The Maya made offerings to their gods, including human sacrifices, in hopes that the gods would bring rain. This skull was found in Belize's Actun Tunichil Muknal Cave. It's covered with a patina of calcium carbonate that resulted from dripping water.

JAIME AWE

A TIME OF DESPERATION

Research in Belizean caves has revealed paleoclimate data indicating the Maya suffered a series of droughts from the seventh through tenth centuries. The research also shows how the Maya beseeched their gods to end the droughts, the latest of which coincided with their collapse.

By Kristin Ohlson

IN 1989, William Pleitez was hunting near his farm in western Belize when his dog squeezed between some boulders near a hillside and disappeared. Pleitez soon found that the boulders blocked the entrance to a large cave and, pushing his way inside, he discovered a vast underworld studded with ancient pots. With permission from the Belize Institute of Archaeology, he and his family decided to open the cave to the public six years later. They arranged a careful tourism trail through the cave that allowed visitors to gawk at, but not disturb, the pots, a stela, and other artifacts.

Pleitez couldn't have anticipated the impact his cave—now known as Chechem Ha, or the Cave of Poisonwood Water—would have on Maya archaeology. Archaeologists had never encountered a cave in the Maya world quite like this one: it had an extraordinarily long history of use and was purposely sealed 1,000 years ago, its contents safe from looters and animals. In the dirt lay charcoal fragments from centuries of people carrying pine torches into the cave.

"There are literally carpets of charcoal laid down in layers," says Holley Moyes, an archaeologist at the University of California Merced who excavated the cave during four summers between 1998 and 2003. "We radiocarbon dated the layers, and they are like stair steps going back in time, from 1100 B.C. to A.D. 950. Basically, we have the entire history of the Maya people in this cave."

By studying the charcoal and pottery at Chechem Ha, Moyes noticed that the way the Maya used the cave changed over time. She and her colleagues—Jaime Awe, the director of the Belize Valley Archaeological Reconnaissance Project and an archaeologist at Northern Arizona University, geographer George Brook from the University of Georgia, and James Webster from the U.S. Environmental Protection Agency—proposed that around A.D. 610, during the beginning of the Late Classic Maya period, the frequency of ritual incursions into the cave intensified and the ritual activities shifted. Archaeologists had noted ritual changes in other caves in the middle of the seventh century, including an increase of food offerings and human sacrifice, but Chechem Ha cemented their view that a significant cultural shift was taking place.

To the archaeologists, the timing of this great shift was

significant. Paleoclimate studies indicate that the Maya region began to suffer a period of decreased rainfall, beginning in the middle of the seventh century. Moyes and her colleagues believe that the changes in cave rituals reflect the Maya's increasingly desperate situation. The researchers suggest that people responded with a drought cult and an intensification of ritual activity, initiated as the dearth of rain began to wreak havoc on farming and the political structure. A series of severe droughts that persisted for decades is recorded in paleoclimate records, continuing through the ninth century. By around A.D. 900-950, the political structure collapsed and people left the major Classic Period population centers.

"If you are praying and looking for divine intervention and nothing is happening, you have three choices," says Awe, who was born in western Belize. "You either stop, or you keep doing the same thing, or you up the ante because your offerings haven't worked."

EVER SINCE John Lloyd Stevens and Frederick Catherwood documented Maya ruins in the mid-19th century, archaeologists and others have wondered what caused the abandonment of the great Maya cities. Early evidence that climate change might have played a role came in the mid 1990s, when paleoclimatologists David Hodell, Jason Curtis, and Mark Brenner analyzed a sediment core from Lake Chichancanab in the northern Yucatan that indicated there was a severe drought in the Late Classic period. Based on climate patterns, they postulated that if the northern Yucatan had been dry, there had likely been extended drought throughout much of the Maya region. But finding more such evidence from lakebeds, especially ones near Maya settlements was difficult, since deforestation and agriculture had altered the composition of other lake sediments in ways that mask the effect of climate. So the impact of climate change on the development and downfall of the Classic Maya civilization (A.D. 300-950) remained a hotly debated topic.

