

June 17, 2010

Will Bacterial Plague Follow Crude Oil Spill Along Gulf Coast?

By PAUL VOOLEN of [Greenwire](#)

Some bacteria in the Gulf of Mexico love eating oil as much as they like infecting humans.

A close relative of the bacteria infamous for seafood contaminations that often lead to fatal disease, the microbe *Vibrio parahaemolyticus*, is common in warm coastal waters like the Gulf. The long comma-shaped bacteria, slurped down with raw oysters, brings twisting cramps and nausea to 4,500 American shellfish aficionados each year.

But unlike some of its finicky peers, *V. parahaemolyticus* has a deep thirst for crude oil. "You can feed it exclusively oil," and it will thrive, said Jay Grimes, marine microbiologist at the University of Southern Mississippi.

As many have noticed, oil is not in short supply on the Gulf Coast.

Scientists have long known that the ultimate end of the crude oil spewing into the Gulf of Mexico from the damaged BP PLC well will rest in the hands of marine bacteria, single-cell organisms that have been purging the seas of oil from natural seeps for millenia, having only recently added human folly to their cleanup resume. Without these bacteria, whose numbers surge in response to hydrocarbons, enough oil would leak each year to coat the world's oceans in a fine film, molecules deep.

Beneath this awareness, however, sit vast reserves of uncertainty. Microbiologists are unsure which bacteria, feeding off the oil, are already growing exponentially in the Gulf. They are curious how long the bacterial growth will last once the oil's hard remnants drift down into ocean sediment. And no one seems certain how the surge in microbial life will alter the intricate, disentangling web of the Gulf's already weakened ecology.

One of the more pressing questions involves *Vibrios*, which, until the oil spill, were one of the primary threats to the region's vital shellfish business. While *parahaemolyticus* rarely causes serious disease, another *Vibrio* species, *vulnificus*, kills dozens of Americans each year, largely through seafood contamination. The disease, only recently discovered, has caused fierce debate between health officials and local Gulf politicians over raw oysters, the primary carriers of the

disease.

Since *Vibrio* populations swell in the summer -- they love the heat -- this year there is a likely possibility, scientists say, that *Vibrio* growth could be further spurred, directly or indirectly, in response to the oil and the organic flotsam it has left behind.

"The question is: Will there be an inadvertent enhancement of the growth of these potential human pathogens?" said Rita Colwell, former director of the National Science Foundation and an expert in marine microbial life. "It's a question, and the answer is uncertain."

So far, hard evidence is scant. Grimes recently examined an oiled water sample taken by the research ship *Pelican*. The oil, likely exposed to dispersant, was finely divided. Using gene-staining technology, Grimes discovered several microbes attached to the droplet. Now glowing blue, they had been gorging. At least one was a *Vibrio*.

"There's no question bacteria, in general, increase following spills, and this includes *Vibrios*," said Jim Oliver, a *Vibrio* specialist at the University of North Carolina, Charlotte. Whether the pathogenic *Vibrios* "significantly increase is unsure, I would say, but they are coastal bacteria ... so [they] could well increase either as a direct result of oil degradation or as a side effect of the added nutrient levels."

The ingredients are there for heightened concern, Oliver added. The carcasses of bacteria feeding off the oil will increase overall nutrient levels as sweltering summer temperatures hit their peak. While there are natural controls, like bacterial viruses and protozoa, that can check *Vibrio* growth, those can be overwhelmed, studies have shown. And because of the cleanup, more people could be coming into direct contact with the bacteria.

"I think that combination could lead to very serious public health concerns," Oliver said.

FDA aware of threat

Already, the spill is stressing and killing marine life, covering oyster cages in oily films, Oliver's Gulf colleagues tell him. The most common vector for seafood contamination, the oysters that survive the crude could see their immune systems weakened, potentially leaving them easy prey for bacteria. And what if their offspring are weakened?

There are few answers, said Doug Bartlett, a microbiologist at the Scripps Institution of Oceanography. Mostly questions. "If the oil is killing all these marine animals and if the marine animals are highly compromised, would they be more likely to succumb to infectious disease?" he said.

