Abstractions

FIRST AUTHOR

It's widely agreed that the presence of complex musical instruments in an early modern society signals the existence of a highly evolved and creative culture. But because so few instruments have been found in archaeological digs, no one could determine when musical traditions and instruments first made their appearance. Now, however, archaeologist Nicholas Conard at the University of Tübingen in Germany and his colleagues have discovered a bird-bone flute in a German cave that dates to the Upper Palaeolithic period, some 40,000 years ago (see page 737). Conard tells *Nature* about the oldest musical instrument yet found.

How old is the flute?

It's close to 40,000 years old. It was carved from the radius bone of a griffon vulture, a bird that still exists today in Spain. We found it about 3 metres below the surface inside the Hohle Fels Cave in the Ach Valley west of Ulm. It was buried in clay-rich, muddy sediments that get no sunlight and stay at about 10 °C, so it was extremely well preserved, even though it was in 12 pieces. It's as if you had a delicate china teacup that you buried in the ground and left there for 40,000 years. It would probably break, but if you glued it back together it would be in pretty good shape.

Has anyone played it?

The independent experimental archaeologist Wulf Hein made a replica for us that could be played. It took him a while to get the right griffon vulture bone, but he finally got the flute carved and sent us a tape of the first song he recorded. It was *The Star-Spangled Banner*, which he had dedicated to US President Barack Obama. He said that when he first blew into the flute, the first three tones that sounded were the three opening notes of the US national anthem.

Were you surprised to discover the flute?

It was a shock. We've found a number of prehistoric flutes in recent years but none that was so complete. People's response to the replica flute music is also very powerful. When I've played recordings of it at assemblies, half the people in the audience have started weeping.

What does your finding tell us about prehistoric peoples?

This is the first time in early human evolution that we can say that we're dealing with people just like ourselves. If you could be transported back to 35,000 to 40,000 years ago, you might have to make a few cultural and material adjustments, but you'd find that everyone around you had the same intellectual capacities as you and your best friend. ■

MAKING THE PAPER

Paul Knauth

A fresh look at isotope data pushes Earth's greening further into history.

The Cambrian period, roughly 500 million years ago, was marked by a seeming explosion of diverse multicellular organisms. For the past 10–15 years, the carbon-isotope signature in Precambrian limestone has been studied for clues to what prompted this burst of life.

Wild fluctuations in carbon-isotope values during the late Precambrian were interpreted as sudden, drastic changes in the global carbon cycle, such as methane releases or glaciations that could have altered ocean conditions to such extremes that an evolutionary burst was plausible. But new analysis suggests that photosynthetic organisms spread over land earlier than previously thought, and the subsequent rise in atmospheric oxygen was what triggered the Cambrian explosion (see page 728).

Paul Knauth, a geochemist at Arizona State University in Tempe, and Martin Kennedy, a geologist at the University of California, Riverside, came this conclusion while trying to understand an isotopic puzzle. Studies published in the past decade that plotted values of carbon isotopes in the Precambrian have ignored the oxygen isotope — a key omission.

Some 25 years ago Knauth and others documented how carbon-isotope signatures get recorded in limestone. As mineral deposits on the ocean floor form into limestone, and sea level rises and drops, coastal fresh water often enters the rock pores. This fresh water carries with it carbon from terrestrial vegetation, dissolved as bicarbonate. The carbon shows up in marine limestone together with the oxygen isotope specific to the water the carbon was dissolved in. The oxygen can be used to track the timing of any freshwater entry into rock.

Researchers used the fluctuations in the limestone carbon isotopes to suggest that dramatic changes had occurred in the global carbon cycle, but, because of his past research, Knauth knew that plotting carbon- and oxygen-isotope levels in marine limestone might give a more accurate picture of what the carbon-isotope variations meant. "Everybody who works on how limestones form agrees you can't look at carbon alone," says Knauth.

Knauth joined forces with Kennedy, who has extensive experience examining rocks from all over the world. Together they studied thousands of published records of carbon-isotope studies and plotted carbon alongside oxygen values. They found that the oxygen and carbon isotopes of the Precambrian limestones were identical to those of more recently formed Phanerozoic rocks, which were known to have received a groundwater influx of photosynthetic carbon from plants.

"This means that an extensive greening happened in the late Precambrian times," says Knauth. He is not sure exactly when the greening began, but no rock older than 850 million years shows this carbon signature.

Knauth is concerned that some respected colleagues may take issue with his challenge to the accepted paradigm, but he's comfortable with his interpretation. "Isotopes speak with a robust voice — that's why I like them," he says. "To me, this is one of the most beautiful examples of isotope geochemistry."

Knauth is currently in Australia looking for fossil evidence of photosynthetic organisms from about 500–800 million years ago. "The search is on for what organisms caused the greening of Earth," he says. ■

FROM THE BLOGOSPHERE

Scientists following the advent of online tools for collaboration may soon be adding Google Wave to their toolbelt. One blogger describes the still-in-development open-source project as "email on steroids" with wiki and instant-messaging functions rolled in. The application's demo at the SciFoo '09 meeting last month at Google headquarters in Mountain View, California, generated excitement among scientists about using it to author papers collaboratively or even for online peer review (see http://tinyurl.com/mcovhf and http://tinyurl.com/l97tns).

Now, Nature Network's product development manager, Euan Adie, notes that a new virtual lab assistant, Igor, for retrieving those pesky citations has been added. On *Nature*'s Nascent web technology blog, Adie shows how the prototype Igor robot, an automated participant in a Wave discussion, works (http://tinyurl.com/lshvnd). While writing a document, typing a simple command will send Igor scurrying off to find the appropriate citation in PubMed Central or another database, and insert it. The robot also reorders citations as you add or delete them. ■

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