But coincident to the work at Chechem Ha, researchers found an even more convincing record of climate fluctuations encoded in a stalagmite from another Belizean cave called Yok Balum. There are hundreds of caves in the ancient Maya homeland, which sits on a shelf of soft limestone that has been carved and hollowed by rivers. Inside these caves speleothems—cave formations such as the stalactites that knife down from the top of a cave and the corresponding stalagmites that rise from the floor—are often found. The speleothems form as rain falls on the surface above the cave and

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Several researchers stand in a large chamber known as the Sand Passage in Actun Kabal Cave in Belize. This is one of the caves that has yielded evidence of increased ritual activity during the Late Classic period.

water percolates through the limestone, depositing calcium carbonate drop by drop. Consequently the speleothems grow in bands that correspond to yearly precipitation and even to the twice-yearly weather fluctuations during the wet and dry seasons. A cross-section of a speleothem can be as vividly banded as a tree trunk or a beet.

Yok Balum cave is especially well suited for research, as it's in a hilly area and there's never been much agricultural activity above the cave to interfere with the flow of rainwater below. So environmental archaeologist Doug Kennett from Pennsylvania State University and a group of colleagues selected a three-foot-long stalagmite from 160 feet inside the cave and took some 4,000 samples for stable oxygen isotope analysis as a gauge of changing rainfall.

The Yok Balum stalagmite turned out to hold a 2,000-year record of annual rainfall in the Maya region. Moreover, the researchers were able to establish a precise chronology of changing patterns of rainfall fixed in the cave formation with uranium-thorium dating, which uses mass spectrometry to determine the age of calcium carbonate and similar materials by tracking the decay rates of their constituent uranium and thorium. What they found was an anomalously wet period from A.D. 440 to 660, followed by periodic severe droughts that continued until 1100.

"Clearly, climate is the underlying environmental stage for the Maya's rise and fall," says Kennett. "The rise of kings and cities occurred within a salubrious interval of time when there was lots of rainfall and food. The kings were an intermediary between the people and the gods, and that means keeping the rain coming and the food plentiful. But then the climate changed, and people dealt with that in a number of ways—going to war as well as going to the caves."

With this precise dating of drought patterns in the area, researchers can pinpoint where social changes detailed in the archaeological record converge with the changes in rainfall. For instance, the stalagmite record shows that a dry period corresponds with texts on stone monuments in Guatemala's Petexbatun region created between A.D. 760 and 800. These texts tell of increased warmongering and geopolitical instability. As the droughts became more frequent and severe, especially in the ninth century, the carved stone monuments were commissioned less and less frequently. "These stone monuments are a proxy for how well the kings are doing at each site," Kennett explains. "If they're doing well, they have the resources to hire scribes and build centers and carve the monuments."

HOLLEY MOYES

This speleothem was taken from Yok Balum Cave in Belize and sent to a laboratory for analyses. Like trees, speleothems grow in rings that can be dated and analyzed.

IF DESPERATION over the droughts spurred turmoil aboveground, it caused an acceleration of ritual activity in the caves. Moyes says that up until around 50 years ago, archaeologists assumed that signs of activity in the caves were evidence that people sometimes lived there, much as the Neanderthals did in Europe. "The idea of cave men had really fired up the public imagination and inspired so many things in popular culture, like The Flintstones and the book *Clan of the Cave Bear*," Moyes says. "But tropical caves are not instant houses. They are full of assassin beetles that carry Chagas, a potentially deadly disease, and the bat guano in caves carries histoplasmosis. They are dark, damp, moldy, and would be an unpleasant and somewhat dangerous place to live."

Archaeologist James Brady, whose research focused on the Naj Tunich cave in Guatemala, refuted the idea that these caves served as homes. He concluded that the ancient Maya, like their modern descendants, primarily visited the caves for ritual purposes. Given the beliefs the Maya had about the caves, it makes sense that they would be used for ritual activities during droughts. "These caves were formed by water and were perceived to

CHRIS AWE

Jaime Awe examines a Late Classic period bowl in the Main Chamber of Actun Tunichil Muknal Cave.

be both a source of water and an access point to the underworld," Awe says. The Maya rain god Chac was believed to live in caves, and when mist emerged from a cave mouth people thought it would then rise to the sky and become rain.

