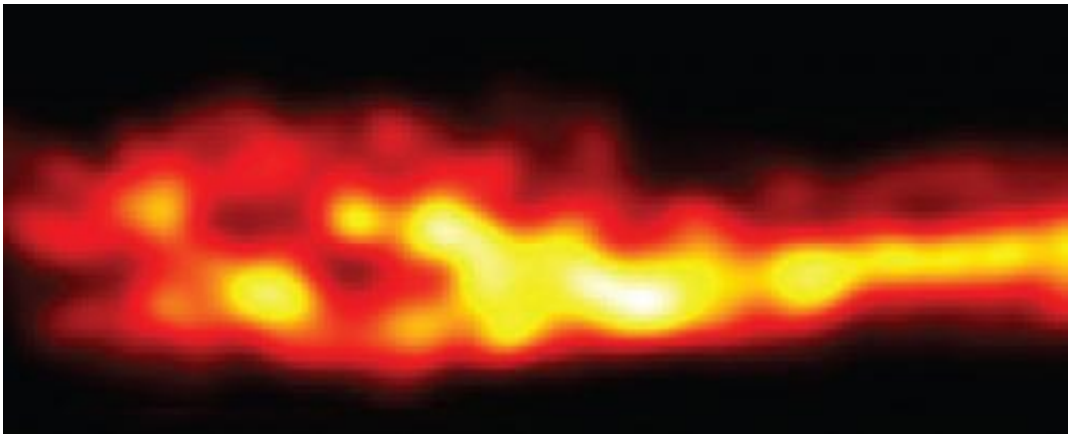
Rising ocean acidification leads to anxiety in fish

December 4 2013, by Mario Aguilera



Researchers tracked the movements of fish in highly acidic waters, represented above in a movement "heatmap."

A new research study combining marine physiology, neuroscience, pharmacology, and behavioral psychology has revealed a surprising outcome from increases of carbon dioxide uptake in the oceans: anxious fish.

A growing base of scientific evidence has shown that the absorption of human-produced carbon dioxide into the world's oceans is causing surface waters to decline in pH, causing a rise in acidity. This ocean acidification is known to disrupt the growth of shells and skeletons of certain marine animals but other consequences such as behavioral impacts have been largely unknown.

In a study published in the journal *Proceedings of the Royal Society B: Biological Sciences*, scientists at Scripps Institution of Oceanography at UC San Diego and MacEwan University in Edmonton, Canada, have shown for the first time that rising acidity levels increase anxiety in juvenile rockfish, an important commercial species in California. Using a camera-based tracking software system, the researchers compared a control group of rockfish kept in normal seawater to another group in waters with elevated acidity levels matching those projected for the end of the century. They measured each group's preference to swim in light or dark areas of a testing tank, which is a known test for anxiety in fish. The researchers found out that normal juvenile rockfish continuously moved between the light and dark areas of the tank. However, experiments have shown that fish administered with an anxiety-inducing drug (anxiogenic) prefer the darker area and seldom venture into the light. Hence, dark-preference is indicative of increased anxiety in juvenile rockfish.

Next, the researchers found that rockfish exposed to acidified ocean conditions for one week also preferred the dark area of the tank, indicating they were significantly more anxious than their normal seawater counterparts. Rockfish exposed to acidified ocean conditions remained anxious even one week after being placed in seawater with normal carbon dioxide levels. Only after the twelfth day in normal seawater did the anxious fish behave like the control group and resumed normal behavior.

The researchers say the anxiety is traced to the fish's sensory systems, and specifically "GABAA" (neural gamma-aminobutyric acid type A) receptors, which are also involved in human anxiety levels. Exposure to acidified water leads to changes in the concentrations of ions in the blood (especially chloride and bicarbonate), which reverses the flux of ions through the GABAA receptors. The end result is a change in neuronal activity that is reflected in the altered behavioral responses

described in this study.

"These results are novel and thought-provoking," said Martín Tresguerres, a Scripps marine biologist and study coauthor, "because they reveal a potential negative effect of ocean acidification on fish behavior that can possibly affect normal population dynamics and maybe even affect fisheries."

Tresguerres says anxious behavior is a concern for juvenile rockfish because they live in highly dynamic environments such as kelp forests and drifting kelp paddies that offer variable lighting and shading conditions.

"If the behavior that we observed in the lab applies to the wild during ocean acidification conditions, it could mean that juvenile rockfish may spend more time in the shaded areas instead of exploring around," said Tresguerres. "This would have negative implications due to reduced time foraging for food, or alterations in dispersal behavior, among others."

Alteration of GABAA receptor function in fish exposed to ocean acidification was originally described by Phil Munday (James Cook University, Australia), Göran Nilsson (University of Oslo) and collaborators, who found that ocean acidification impaired olfaction in tropical clown fish. The study by Hamilton, Holcombe, and Tresguerres adds anxiety behavior to the list of biological functions that are susceptible to future ocean acidification, and it is the first to describe effects of ocean acidification on the physiology and behavior of Californian fish.

"Behavioral neuroscience in fish is a relatively unexplored field, but we do know that fish are capable of many complicated cognitive tasks of learning and memory. Increased anxiety in rockfish could have a detrimental impact on many aspects of their daily functioning," said

Trevor James Hamilton, a neurobiologist at MacEwan University and coauthor of the study.

Tresguerres noted that laboratory tests cannot fully model the steady progression of acidity levels that will be seen in the wild over years and decades. "Nonetheless, our results suggest that ocean acidification may affect an important aspect of fish behavior."

Provided by University of California - San Diego