Surf's Up -- And One Coastal Microbe Has Adapted

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California beachgoers may look lazy. But just a few miles off shore, scientists have discovered that a common coastal strain of cyanobacteria works diligently to thrive in choppy, polluted waters.

In a study in this week’s early online edition of *The Proceedings of the National Academy of Sciences*, researchers at The Institute for Genomic Research and Scripps Institution of Oceanography have sequenced the cyanobacterium’s genome—and found that this coastal dweller has adapted to a turbulent environment by learning to use metals in ways that its open-ocean relatives cannot.

In the study, led by Ian Paulsen of The Institute for Genomic Research (TIGR), scientists set out to begin understanding the adaptation of bacterial genomes to the coastal versus open ocean environments. Cyanobacteria are abundant in coastal waters reaching more than 100,000 per ml. Using a strain called Synechococcus CC9311 isolated just off the California coast by collaborator Brian Palenik of Scripps, they team sequenced its genome. They then compared the microbe’s genome to that of Synechococcus WH8102, a related cyanobacterial strain found in the open ocean, which they had previously studied.

As habitats, the coast and open ocean differ strikingly. Put simply, the coast is dicier. The wind stirs up nutrients from deeper depths, as well as sediments and land litter, sporadically sending metals and minerals surging through the water. Algae and other organisms enjoy this buffet of nutrients, which include pollutants from farm run-off and other human activity. All this gritty biomass alters the sunlight that seeps into the ocean layers, challenging organisms that photosynthesize, including cyanobacterium. In contrast to the disorderly coast, the open ocean presents a cleaner, more constant marine ecosystem.

How do cyanobacteria adapt to these starkly different settings? Genomics offers answers. In the PNAS study, the research team found that CC9311, the coastal cyanobacterium, has evolved a suite of metal-processing biology missing in its open-ocean relative. This molecular toolkit includes roughly a dozen metal enzymes or cofactors that can absorb, process, and store iron, copper, and possibly the element vanadium. What's more, the coastal cyanobacteria strain has a relatively complex regulatory system, with 11 histidine kinase sensors and 17 response regulators--nearly double the number found in the open-ocean strain—that is likely needed for its metal metabolism and to respond to the complex coastal environment.

Like a canary in a coal mine, Paulsen says, these cyanobacteria may in the future serve as biosensors. "With further studies, we'd like to use these organisms to detect environmental changes, such as pollution, in these different environments," Paulsen remarks. The team is already at work on a follow-up study, comparing differences in gene expression between the coastal and open-ocean cyanobacteria strains, when both are exposed to metal ions and other substances at very low (open ocean) or very high (coastal) concentrations. The current work was funded by the National Science Foundation.

Source: The Institute for Genomic Research