In the excavations of Chechen Ha, the charcoal deposits indicate that people used the cave heavily in the Early Middle Preclassic period (1200-800 B.C.), but they didn't bring in much pottery. By the Late Classic period, it appeared from the amount of charcoal deposits that fewer people were using the cave and staying for shorter periods of time, but they were bringing in far larger amounts of pottery. "They started bringing in these huge pots at around A.D. 610," Moyes says. "They'd never done that before." Instead of the ritual activities taking place on the tunnel floor, these members of the drought cult were installing the pots on high ledges and other hard-to-reach areas of the cave. Some pots were ritually terminated—a practice that insures that the vessels could not be reused. This is a way of giving them to the gods.

The large pots sometimes contained food offerings to the gods, or were in a few instances placed beneath stalactites to collect drip water that was used in ceremonies to petition for rain. "Large jars are like symbolic representations of caves," Awe says. "They have large openings, a deep inside, and they can contain water. Maya art includes many depictions of gods holding large jars and pouring water out of them."

Awe and his associates examined other caves in the region to see if there was a comparable shift in rituals. As their desperation increased, the Maya chose to up the ante. During the Late Classic period, for instance, people were going deeper into the caves than ever with huge pots, and in one cave they left incense burners carved with the image

JAIME AWE

Handprints often served as the signatures of the Maya who visited caves. These handprints, which are thought to date to the Late Classic period, are located on a wall of Actun Uayazba Kab Cave in Belize. The Maya made these prints by applying paint around the edges of their hands, which were placed on the cave wall. The handprints were illuminated for this photograph.

of Tlaloc, a Mesoamerican rain god. Sometimes they left food offerings. Other times they offered human beings, who were deposited in areas where water flowed in the caves. The sacrifice of humans grew more common in the seventh through ninth centuries, as the Maya practiced what Awe calls "sympathetic magic"—they believed humans were made from maize and that by sacrificing them they were literally offering food to the gods, hoping that the gods, in turn, would reciprocate and bring the rains that would grow more maize. Many of the sacrificial victims were children, whose tears were thought to summon the rain god.

As the droughts continued to punish the Maya and challenge their faith in their rulers, their centers of power were disrupted. Archaeologist Julie Hoggarth of Baylor University, who is also the co-director for the Belize Valley Archaeological Reconnaissance Project, is currently collaborating with Kennett on the Maya Bone Project, which aims to radiocarbon date thousands of burials from sites across the Maya lowlands. "We're trying to get a better idea of how long people persisted at Maya sites," Hoggarth says. "We want to find out when they abandoned the region and if that time frame corresponds with the episodes of severe drought. Directly dating burials from different regions can tell us when elite and royal burial practices, associated with the complex political systems of the Classic Maya, ended. These dates will also help us understand if populations migrated to areas with stable food resources, such as near lakes, rivers, and the coast, as a result of the effects of decreased rainfall on agricultural production."

The archaeologists already know when the people practicing the Maya drought cult at Chechem Ha gave up trying to appease the gods: the most recent dates from the charcoal pieces hidden in the subfloor dated to around A.D. 950. Awe likes to compare the drought cult at the cave to the behavior of Americans during the Dust Bowl of the 1930s. People on the prairies turned to prayer and ritual, even to rituals that were not their own—like the Maya with their incense burners carved with images of Tlaloc, white farmers killed rattlesnakes and hung them on fences, a Native American rain-begging ritual. When the rains didn't come, many of the prairie dwellers left. But some stayed and formed a Last Man Club, daring each other to hold on despite the hardship.

At Chechem Ha, the last of the Maya sealed the entrance to the cave with boulders before they abandoned it. The drought cult ended, but not the drought.

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