The Americas and Time Keeping: Crash Course History of Science #5

Crash Course: History of Science
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Let's recap the history of science so far: systematic knowledge-making has probably occurred as long as humans have been around.

Unfortunately, historians rely primarily on written records, and those are only a few thousand years old. Although ancient Egyptian, Sumerian, and Chinese cultures had writing and useful sciences, we started with classical Greek and Indian cultures that developed systems for understanding the cosmos and all the stuff in it.

Today, we're going to jump through space to see how other cultures made knowledge at roughly the same time without any contact with the peoples of Africa, Asia, or Europe. This is a story about the planet Venus, breathtaking pyramids, and most of all the question "when are we?" What is time, and how do you measure it? [Intro Music Plays] The classical civilizations of Mesoamerica, or what is now Mexico and Central America, didn't "leave behind" as many paper sources as those of the Indian or Greco-Roman linguistic worlds… Because after CE 1500, Spanish imperialists destroyed those records. Of all the Mayan books made of folded-up bark cloth—called codies—only four survive today.

Luckily, stone tends to stick around. There are thousands of Mayan stone engravings. Archaeologists are still working to learn what role monumental stone works served in ancient Mesoamerican society.

And linguists have only recently decoded many hieroglyphs found on Mayan engravings. But stone carvings mostly concern gods and wars. Historians struggle to understand what daily life was like and—in the case of science—how ancient Mesoamericans produced knowledge unrelated to the divine stars.

To paraphrase archaeologist Michael Coe, imagine that everything we knew about English came from only three prayer books… The earliest Mesoamerican writing comes from the Olmecs, who lived in what is today southern Mexico from 1500 to 400 BCE. Their carvings included human–jaguar hybrids. But the Olmecs are best known for their colossal human heads cut from volcanic stone.

From an early date, Mesoamerican cultures traded goods and knowledge. Over time, sites elsewhere took on Olmec features. In addition to an art style and a writing system, the Olmecs invented a mathematics, including the number zero, and a calendar system that influenced later Mesoamerican civilizations.

Ancient Mesoamerican civilization reached a height of astronomical knowledge under the Maya. They ruled over what is now all of Belize and Guatemala, western El Salvador and Honduras, and southern Mexico from 2000 BCE until the 1600s, in the common era. The Maya built great step pyramids.

These were temples devoted to kings as well as sites for making astronomical observations. The Caracol or Observatory of Chichén Itzá, for example, was built to align with the extremes of Venus's rising and setting in the year CE 1000. That's cool!

The Maya had a base-twenty or vigesimal mathematical system that included zero, but no fractions. And they created very large tables for calculations. These tables came in handy because one of the principal cultural obsessions of the Maya priesthood was calculating future calendar dates—and we're talking very far future.

You may have heard a sort of history of science urban legend—that the Maya thought the world would end when their calendar calculations ran out on December 23, 2012… Which, I think we can confirm, didn't happen. We aren't sure what the ancient Maya thought, but it's true that they made of lot of calculations about time for religious purposes. To understand Mayan time-keeping, let's head to the Thought Bubble: "When are we?" To answer this question, the Maya used an extraordinarily complicated system of five interlocking calendars of different lengths. This provided them with very accurate timing regarding both the solar and lunar years… and the Venusian year. Because, to the Maya, Venus was the most important heavenly body. The primary calendars were the tzolkin, a 260-day sacred cycle that developed by CE 200, and the "Vague Year" solar calendar. The Vague Year has eighteen 20-day months with a period of five unlucky corrective days to bring the year to 365 days total. But vaguely. The tzolkin and Vague Year together made the Calendar Round, which repeated every 52 years. Also, the 260-day tzolkin was made up of two smaller calendars, marking a 13-day numbered and 20-day named cycle of days. But also the Maya kept track of the "Long Count"—a calendar made of different units ranging from one day to sixty-three thousand years. Using the Long Count, the Maya reckoned time in the millions of years. Thus every single day of the Maya year served a specific sacred function defined in relation to Venus, which mattered in Mayan astrology and medicine; and gave the average person a useful sense of time, for example in relation to the harvest; and also answered the question "when are we?" accurately across literally millions of years. Perhaps no other people in human history have cultivated such a complete understanding of time. And this isn't just history. In Guatemala, there are Mayan priests called Day Keepers who still keep the sacred calendar. And you can buy tzolkins in your local mini-mart. Thanks Thought Bubble. The Maya developed a writing system of hundreds of square glyphs depicting natural elements such as jaguars, fish, and people. These carry both symbolic and phonetic meanings. That is, they can indicate sounds and directly represent ideas. The complexity of the system points to a priest–scribe caste. And there was an academy for them at Mayapán. From the few Mayan codices that remain, we know that the scribes determined the lunar month to three decimal places and predicted eclipses. They also actively undertook research to improve the accuracy of their tables, improving their understanding of Venus's movements over time. They may have worked on astronomical tables for Mars, Mercury, and Jupiter as well. Why did the Maya undertake a long-term research program about the planets? We don't know for sure, but we know they had a complex astrological system that generated prophecies by correlating the positions of Venus and other heavenly bodies with historical events. With this system, the Maya coordinated military campaigns and how your individual daily life would work out… and what would happen millions of years in the future. You know, small stuff. How do you build all of those temples to Venus? You need a lot of people. In pre-industrial times, that meant you needed good farmers. In addition to swidden or shifting agriculture, the Maya also practiced intensive cultivation of crops such as maize, sunflower, cotton, chiles, chocolate, and vanilla using irrigation. They domesticated dogs and ducks, and penned up wild turkeys and deer. Is agriculture a science? It definitely encompasses lots of knowledge-work, including crop improvement and the management of large-scale production systems involving canals and multiple harvests. In fact, historians are only today coming to understand just how densely populated the Mayan world was. Central America is tropical, so many Mayan ruins lie buried underneath the forest. But recent archaeological evidence uncovered using LiDAR—light detection and ranging—at the metropolis of Tikal, in what is now Guatemala, has shown that Mayan civilization was perhaps three times as populous as previously thought. By the way, LiDAR a good example of how modern science can help us understand history, including the history of science. Without the wheel or the horse, the Maya cities were for a while united in a true hydraulic empire. Maya civilization was not only much larger than, say, the equivalent one in medieval England, but on the same scale as the great dynasties of medieval China. Mayan culture came under stress in CE 800, and the Long Count fell into disuse after 1200. The fragility of the Mayan food system probably played a role in collapse. Deforestation to make lime for stucco, or plaster for decoration, may have played a

