RNA editing responsible for colder water survival in octopus

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Octopus vulgaris. Image: Wikipedia.

(PhysOrg.com) -- Researchers have discovered that when it comes to the survival of an octopus living in frigid waters, the reasoning is not a difference in the gene DNA but rather a difference in the RNA editing.

The new study, led by molecular neurophysiologist Joshua Rosenthal and his graduate student, Sandra Garrett, from the University of Puerto Rico Medical Sciences Campus in San Juan was published in *Science*.

When it comes to cold temperatures, certain proteins that are responsible for nerve signals can be hampered. As a nerve cell fires, protein channels open or close to allow potassium ions in or out. Cold temperatures can delay the channels' closing and stop the neurons ability to fire.

Rosenthal and Garrett believed that in order for an octopus to survive in the frigid cold waters of the Arctic and Antarctic seas, they would have had to have changes in the DNA sequence.

To test this theory, the researchers compared octopus species from the cold waters of the Antarctic as well as warm water octopus from the Puerto Rican reef. When they examined the potassium channel genes, they discovered almost identical DNA sequences.

They then took the genes and inserted them into frog eggs cells in order to measure the electrical activity of each channel. Again they discovered that both species functioned in the same manner. But if the cold water octopus fired at the same rate as the warm water species, the channel would close 60 times slower so how could the octopus survive?

They realized that RNA editing must be in play. In RNA editing, the cells synthesize an RNA version of the particular DNA with an amended nucleotide sequence which will alter the amino acids and change the proteins function. When the researchers looked at this, they discovered that the Antarctic species edits its RNA in nine different locations to change sequence of amino acids in the potassium channel.

On site, known as I321V, is important for the survival in cold weather as it changes the potassium channel's closing speed by more than 50 percent. The colder the octopus' habitat is, the more likely they are to find edits at this location.

This study shows that RNA editing can play a significant role in organism adaptation.

More information: RNA Editing Underlies Temperature Adaptation in K+ Channels from Polar Octopuses, *Science*, Published Online January 5 2012. DOI: 10.1126/science.1212795

ABSTRACT

To operate in the extreme cold, ion channels from psychrophiles must have evolved structural changes to compensate for their thermal environment. A reasonable assumption would be that the underlying adaptations lie within the encoding genes. Here, we show that delayed rectifier K+ channel genes from an Antarctic and a tropical octopus encode channels that differ at only four positions and display very similar behavior when expressed in Xenopus oocytes. However, the transcribed mRNAs are extensively edited, creating functional diversity. One editing site, which recodes an isoleucine to a valine in the channel's pore, greatly accelerates gating kinetics by destabilizing the open state. This site is extensively edited in both Antarctic and Arctic species, but mostly unedited in tropical species. Thus, A-to-I RNA editing can respond to the physical environment.