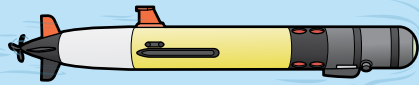


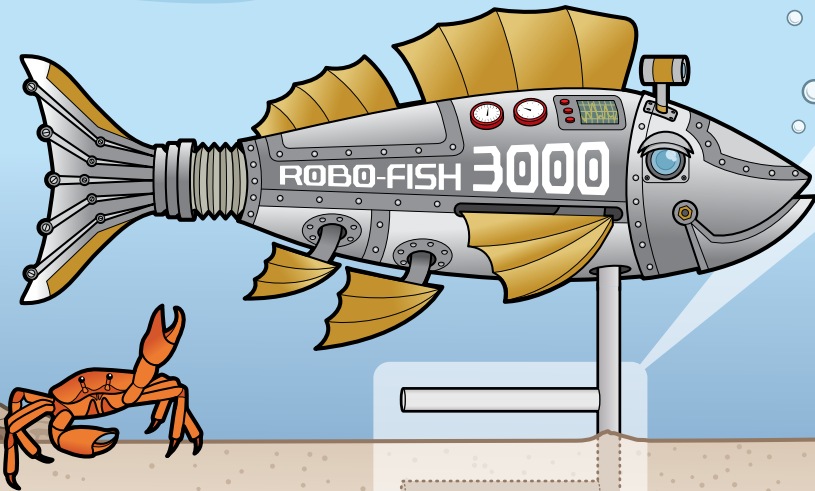
HERE'S HOW AN OCEANGOING ROBOT might power itself one day: Sensing its battery is low, it sinks to the ocean bottom and gets a revitalizing stream of electricity by sticking a graphite arm into the muck. That's it. Done. Back to counting manatees or testing water quality.

What makes this scenario possible is the "benthic microbial fuel cell." Fuel cells are like batteries, but they last longer and produce no waste. Most fuel cells rely on hydrogen, natural gas, or methanol, but the sediment in the world's oceans, harbors, lakes, and rivers offers a virtually inexhaustible supply of microbes, which can also fuel the fuel cells.

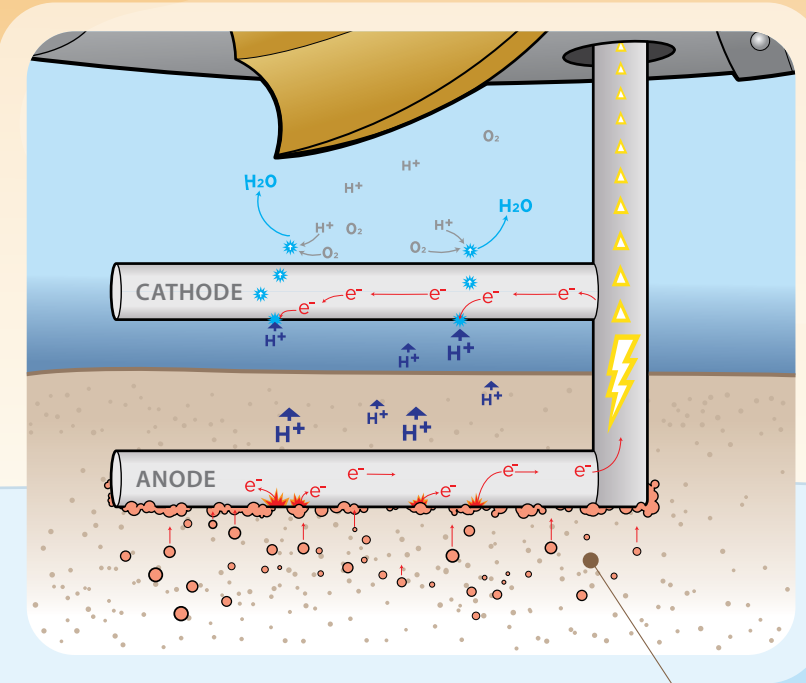
One of the biggest obstacles to underwater exploration is simple: Batteries die. After a few months, even the trustiest rover needs to be retrieved and recharged. But a microbe-powered water bot could operate independently for months or years, rising to the surface on schedule to beam back its data, powered by the silt beneath its cold metal belly.



Researchers believe the benthic microbial fuel cell could power a new age of ocean discovery. Scientists already deploy a menagerie of battery-powered **SWIMMING SENSORS** and **UNMANNED GLIDERS** into the seas to measure temperatures and currents and sniff out pollutants. Underwater probes and sensors are also of great interest in modern warfare; they were used to discover mines in the Persian Gulf during Operation Iraqi Freedom.



A **FUEL CELL** includes an electrical circuit and two arms, known as the anode and the cathode. The benthic microbial fuel cell is unique because that's *all* it needs. Fuel cells convert hydrogen and oxygen into an electrical current. Those essential ingredients are present in mud and water.



When a positively charged hydrogen molecule and a negatively charged electron arrive at the **CATHODE**, they combine with free-floating oxygen and hydrogen molecules to form the fuel cell's only "waste" product—water.

ELECTRONS flow through an electrical circuit, providing a stream of power. Meanwhile, a corresponding number of **HYDROGEN MOLECULES** rise through the silt.

Certain **MICROBES** break down sugars in mud's organic matter into fuel. They grow a thick biofilm on the fuel cell's **ANODE** and release electrons. Those microbes can be found anywhere there is sediment.

