Viruses found to attack ocean archaea far more extensively than thought

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Credit: Tiago Fioreze / Wikipedia

(Phys.org)—A team of researchers with members from Italy, Australia, the U.S. and Japan has found that viruses are the main culprit in killing archaea in the deep sea. In their paper published in the journal *Science Advances*, the researchers describe the techniques they used to study archaea in soil samples from multiple deep ocean locations, what they found and what it could mean for global warming.

Archaea, short for archaebacteria, are microorganisms similar to bacteria , but which have different molecular structures. Many of them exist in the oceans alongside bacteria living off organic matter.

The researchers began their study by focusing on viruses that infect prokaryotes, which include both bacteria and archaea—they started with the assumption that most prokaryote deaths in the ocean are due to viral infections, and that, they note, would make the viruses responsible for the release of approximately 0.37 to 0.63 gigatons of carbon into the atmosphere every year. To learn more and to back up their assumptions, the researchers obtained 500 sea bottom soil samples from multiple areas around the world, each of which was rife with prokaryotes. Prior research has shown that bacteria are more common than archaea both on land and in shallow waters, but archaea become much more numerous in deeper water—the researchers found they made up approximately 12 percent on average of prokaryotes in such areas—though in some regions they ran as high as 32 percent.

To learn more about the impact of viruses on prokaryotes, the researchers studied the infection rates of prokaryotes using a variety of methods, one which of which was a molecular analysis that revealed genes released by viruses when causing infections. They found that bacteria were infected at an average rate of 1 to 2.2 percent per day, while archaea were infected at nearly double that rate—2.3 to 4.3 percent. This shows, the team claims, that archaea are far more susceptible to viral than bacterial infection. They then calculated that archaea deaths due to viral infection accounted for approximately 15 to 30 percent of all carbon emissions from prokaryote deaths. They sum up their analysis by suggesting that archaea play a more vital role in the life-cycle of the deep sea than has been thought.

More information: R. Danovaro et al. Virus-mediated archaeal hecatomb in the deep seafloor, *Science Advances* (2016). DOI:

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Abstract
Viruses are the most abundant biological entities in the world's oceans, and they play a crucial role in global biogeochemical cycles. In deep-sea ecosystems, archaea and bacteria drive major nutrient cycles, and viruses are largely responsible for their mortality, thereby exerting important controls on microbial dynamics. However, the relative impact of viruses on archaea compared to bacteria is unknown, limiting our understanding of the factors controlling the functioning of marine systems at a global scale. We evaluate the selectivity of viral infections by using several independent approaches, including an innovative molecular method based on the quantification of archaeal versus bacterial genes released by viral lysis. We provide evidence that, in all oceanic surface sediments (from 1000- to 10,000-m water depth), the impact of viral infection is higher on archaea than on bacteria. We also found that, within deep-sea benthic archaea, the impact of viruses was mainly directed at members of specific clades of Marine Group I Thaumarchaeota. Although archaea represent, on average, ~12% of the total cell abundance in the top 50 cm of sediment, virus-induced lysis of archaea accounts for up to one-third of the total microbial biomass killed, resulting in the release of ~0.3 to 0.5 gigatons of carbon per year globally. Our results indicate that viral infection represents a key mechanism controlling the turnover of archaea in surface deep-sea sediments. We conclude that interactions between archaea and their viruses might play a profound, previously underestimated role in the functioning of deep-sea ecosystems and in global biogeochemical cycles.

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