What's in ocean water? Shards of bacteria

When a team of oceanographers used state-of-the-art techniques to analyze seawater, they came to a surprising conclusion: Tattered remnants of bacteria constitute much of the dissolved matter in the open ocean. This finding adds to a growing appreciation of bacteria's role in the seas.

"Bacteria are seen as more and more central to every aspect of what's going on in the open ocean," says Matthew D. McCarthy of the University of Washington in Seattle.

McCarthy and his colleagues collected thousands of liters of water from remote spots in the central Pacific, the Gulf of Mexico, and the North Sea. They pumped the water through a series of filters, the last of which were so fine that they sifted out individual biological molecules—material collectively called dissolved organic matter.

The oceanographers focused on amino acids, the building blocks of peptides and proteins. They found that four of the amino acids in the dissolved matter appeared in two flavors, left-handed and right-handed forms. This observation indicates that bacteria produced the amino acids, the scientists conclude. All other types of organisms make only the left-handed versions. The amino acid fingerprint, the mix of the various forms, indicates that they came from peptidoglycans, the main structural molecules in bacterial cell walls, says McCarthy, who collaborated with Washington's John I. Hedges and Ronald Benner of the University of Texas Marine Science Institute in Port Aransas. They report their findings in the July 10 Science.

McCarthy and his colleagues rule out other possible sources of the right-handed amino acids. These uncommon structures can form naturally when left-handed amino acids undergo a transformation known as racemization. This process, however, takes many thousands to millions of years—too long to explain the amino acids' presence in ocean water. Moreover, the ratios of right- and left-handed amino acids in the seawater samples do not match the ratios expected from racemization.

Jeffrey L. Bada of the Scripps Institution of Oceanography in La Jolla, Calif., agrees that bacteria are the source of the right-handed amino acids. "You really can't explain it any other way," he says. Bada notes that bacteria coat themselves with right-handed amino acids because the unusual structures provide a tough exterior that resists other organisms. This is what helps bacteria evade digestive enzymes in human stomachs, he says.

From the ratios of right- to left-handed amino acids in seawater, McCarthy and his colleagues conclude that a substantial fraction of the dissolved organic matter comes from bacteria. This challenges the traditional view that algae produce most of the ocean's soluble biological material.

Until recently, oceanographers thought of algae as the main photosynthesizers in the ocean, occupying a niche similar to plants on the continents. Bacteria were considered instead to be the consumers that break down leftover pieces of algae and other organisms. Researchers, however, are gradually realizing that bacteria play an important role as primary producers in the nutrient-deprived ocean areas far from land, says McCarthy. "This suggests that actually the trees and grasses and bushes of the open ocean are largely bacteria." *—R. Monastersky*

Tiny icicles grow in electric fields

Ice crystals can assume many complex shapes, as the delicate, intricate patterns of snowflakes clearly show. Scientists are attempting to understand better the process by which ice crystals extend their tendrils outward to grow like branches on a tree.

Now, Kenneth G. Libbrecht and Victoria M. Tanusheva of the California Institute of Technology in Pasadena have found that in a strong electric field, ice crystals abandon their conventional branching patterns and grow into long, sharp needles. Moreover, the electric field stimulates the crystals to grow more than ten times faster than normal.

This technique may help in producing uniform ice crystals that can be studied systematically. "It could be a very useful tool—the problem is control, to get crystals to behave in the way that you want," says Peter G. Kusalik of Dalhousie University in Halifax, Nova Scotia.

The Caltech team grew ice crystals on the tip of a tungsten wire inside a cold chamber filled with water vapor. By attaching the wire to a power source, the researchers could observe the influence of an electric field on the growing crystals. In the July 6 Physical Review Letters, Libbrecht and Tanusheva present a theory to predict such effects and describe their findings.

With no applied field, the crystals grow at their normal speed, about 3 micrometers (μm) per second, and form treelike branches known as dendrites (SN: 7/21/90, p. 47). A low electric field accelerates the growth somewhat, says Libbrecht, but the branched shape of the crystals remains essentially the same.

Above a certain voltage, however, the growing crystal shoots forward, lengthening at 20 to 70 μm per second and sharpening into a thin, smooth needle.

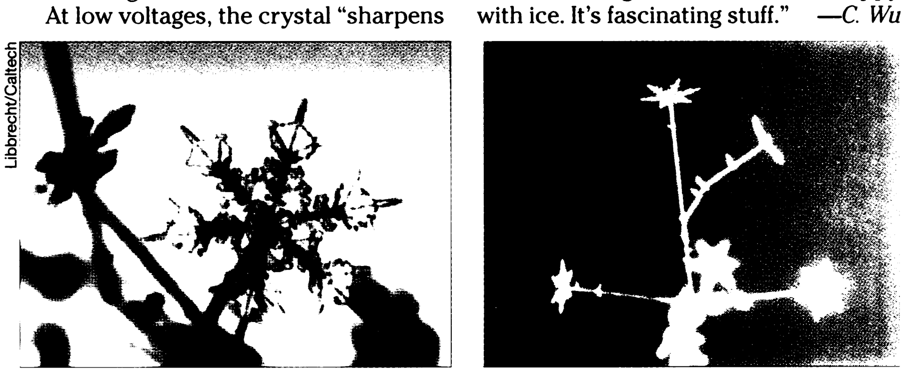
The observed behavior fits well with what their new theory predicts, says Libbrecht. An electric field emanating from the sharp tip of the crystal draws water molecules toward it, speeding up the growth (SN: 5/9/92, p. 311). The pointed tip, however, also has high surface tension, which tends to inhibit attachment of fresh molecules and slow down the growth.

At low voltages, the crystal "sharpens up until the two effects balance," Libbrecht says. At high voltages, the attraction of water molecules to the tip overwhelms surface tension, launching the crystal into a "runaway growth regime."

Another force must stabilize the growth under these conditions, Libbrecht says, since the ice tip doesn't grow infinitely sharp as the theory would indicate. He suspects that the rapidly lengthening crystal heats up at its point, keeping the growth in check.

The researchers grew the needles at -15°C. Other temperatures produce different shapes, such as flat plates, and this variation is not well understood.

To further explore this crystallization process, the researchers might study a different material. "Water is not the best system," says Libbrecht. "It's too crazy." For now though, he adds, "we're happy with ice. It's fascinating stuff." *—C. Wu*



Flowers of ice: An applied electric field stimulates ice crystals to grow in the form of sharp needles, making the long stems in these examples. When the field is turned off, the ice resumes growing in the shape of snowflakes.