The Food and Drug Administration is aware of the *Vibrio* threat but believes the bacteria's

numbers will decline in parallel with the oil, said Meghan Scott, an FDA spokeswoman. Currently, most oyster reefs within the spill's reach are closed as part of the federal response, which has shuttered about a third of federal waters in the Gulf.

"Closure of oyster harvesting areas is based upon the presence of oil, and reopening cannot occur until the presence of oil is gone and shellfish have been tested by sensory and chemical analysis," Scott said. "Concurrent with acceptable test results for oil in oysters, *Vibrio* levels will have returned to background."

When harvesting resumes, *Vibrio* controls will be enforced by state shellfish control authorities. Those requirements have been the source of controversy in recent years, as last year FDA sought to reduce *Vibrio*-related deaths by tightening controls on raw oyster processing. Gulf fishermen and politicians fended off those standards, at least temporarily, citing economic concerns.

Without a doubt, higher *Vibrio* numbers would pale in comparison to the oil, which should remain the primary concern of emergency responders, given its potential to accumulate in wildlife and disrupt fish larvae. The synthetic dispersants used to break down the crude, making it available for microbes, are a close second. But there should be awareness that even as the oil recedes -- which, at times, seems an ever remote possibility -- its impact on the Gulf will linger, invisibly.

"I honestly don't know what is going to happen with regard to the oil spill," Scripps' Bartlett said. "It's very likely in the heavily impacted areas to have a strong influence on the composition of microbial communities. But gosh, I just don't have a good sense of where that all is going to go."

'Insufficient investment' in research

Marine microbiology has long been a meagerly funded field. Even when oil spills have been on politicians' agendas, most money has gone toward technological fixes like double-hulled tankers. As a result, microbiologists have few specific answers to offer on how the Gulf's bacterial life will change. Some lessons have been learned from spills in Japan, Alaska and France, but over the past 20 years, when biological tools have rapidly advanced, money has slipped out of reach.

"We are now reaping the sad result of insufficient investment in the kind of research that should have been happening all along," said Colwell, who was tapped this week to lead an independent panel advising where BP's promised \$500 million in research funds should be invested.

Given the uncertainty, microbiologists are scrambling to reach the Gulf and sample waters near the former site of the Deepwater Horizon. Researchers from the Lawrence Berkeley National Laboratory and the University of California, Santa Barbara, backed in part by emergency federal grants, have set out on research ships like *Cape Hatteras*, *Brooks McCall* and *Ocean Veritas* to

sample the ocean's smallest residents.

Few initial results are available, and much microbial activity has been inferred from a drop in oxygen levels in waters surrounding the spill. This plunge, however, even in the undersea plumes of oil-water mixture, has not been deep enough to limit the oxygen needed by microbes, according to Ken Lee, director of Canada's Centre for Offshore Oil, Gas and Energy Research. Lee has had researchers monitoring the spill for weeks.

"We've been monitoring oxygen profiles in the water column continuously," Lee said. Early tests likely used inaccurate equipment, he added, as "it doesn't look like there's a significant or any significant change in oxygen profiles at this time."

The undersea plumes are less dense than previous analogies may have suggested, Lee added. "It's certainly not salad dressing under water at depth," he said. "We've collected many samples for [analysis] and it appears that the concentrations are quite low."

There is evidence that the dispersants, despite whatever toxicity they may cause in the deep sea, are breaking down the oil into finer droplets than even the most efficient microbes, Lee added. Since most bacteria cannot live in oil and can only "stick their noses into it," as Oliver put it, increasing the surface area is critical to degradation. It is a tough call to use them in such volumes -- more than 1.3 million gallons so far -- but it may have been the right one, USM's Grimes added.

"As a microbiologist, I think the dispersants were the right way to go," Grimes said.

Colwell is not so certain, though, citing evidence that the dispersants could block vital nutrients from reaching oil-degrading bacteria. Much of the first \$25 million pledged to Gulf-area research institutes from BP will investigate the effect of dispersants.

