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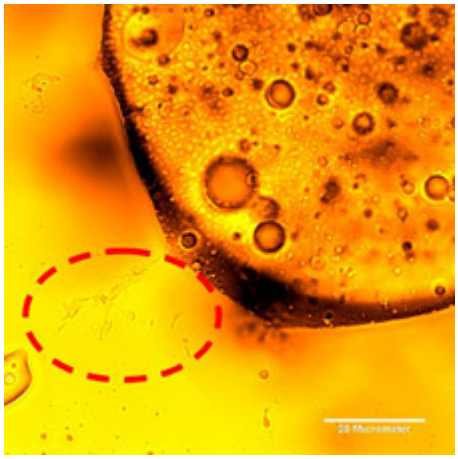
How Fast Can Microbes Clean Up the Gulf Oil Spill?

New research suggests bacteria in the deep waters of the Gulf of Mexico may be eating oil plumes quickly. By David Biello | Tuesday, August 24, 2010



OIL EATERS: Newly discovered microbes (circled here in red) feast on specific hydrocarbons in the Gulf of Mexico oil spill. Image: © Science / AAAS

These are boom times for oil-eating microbes in the deep waters of the Gulf of Mexico, thanks to BP's Deepwater Horizon accident that has added some 600 million liters of hydrocarbons to those waters. And now research published online in *Science* on August 24 shows that an array of new and unclassified oil-eating bacteria are feasting on the newly rich resource of hydrocarbons.

Microbial ecologist Terry Hazen of Lawrence Berkeley National Laboratory (LBNL) and his colleagues used two ships to collect 200 samples from 17 deep water locations between May 25 and June 2. The samples revealed a broad array of microbes, closely related to those of the Oceanospirillales family that includes such oil eaters as *Oleispirea antarctica*, *Oceaniserpentilla haliotis* and *Thalassolituus oleivorans*. These new microbes—led by one particular unusually long (20 microns), yet to be named species that made up more roughly 95 percent of the community responding to the spill—had consumed roughly 8 percent of the available oxygen in these cold, deep waters as they busily converted hydrocarbons into more microbial cells, limited only by a lack of iron. As a result, oxygen saturation at depth dropped from an average of 67 percent to 59 percent while microbial cell concentrations doubled to 5,510 cells per milliliter compared with just 2,730 cells per milliliter outside the plume. So far, no one has measured an impact on other ocean life from the drop in oxygen, which is unexpectedly small, a fact that Hazen ascribes to the dispersed nature of the oil plume. "Concentrations of oil in this deep plume are so low that we don't see oxygen depletion," he explains.

The microbes did this at extremely low temperatures—4.7 degrees Celsius—that slow ordinary bacterium's metabolism as well as under high pressures. And it was a group of roughly 16 gamma-Proteobacteria species doing the bulk of the work. Genetic testing revealed these microbes engaged the same cellular equipment as known oil-eaters, such as *Alcanivorax borkumensis* from the Oceanospirillales order, to break down the hydrocarbons. Large quantities of the various genes necessary to such oil-eating work were found in hydrocarbon-contaminated waters compared to untainted waters.

The scientists also found that the microbes were making quick work of many of the hydrocarbons in the deep sea plumes. Alkanes, for instance—a hydrocarbon easily digested by such bacteria—could be consumed in as little as a day. In fact, the alkanes in these samples lasted, at best, roughly six days in the presence of microbes. Hazen and his colleagues attribute

that quick work to the large contingent of such volatile hydrocarbons that are readily biodegradeable in the Louisiana light sweet crude spilled as well as the breaking up of the oil into small particles by chemical dispersants.

"Microbes eat [hydrocarbons] like we eat at a buffet: they like some compounds better than others," explained marine chemist Chris Reddy of the Woods Hole Oceanographic Institution during an August 19 press conference announcing the existence of such oil plumes—though their findings also published in *Science* suggested microbes were consuming the plume slowly in late June due to low levels of oxygen depletion. "They leave behind a fingerprint of what they chose to eat," Reddy explained.

In fact, some scientists disagree with the analysis of the biodegradation rates by Hazen and his colleagues. "The microbiology is very convincing," but the extrapolation to the rate of hydrocarbon consumption "is potentially flawed and gives the wrong impression," says biogeochemist David Valentine of the University of California, Santa Barbara, who is also attempting to characterize the microbial response to the oil spewing from BP's Macondo 252 well in the Gulf of Mexico. "They are probably measuring the dilution time for the early plume, more so than the biodegradation rate." In other words, the microbes don't eat the alkanes in the hydrocarbon plume in less than a week; rather these compounds get diluted among all the trillions of gallons of seawater in the Gulf.

Hazen agrees that dilution is a factor. But "there's a lot of biodegradation going on. Clearly we've shown that in the changes in the hydrocarbon ratios," he argues. "The only way that can change is by biodegradation."

Hazen's work on the oil spill sprang from techniques developed as part of BP's $500 million grant to the Energy Biosciences Institute—a research and development joint effort between LBNL, University of California, Berkeley and the University of Illinois–Urbana-Champaign. "This is what enabled us to immediately tell BP we have this whole program, do you want us to come down and help," Hazen says. "They invited us down."

Continued sampling by Hazen and his team—who have been taking samples since late May and will continue to do so in coming weeks, including sediment cores near the well itself—reveals that the plume may now be gone, thanks to the microbes' work and dilution. "For the last three weeks, we haven't been able to find anything in the deep water," he says. "We can't detect anything. It's mostly biodegradation probably."

And scientists agree that one thing is clear: the microbes of the deep Gulf of Mexico were ready to handle an oil spill. Hazen, who has studied previous oil spill sites, notes that natural oil seeps in the region ensure a constant presence of such cold-loving oil-eaters. "There's the equivalent of an *Exxon-Valdez* worth of oil going into the Gulf every year and that's been going on for millions of years," Hazen says. "These microbes have evolved to take advantage of that and outcompete everybody else."