SCIENTIFIC AMERICAN

It's a Gas: Light Hydrocarbons Drove Microbial Blooms Cleaning Up the Gulf Oil Spill

In the hydrocarbon buffet provided by the Deepwater Horizon disaster in the Gulf of Mexico, microbes chose to rapidly eat light gases first. By David Biello | Thursday, September 16, 2010

NATURAL GAS: Microbes first ate natural gases, such as ethane, propane and butane pictured being flared here, after the Deepwater Horizon disaster in the Gulf of Mexico. Image: Courtesy of David L. Valentine, UCSB

Natural gases, not oil, helped jump-start the growth of microbial blooms that are consuming the various hydrocarbons spilled into the Gulf of Mexico during the Deepwater Horizon disaster, according to new research. Biogeochemist David Valentine of the University of California, Santa Barbara, and his colleagues tracked at least four distinct plumes of these gaseous hydrocarbons during a June research cruise—not just the one plume reported previously by a separate team of scientists.

The microbial communities in the four plumes first tackled easy-to-digest hydrocarbons, such as propane, butane and ethane, which were kept from bubbling quickly to the surface by deepwater high pressure and cold temperature. Only after consuming these gases, which boosted the populations, did the larger communities move on to harder-to-eat compounds, such as energy-dense but hard-to-crack methane and longer-chain hydrocarbons, such as the alkanes that comprise oil, the research suggests.

The finding published online in Science on September 16 indicates that earlier reports—both from the U.S. government and other microbial ecologists—might have been too optimistic in assessing how quickly such bacteria could clean up the spill. Valentine argues that these optimistic assessments may have mistaken bacterial consumption of, for example, propane for consumption of other, heavier hydrocarbons in the oil spill, which could falsely suggest that a greater quantity of oil products had been processed by the microbes.

"They can take down all that gas in a matter of several days," Valentine says. "Undoubtedly, [the consumption of these gases by microbes] is all happening in the first couple of weeks, whether it's a few days or a week and a half." But he adds: "The population had to grow up to the point where it had the potential to do that. It was undoubtedly slower than previously reported."

Between June 11 and 21 Valentine and his colleagues sampled the seawater and marine microbial world within 12.5 kilometers of the Deepwater disaster at 31 different sites. The results show that natural gas consumption caused the initial bacterial blooms, rather than did the oil, dropping oxygen levels by as much as 35 percent below normal, as the microorganisms busily feasted and grew.

"The stable isotope and tracer measurements pointed to very rapid consumption of hydrocarbon gases—propane, ethane and butane—…that is the main cause of the oxygen depletions," Valentine says. And the bacteria did not face any other constraints on their growth, such as a lack of other vital nutrients. "There doesn't seem to be any real limit except the growth rate of the organisms themselves."

As for these bacteria, previous research had pinpointed a new, unusually long member of the Oceanospirillales order as the primary eater of the oil spill. But Valentine and his colleagues found members of the Colwellia and Cycloclasticus genuses predominating in each of the separate plumes they studied. These microbes represent the first responders to hydrocarbons spewing from BP's MC252 well on the Gulf of Mexico seabed.

Valentine and his colleagues did find Oceanospirillales members dominant in at least one sample. It remains unclear whether that represents a successional bloom or whether the Oceanospirillales finding had something to do with that plume's specific ecology. For example, as the Colwellia and Cycloclasticus bacteria bloom their natural predators could follow suit, potentially wiping them out and clearing a path for the Oceanospirillales. "Nature doesn't necessarily like having a bloom," Valentine notes.

It's also likely that the same organisms shifted their diet as the plumes of hydrocarbons aged, eating all the butane, ethane and propane present before resorting to longer-chain oil compounds, known as alkanes, that they also can digest. "We suspect that probably occurred but we have no direct evidence yet," Valentine says.

Of course, no plume has yet been tracked from start to finish (and it is unlikely that any will be because the oil is no longer flowing from the leaking well) but Valentine has returned to the gulf again this month, on board the National Oceanic and Atmospheric Administration ship Pisces, to study the long-term fate of the deep plumes. While speaking with Scientific American on September 15 he was informed of another spike in hydrocarbon detection, suggesting that spilled Deepwater oil is still detectable in the deep waters. "It's very dilute because it's mixed but there's certainly something down there in the water," he says, contradicting more optimistic reports this summer from the U.S. government, along with other scientists, that much of the oil spill was gone. "There's still a persistent oxygen anomaly over a very wide area of the gulf."

What impact that may be having on creatures beyond the bacteria, ranging from microscopic zooplankton to the massive sperm whales that feed at these depths, remains to be discovered. But it's clear that the microorganisms are having an outsized impact on the fate of spilled oil itself, eating hydrocarbons and sending oil drifting to the seafloor to coat sediments there. The resulting material on the bottom includes heavier and undigested oil, such as tar balls, as well as globules of dead bacteria, their excretions and the hydrocarbon molecules these agglomerations pick up on the way down.

Similarly, Valentine and colleagues showed in the May 15, 2009, issue of *Environmental Science & Technology* that a large portion of the hydrocarbons flowing from a natural seep at Coal Oil Point in California ends up on the seabed, rather than being digested by microbes in the water. The same may prove true for the more than 600 million liters of oil spewed by BP's leaking well, running counter to the hopes raised by more optimistic reports.