Living power cables discovered

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A multinational research team has discovered filamentous bacteria that function as living power cables in order to transmit electrons thousands of cell lengths away.

The *Desulfobulbus* bacterial cells, which are only a few thousandths of a millimeter long each, are so tiny that they are invisible to the naked eye. And yet, under the right circumstances, they form a multicellular filament that can transmit electrons across a distance as large as 1 centimeter as part of the filament's respiration and ingestion processes.

The discovery by scientists at Aarhus University in Denmark and USC will be published in *Nature* on October 24.

"To move electrons over these enormous distances in an entirely biological system would have been thought impossible," said Moh El-Naggar, assistant professor of physics at the USC Dornsife College of Letters, Arts and Sciences, and co-author of the *Nature* paper.

Aarhus scientists had discovered a seemingly inexplicable electric current on the sea floor years ago. The new experiments revealed that these currents are mediated by a hitherto unknown type of long, multicellular bacteria that act as living power cables

"Until we found the cables we imagined something cooperative where electrons were transported through external networks between different bacteria. It was indeed a surprise to realize, that it was all going on inside a single organism," said Lars Peter Nielsen of the Aarhus Department of

Bioscience, and a corresponding author of the *Nature* paper.

The team studied bacteria living in marine sediments that power themselves by oxidizing hydrogen sulfide. Cells at the bottom live in a zone that is poor in oxygen but rich in hydrogen sulfide, and those at the top live in an area rich in oxygen but poor in hydrogen sulfide.

The solution? They form long chains that transport individual electrons from the bottom to the top, completing the chemical reaction and generating life-sustaining energy.

"You have feeder cells on one end and breather cells on the other, allowing the whole living cable to survive," El-Naggar said.

Aarhus and USC researchers collaborated to use physical techniques to evaluate the long-distance electron transfer in the filamentous bacteria. El-Naggar and his colleagues had previously used scanning-probe microscopy and nanofabrication methods to describe how bacteria use nanoscale structures called "bacterial nanowires" to transmit electrons many body lengths away from cells.

"I'm a physicist, so when I look at remarkable phenomena like this, I like to put it into a quantifiable process," El-Naggar said.

El-Naggar, who was just chosen as one of the Popular Science Brilliant 10 young scientists for his work in biological physics, said physicists are increasingly being tapped to tackle tough biological questions.

"This world is so fertile right now," he said. "It's just exploding."

Provided by University of Southern California