Coral Corrects Carbon Dating Problems

By measuring tiny amounts of radioactive elements in Barbados coral, scientists have discovered unexpectedly large errors in the traditional carbon dating scale. The coral work will not only rewrite the dates of important prehistorical events, researchers say, it will also help resolve how quickly Earth warmed at the end of the last ice age – an issue that feeds into predictions of future climate change.

Since the development of the carbon 14 dating method in the late 1940s, experts have recognized the technique does not work like a perfect clock. To correct the scale, investigators have painstakingly examined the rings of living and dead trees. But the tree ring record reaches back only 8,000 years.

Now, Edouard Bard of the Center for Weak Radioactivity in Gif-sur-Yvette, France and his colleagues report they have used coral to calibrate the carbon 14 scale over the past 30,000 years, an advance one scientist describes as a "quantum leap." Their results suggest the carbon 14 method errs by a wide span – producing dates as much as 3,500 years too young for material from 20,000 years ago, says the research team, which consists of Bard, Bruno Hamelin of the University of Aix-Marseille III and Richard G. Fairbanks and Alan Zindler of the Lamont-Doherty Geological Observatory in Palisades, N.Y.

While carbon 14 specialists expected the scale needed correction, "They are all surprised it's that large," says Fairbanks. The researchers discussed their work last week in Baltimore at a meeting of the American Geophysical Union and in the May 31 NATURE.

Carbon dating involves measuring radioactive atoms of carbon 14 locked within organic material from plants and animals, which take up the carbon only while alive. Because the atoms decay at a steady rate, they can serve as a clock. The amount of carbon 14 remaining in a sample indicates when it lived. Scientists have used the technique to date a wide variety of material, from the ancient shells of plankton to charcoal in hearths used by Ice Age humans.

The timescale is not perfectly accurate, though, because the amount of carbon 14 in the environment fluctuates. The method therefore requires calibration, just like a weight balance or any other scientific measuring device, says Bard.

To this end, Fairbanks and his colleagues took a drilling ship to the waters off Barbados to collect coral samples. Bard and Hamelin dated the coral with two different radioactive clocks: the decay of carbon 14 and the decay of uranium to thorium. They relied on a new technique, perfected during the last two years, that uses a mass spectrometer to measure the relative amounts of uranium and thorium isotopes in the coral.

The thorium technique, which can date only limited types of materials, will not replace the carbon 14 method – which is widely applicable for times as far back as 40,000 years ago. But the thorium dates provide valuable calibration points that provide a true picture of "real" calendar ages says Fairbanks.

The thorium ages suggest extreme fluctuations in the concentration of carbon 14, with the ice age atmosphere holding up to 40 percent more carbon 14 than today's. At the conference, geophysicists debated what process could cause such changes. Bard's group proposed the Earth had a much weaker magnetic field during the ice age, a theory that agrees with emerging geologic evidence about the planet's magnetic history. A weaker field would allow more cosmic rays to penetrate into the atmosphere and raise the amount of carbon 14 on Earth.

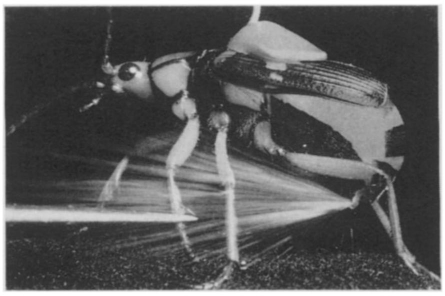
The thorium dates, if correct, will force scientists to revise many milestones of prehistory. The new work suggests the last ice age reached its peak about 21,000 years ago rather than 18,000 years ago. Climate specialists say the older date could resolve some problems that have plagued attempts to estimate the amount of ice during the last glacial period.

For archaeologists, a redating should not alter the order of major events, but it would suggest that more time had elapsed between successive periods of human development. "This would give a little more time for a whole set of innovations to come into use," says Brian Fagan, of the University of California at Santa Barbara. *– R. Monastersky*

Bombardier beetles: Nature's 'buzz bombs'

When escape seems unlikely, harassed "bombardier" beetles resort to a remarkable natural example of chemical warfare, a defense known to science for many decades. "These beetles on being siezed ... immediately ... play off their artillery ... burning ... the flesh to such a degree that only a few specimens can be captured with the naked hand," naturalist John O. Westwood wrote in 1839.

Now chemical ecologist Thomas Eisner of Cornell University and his colleagues have discovered that some species of bombardier beetles deliver their defensive spray in trains of millisecond-length pulses, rather than in continuous streams. What's more, "the ejection system of the beetle shows basic similarity to the pulse jet propulsion mechanism of the German V-1 'buzz' bomb of World War II," they report in the June 8 SCIENCE.


Thomas Eisner and Daniel Aneshansley

Bombardier beetle caught in the act.

When another creature yanks on one of its legs or antennae, a bombardier beetle contracts muscles in glands that store chemical reactants in separate compartments. This forces the previously segregated reactants through a one-way valve in each gland into an underlying reaction chamber, where enzymes convert the chemicals into the spray's active ingredient (benzoquinones), while liberating lots of heat. The accompanying surge in pressure spits the hot chemicals from the chamber through a "gun-turret" in the beetle's abdomen.

"You see a little puff of smoke" and hear a little popping sound, Eisner told SCIENCE NEWS. The seemingly singular puffs and pops actually are composed of short pulses, each lasting about two-thousandths of a second. Acoustic recordings and readings from force sensors placed in the path of the spray yielded the first evidence for the pulses. Using high speed cinematography technology developed by the late Harold Edgerton of MIT, the researchers also filmed the individual pulses.

The scientists postulate that the initial pressure on the gland side of a valve drives reactants into the chamber. As the chamber pressure quickly builds during the ensuing reaction, the passive valve closes and the chamber's contents explosively eject through the opening. The now lowered chamber pressure once again allows reactants from the gland to push through the valve. Each spray consists of two to 12 such pulses.

The German V-1 "buzz" bomb worked according to a strikingly similar principle. "Both the beetle and the V-1 engender a pulsed jet through an intermittent chemical reaction, and both have passively oscillating valves controlling access to their reaction chambers," the scientists write. *– I. Amato*