Ice age sent shivers through the tropics

Among climate scientists, the tropics have the reputation of unwavering stability. When the rest of the globe turned frosty during the last ice age, some 115,000 to 10,000 years ago, Earth's midsection seemed to weather the glacial epoch with little or no cooling.

But gathering evidence is shaking this appraisal by showing that parts of the tropics chilled substantially during the ice age. If duplicated at other sites, the new findings will remove one of the major problems plaguing people trying to forecast Earth's climate.

Martin Stute of Columbia University's Lamont-Doherty Earth Observatory in Palisades, N.Y., and his colleagues took the temperature of the tropics during the ice age by analyzing groundwater from aquifers in northeastern Brazil at a latitude of 7°S. The researchers measured the concentrations of four noble gases—neon, argon, krypton, and xenon—in water samples pulled from enclosed aquifers hundreds of meters below the surface.

Because gas is more soluble in cooler water, the scientists could gauge the temperature of the water at the time it percolated down into the aquifers.

Using the carbon-14 dating technique, Stute and his colleagues determined an age for each water sample. Samples less than 10,000 years old had an average temperature of 29.6°C, while older samples, from the glacial epoch, averaged 24.2°C, the scientists report in the July 21 SCIENCE.

Evidence of a marked drop in temperature so close to the equator conflicts with data collected by oceanographers in the 1970s, which indicate that the low-latitude oceans cooled by less than 2°C.

Another recent study from South America also challenges the idea of unvarying tropical warmth during the ice age. In the July 7 SCIENCE, Lonnie G. Thompson of Ohio State University in Columbus and his coworkers describe new climate data collected during an expedition to the Peruvian Andes. The scientists drilled into a glacier at an altitude of 6,048 meters and pulled up two long ice cores containing evidence about past conditions going back into the ice age.

The cores represent the first ice this old found at a tropical site, and they will enable researchers to compare the low-latitude ice record with those of the Arctic and Antarctic. Using the ratio of two oxygen isotopes as a thermometer, the Ohio State team calculated that the Andes were roughly 8°C cooler during the ice age.

The work by Stute and Thompson supports other reports of low-latitude cooling. Last year, scientists studying coral from Barbados found evidence that the tropical western Atlantic Ocean chilled by 5°C during the ice age (SN: 2/19/94, p.124).

"All these diverse types of information appear to give a very consistent story—that temperatures were probably on the order of 5°C colder at the lower elevations and probably 8°C colder at higher elevations," says Ohio State's Ellen Mosley-Thompson.

Lloyd D. Keigwin of the Woods Hole (Mass.) Oceanographic Institution calls the new results intriguing. He notes that oceanographers who study oxygen isotopes in sediments are beginning to find hints of substantial low-latitude cooling during the ice age. But other evidence, based on the species of plankton living in the ocean, continues to support the story of unchanging ice age temperatures—a discrepancy that oceanographers have yet to resolve.

Climate modelers eagerly await an answer. They have always had trouble simulating ice age conditions, because it has proved difficult to cool off the poles and midlatitudes while keeping the low latitudes at today's temperatures. This chronic problem has caused some researchers to wonder whether the models lack some critical element. But the new evidence from Brazil and Peru may vindicate the models after all.

— R. Monastersky

Do proteins in cells make computations?

Within the molecular machinery of living cells, information of a chemical nature flows almost as freely as the oxygen that facilitates life. Biomolecules signal each other, exchanging, updating, and using chemical data to keep the cell healthy and functioning.

"In principle, any protein that transforms an input signal into an output signal could act as a computational, or information-carrying, element," says Dennis Bray, a chemist at the University of Cambridge. For instance, "an enzyme in a biochemical pathway 'reads' the concentration of its substrate and produces a corresponding level of product."

From the viewpoint of information processing, every cell contains unique "biochemical circuits." These perform various simple computational tasks, among them amplifying, integrating, and storing information, he maintains in the July 27 NATURE.

"In unicellular organisms, protein-based circuits act in place of a nervous system to control behavior," Bray states. "In the larger and more complicated cells of plants and animals, many thousands of proteins functionally connected to each other carry information from the plasma membrane to the genome."

A cell's internal and external environment affect the concentration and activities of those many macromolecules, giving rise to what Bray calls a "memory trace." As with a computer's random-access memory, which serves as temporary storage for transient information, a cell's proteins maintain a record of its ever-changing surroundings.

"Because of their high degree of interconnection, systems of interacting proteins act as neural network [computers], trained by evolution to respond appropriately to patterns of extracellular stimuli," Bray says.

Communication within such chemical networks relies on the diffusion and concentration of information-bearing molecules, a characteristic that gives them "unique features not found in conventional computer-based neural networks," he stresses.

"This area of research is very intriguing," says John Ross, a chemist at Stanford University who has measured the capacities of biomolecules to serve as logic elements. Chemical agents can serve as information processors, Ross contends, adding that by bringing analytic approaches from computer science to bear on biochemical reactions, a researcher can shed light on the flow of information within living systems.

As far back as 1943, neurophysiologists working in the field of artificial intelligence showed that a few idealized nerve cells, hooked together as feedback circuits, could perform logical processes and make simple calculations. Though scientists scoffed at the simplicity of those systems, even skeptics acknowledged that, in principle, neurons in the central nervous system could behave in similar ways.

"As with neurons, so with proteins," Bray argues. "Protein molecules are, in principle, able to perform a variety of logical or computational operations."

Serving as logic elements, proteins provide cells with tool kits for building circuits, he adds. However, unlike silicon-based computers, cells make calculations purely for their own maintenance and survival by monitoring and responding to environmental changes.

"Many proteins in a living cell are used to build macromolecular structures, produce movement, degrade unwanted molecules, or synthesize specific chemical species," Bray says. "The molecular interactions that regulate chemical catalysis and direct motion merge seamlessly with those involved in the transmission of information."

As scientists look to chemical systems for computing potential, Bray concludes, nature's own methods of regulating cell functions may give insight into how molecules process information. *—R. Lipkin*

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