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From Trees and Grass, Bacteria That Cause Snow and Rain

By JIM ROBBINS

BOZEMAN, Mont. — Walking across the campus of Montana State University here, David Sands, a plant pathologist, says the blanket of snow draped over the mountains around town contains a surprise.

The cause of most of it, he said, is a living organism, a bacterium, called pseudomonas syringae.

In the last few years, Dr. Sands and other researchers have accumulated evidence that the well-known group of bacteria, long known to live on agricultural crops, are far more widespread and may be part of a little-studied weather ecosystem. The principle is well accepted, but how widespread the phenomenon is remains a matter of debate.

The accepted precipitation model is that soot, dust and other inert things form the nuclei for raindrops and snowflakes. Scientists have found these bacteria in abundance on the leaves of a wide range of wild and domestic plants, including trees and grasses, everywhere they have looked, including Montana, Morocco, France, the Yukon and in the long buried ice of Antarctica. The bacteria have been found in clouds and in streams and irrigation ditches. In one study of several mountaintops here, 70 percent of the snow crystals examined had formed around a bacterial nucleus.

Some of the bacteria promote freezing as a means of attacking plants. They make proteins that will trigger freezing at higher temperatures than usual and the resulting water ice damages the plant, giving the bacteria access to the nutrients they need.

This ability to promote freezing of water at higher-than-normal freezing temperatures has led Dr. Sands and other scientists to believe the bacteria are part of an unstudied system. After the bacteria infect plants and multiply, he says, they may be swept as aerosols into the sky, where it seems they prompt the formation of ice crystals (which melt as they fall to earth, causing rain)

at higher temperatures than do dust or mineral particles that also function as the nuclei of ice crystals.

“The rain is a mechanism that helps these things move,” said Cindy Morris, a plant pathologist with the French National Institute for Agricultural Research, who is studying the bacteria.

The ability of the protein in the bacteria to make snow is well known. Ski areas use a cannon to shoot it into the air with water for snow making, and it is used in cloud seeding efforts to create rain. A single bacterium, far too small to be seen with the naked eye, might make enough protein molecules for a thousand snow crystals.

The researchers believe that there are other bacteria and fungi out there that do the same thing.

Roy Rasmussen, a cloud physicist at the National Center for Atmospheric Research, says the research, mostly by plant pathologists, has renewed the study of bacteria as a cause of rainfall by atmospheric physicists. Some big questions remain, though.

“It’s a sound theory,” Dr. Rasmussen said. “The question is, do these guys get into the atmosphere in large enough concentrations to have an effect? My gut feeling is this may be important for specific places and specific times, but it’s not global. It’s not something we missed.”

Russ Schnell, an atmospheric scientist with the National Oceanic and Atmospheric Administration, first proposed the importance of bacteria in forming ice crystals in clouds, along with a colleague, Gabor Vali, in a paper in Nature in 1970. “But we didn’t have the techniques to do more,” Dr. Schnell said. “The tools now are unbelievably better than when we were doing this stuff. It’s a neat thing to see.”

Interest in the bacteria has grown because of recent publications, and two international meetings on the subject. Ms. Morris estimated that some 30 scientists around the world are researching the role of bacteria in precipitation.

If Dr. Sands is correct about the importance of bacteria, there would be implications for destruction of vegetation through overgrazing or logging, which might decrease the presence of bacteria and contribute to droughts. On the other hand, because the bacteria flourish on some plants and are sparse on others, planting the right vegetation could enhance rain. “Wheat or barley might differ a thousandfold” in the number of bacteria, Dr. Sands said, “depending on the variety.”

The research continues. In England, scientists are flying into clouds to take samples of cloud water, and analyzing the DNA of microbes in it. Researchers at Virginia Tech have sequenced

the DNA of 126 strains of the bacteria to create a database that could allow scientists to trace the bacteria to their geographic origin.

“It’s a complicated system,” said Brent C. Christner, an assistant professor at Louisiana State University, who studies microbial ecology in glacial ice and has found the bacteria in Antarctica. “You can’t bring them into the lab to enumerate them and study them.”

The research could have implications for climate change. Dr. Sands said the bacteria do not grow in temperatures over 82 degrees. If temperatures stayed too warm for too long, he said, they could die. “There’s more work to do,” Dr. Sands said. “It’s a great big complicated picture.”