In these investigations, one of the more impressive bacteria that scientists expect to find in large numbers near the spill are *Alcanivorax borkumensis*, a microbe described only a decade ago by German scientists, or similar species. *Alcanivorax* are selective microbes, so focused on hydrocarbons that they can create their own surfactants, the detergent-like chemicals used by dispersants, to break apart oil.

Typically, bacteria that consume oil grow from less than 1 percent of the marine population to 10 percent or more, as seen in the *Exxon Valdez* spill. It is expected that microbe species similar to *Alcanivorax* constitute a large part of this primary growth, said Kenneth Timmis, a microbiologist at Germany's Helmholtz Centre for Infection Research who helped discover *A. borkumensis*.

"The unfortunate thing is *Alcanivorax* can only handle a small part of the problem," Timmis said. The bacteria target saturated hydrocarbons, simple chemical chains that constitute the major

volume of the Gulf oil but are also the most likely to evaporate. It is small, he said, "but it's an important part of it."

Indeed, the word "oil" can mask the sheer complexity of crude, Colwell said. Recent studies have found more than 17,000 different chemical components in crude, spawning a term that mirrors the complexity of biology: petroleomics. Some bacteria, like the *Alcanivorax*, will degrade the simple components, while others, like some *Vibrios*, hanker for aromatic hydrocarbons like benzene, which are more stable and toxic.

"It's what we call a consortium activity," Colwell said, chains of bacteria that tag-team to devour the oil. "It's a complex system and we, in the 21st century, need to be thinking of systems. ... We have to understand sequential events. It requires a new way of thinking."

Nature's limits

While bacteria -- be they *Alcanivorax*, *Vibrio* or some other flagella-tailed bug -- will degrade much of the oil in the Gulf, they will encounter limits in their efforts. Even with enough dissolved oxygen in the water, it is likely that the nutrients needed by the microbes will be in scarce supply, if they are not already, scientists said.

"My guess is that biodegradation is limited by nutrients including nitrogen, phosphorus and iron," said Jim Spain, a microbial engineer at Georgia Institute of Technology. "There might be a time when addition of such nutrients could be helpful, but the caveat is that stimulation of photosynthesis -- algal blooms -- should be avoided."

Fertilization of the ocean should be explored, Colwell agreed. But, she added it should only be considered in a serious, science-based approach that knows exactly what is being added into contaminated waters with volumes calculated based on oil and microbial concentrations.

Soon enough, however, the Gulf will receive a dose of nutrients that it can do little to control. Each summer, runoff from the fertilizer-saturated farms of the Midwest sluices down and out the Mississippi River, typically causing a massive bloom in algae growth and, in turn, a "dead zone" without oxygen. How this runoff will interact with Gulf microbes is anyone's guess.

It could stimulate the hydrocarbon-degrading bacteria, Bartlett said. But if algae instead bloom, the local *Vibrio* population could also escape its normal limits. Bartlett saw such results during one bloom off the California coast, where the protozoa were no longer able to stop the growth of *Vibrio*, which can have an affinity for algae.

"The lesson from that is that under high nutrient conditions, it may be that the *Vibrio* numbers would go up," Bartlett said. "Though one might need to distinguish one algae from another. So we

have more questions than answers."

In the end, there is just too much oil for bacteria to break down before large recalcitrant chunks of the crude -- resins and asphaltenes -- sink to the seafloor, coating marine life. The chemicals will then burrow into sediment and, while not very toxic, in such a oxygen-free environment, the oil will take many years to degrade, Helmholtz's Timmis said.

While efforts to limit the oil's spread are understandable, given the wildlife and ecosystem concerns, the high concentrations will make it much more difficult for bacteria to mitigate the oil, he said. The short-term fix complicates the long-term solution.

"It needs to be contained on one hand, and dispersed at the same moment," Timmis said.

For the oil that has not reached the shore, it will be "marine bacteria that will ultimately save the day," UNC's Oliver said. They will degrade the oil to water and carbon dioxide, he said, given time and the assistance of wind and waves.

But those days of clear seas remain on a distant horizon.

"This oil," Colwell said, "will be around for a long time."

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