New life beneath sea and ice

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Scientists have long known that life can exist in some very extreme environments. But Earth continues to surprise us. At a European Science Foundation and COST (European Cooperation in the field of Scientific and Technical Research) 'Frontiers of Science' meeting in Sicily in October, scientists described apparently productive ecosystems in two places where life was not known before, under the Antarctic ice sheet, and above concentrated salt lakes beneath the Mediterranean.

In both cases, innumerable tiny microbes are fixing or holding onto quantities of organic carbon large enough to be significant in the global carbon cycle.

Lakes under the ice

Brent Christner of Louisiana State University, in the US, told the conference about the microbes living within and beneath the ice on Antarctica. In the last decade, scientists have discovered lakes of liquid water underneath the Antarctic ice sheet. So far we know of about 150 lakes, but this number will probably increase when the entire continent has been surveyed. These lakes occur as a result of geothermal heat trapped by the thick ice, melting it from underneath, and the great pressure from the ice above, which lowers the melting point of water.

The largest subglacial lake, Lake Vostok, lies beneath the coldest place on the planet, where the temperature at the surface often falls below 60 C. "It's the sixth largest freshwater lake on the planet by volume, and about the size of Lake Ontario," says Christner. "If you were on a boat in the middle of the lake, you would not see shores."

Christner has examined microbial life in ice cores from Vostok and many other global locations. While direct samples of water from subglacial Antarctic lakes have yet to be obtained, the lower 80m or so of the Vostok ice core represents lake water that progressively freezes onto the base as the ice sheet slowly traverses the lake. "Microbial cell and organic carbon concentrations in this accreted ice are significantly higher than those in the overlying ice, which implies that the subglacial environment is the source," says Christner.

Based on accumulating measurements of microbes in the subglacial environment, he calculates that the concentration of cell and organic carbon in the Earth's ice sheets, or 'cryosphere', may be hundreds of times higher than what is found in all the planet's freshwater systems. "Glacial ice is not currently considered as a reservoir for organic carbon and biology," says Christner, "but that view has to change."

Salt below the sea

Beneath the Mediterranean lurks a similar surprise. Michail Yakimov of the Institute of the Coastal Marine Environment, Messina, Italy is a project leader for the European Science Foundation's EuroDEEP programme on ecosystem functions and biodiversity in the deep sea. His team studies lakes of concentrated salt solution, known as anoxic hypersaline basins, on the floor of the Mediterranean. They have discovered extremely diverse microbial communities on the surfaces of such lakes.

The anoxic basins, so called because they are devoid of oxygen, occur below 3,000 m beneath the surface and are five to ten times more saline than seawater. One theory says they exist uniquely in the Mediterranean, because this sea entirely evaporated after it was cut off from the Atlantic around 250 million years ago. Its salt became a layer of rock salt, called evaporite, which was then buried by windblown sediment. Now the sea is filled again, the salt layer has been exposed in some places, perhaps by small seaquakes, and the salts from the ancient Mediterranean have dissolved again, making the water very salty.

Despite the harsh conditions, hypersaline brines have been shown to possess a wide range of active microbial communities. Together with other international partners, Yakimov's team has already identified more than ten new lineages of bacteria and archaea (these are ancient bacteria-like organisms), which they have named the Mediterranean Sea Brine Lake Divisions.

There is ample life at the boundary between the concentrated basin and the ordinary seawater. "Because of the very high density of the brine, it does not mix with seawater," he explains, "and there is a sharp interface, about 1m thick."

In that layer, microbial diversity is incredibly rich. The research shows that these microbes largely live by sulphide oxidation. Like the communities at hydrothermal vents in the deep ocean, they can survive independently of sunlight and oxygen. But they are an important store for organic carbon. "The deep-sea microbial communities in the Mediterranean fix as much or even more carbon dioxide each year as those in the surface layers," says Yakimov. "This carbon sink should be taken into account at the global scale."

Source: European Science Foundation