Hydrothermal Vents Redux

Back on February 3, 2010, I wrote an article titled **Hydrothermal Vents** in which I emphasized the point that these ecosystems depend essentially on the Sun for their existence, contrary to the often stated assertion that they are independent of sunlight. Very recently, a paper has appeared in open-access journal PloS BIOLOGY titled: **The Discovery of New Deep-Sea Hydrothermal Vent Communities in the Southern Ocean and Implications for Biogeography** (January 2012 | Volume 10 | Issue 1 | e1001234) by Alex D. Rogers et. al. that has received a lot of attention in the popular press. The "et. al." covers 31 co-authors with distinguished home institutions and the lead author is from Oxford University in the United Kingdom. This paper describes organisms found by a remotely operated vehicle deep in the East Scotia Ridge of the Southern Ocean. Many of the species observed are new to science and overall the results are fascinating and exciting to biologists and to myself.

Nevertheless, a serious misstatement regarding the energy metabolism in this ecosystem is made in the second sentence of the Author Summary:

"*They host animals found nowhere else that derive their energy not from the sun but from bacterial oxidation of chemicals in the vent fluids, particularly hydrogen sulphide*."

One wonders what the authors, all of them, think is meant by *oxidation of … hydrogen sulphide*. In fact that oxidation is achieved with diatomic oxygen, O_2. This oxygen is the product of photosynthesis (driven by sunlight!) in phyto-plankton and other plants and is dissolved in seawater that makes its way into the ocean's depths. Any of several readily available articles about Thermohaline Circulation address this point. I have selected an excerpt from one, http://www.killerinourmidst.com/THC.html, that reads:

"*One extremely important attribute of thermohaline circulation is that it carries oxygenated water to the deep ocean. The polar seas (the North Atlantic and the Southern Ocean) that produce the frigid water which drives the Great Ocean Conveyer are storm-swept, especially in winter. This turbulence oxygenates the water, and its frigidity (like a frigid can of soda) allows it to carry lots of dissolved gas. Descending to the ocean floor, this frigid water thereby oxygenates the deep sea. Without this input of highly oxygenated water, the deep ocean would become anoxic. (The activity of phytoplankton only provides oxygen to the ocean's*

surface.) A vigorous thermohaline circulation, therefore, translates into a well-oxygenated ocean, whereas a weak thermohaline circulation results in ocean stratification (separation into distinct deep ocean and surface ocean layers, with little mixing between them) and deep water anoxia."

In other hydrothermal vents there are plenty of tube worms that are not found in the Southern Ocean vents. About these tube worms I wrote previously:

"*When there is a lot of H_2S there is an odor :-). Something doesn't smell right about the TV accounts! That rotten egg smell is characteristic of hydrogen sulfide and not of sulfur per se. But something does smell funny about the preceding claims. The hydrothermal vent life is strongly dependent on dissolved oxygen in the cold water! This oxygen comes from the atmosphere in which it arises by photosynthesis. The H_2S is oxidized by O_2 and the Achaea are aerobes as are all the other attendant life forms. It should have been a big clue that all the multitudes of clams, shrimp, crabs, tubeworms, fish and even octopi are aerobic, and only thrive because they live in oxygen-rich waters. Deep currents keep the oxygen rich water flowing past the vents.*

Most striking of all the animals are the giant tubeworms (1-4.5 m). They have a chitinous outer tube from which a vermillion red head emerges. The red color is simply caused by a type of hemoglobin that can bind both H_2S and O_2. It is red because hemoglobin is red, but in the total darkness of the deep most creatures are albino. Under the bright lights used in filming the red really stands out. It is a signal that O_2 is essential. The tubeworms and the bacteria live in obligate symbiosis.

Now that we have cleared the air, let us summarize. The hydrothermal vent food chain starts with an Achaean bacteria that oxidizes H_2S using O_2 that is dissolved in the cold deep ocean currents and is trapped by giant tubeworms. The oxygen in turn has its origin in Sun driven photosynthesis."

The new discovery is highlighted by a very abundant and new species of crab, the *Yeti Crab*. This hairy crab has extra large gills in which live the bacteria that oxidize H_2S with O_2. The gills trap the O_2 and put it in juxtaposition to the bacteria. There is no photosynthesis at these depths but the Sun is absolutely essential to the existence of these ecosystems through the obligate presence of O_2 needed to oxidize H_2S. All the other animals found in this ecosystem, including the

wonderful albino octopus, are aerobes that use the deep water O_2 to drive their energy metabolisms.

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