role in changing rainfall patterns, leading to famines. Then, after 1500, Spanish genocide definitively crushed high Mayan culture. The 260-day sacred tzolkin persisted, but the Maya didn't maintain a class of astronomer–priests. After the decline of the Mayan states but before the arrival of the Spanish, tribes from what is now northern Mexico moved south and established new kingdoms. The largest group of peoples who settled in central Mexico were the Nahuas. The Nahuas called the Aztecs were the great builders of central Mexico. They planned the great capital of Tenochtitlán in 1325, on Lake Texcoco, and this city is still around: you might know it as Ciudad de México, or Mexico City. Building a big stone city on top of a lake and growing enough food for its citizens involved a lot of hydraulic engineering. The Aztecs created a system of canals, floodgates, and aqueducts. They used dikes to separate fresh and saltwater. This allowed them to practice intensive lake-marsh agriculture, growing maize, amaranth, fish, and ducks. In this way, Tenochtitlán supported a population of maybe three hundred thousand. Here, the Aztecs supported a full-time priest caste, as well as a large army and many merchants. Aztec bureaucracy included tax collection, judiciary system, and censuses. The Aztecs used the 52-year Mayan Calendar Round but aligned their great temple with the setting sun, not Venus. And the Aztecs built other buildings on equinoctial lines—or the lines along which the plane of Earth's equator passes through the center of the Sun's disk, once in the spring and once in the fall. The Aztecs collected a wealth of botanical and medical knowledge, maintained by priests who also served as astrologers. They believed in a complicated humoral system that linked plants, the human body, and the heavens. Which was oddly similar to the Greco-Roman-Islamicate one we'll talk about in a few episodes. Aztec healers seem to have been specialists, focusing either on surgery, bloodletting, childbirth, creating herbal drugs, or treating sick turkeys. Aztec physicians had an extensive anatomical lexicon. They even treated dandruff! No wonder Aztec life expectancy exceeded that of the Spanish colonizers. Like the Mesoamericans, the people of South America traded widely. Very widely: a new genetic study of sweet potatoes shows that Polynesians traveled to the Americas around CE 1000 at least once, traded for these vegetables, and then possibly came back. They may have also introduced chickens to the Americas ahead of the Europeans. The South Americans forged empires, featuring monumental stonework and carefully planned agriculture. The Inka developed an empire in the Andes Mountains from roughly CE 1100 until the Spanish conquest. The most famous Inkan site is Machu Pichu, in what is now Peru. This city of polished, carefully fitted stone was built around 1450… on the top of a mountain. The Inkan state involved tax and census records, standard measures, medical specialists, and astronomical and calendric data recorded into the very architecture of their cities. But, unlike the other original empires, no writing system. This makes the story of Incan knowledge making, difficult to recover. The Inka did, however, use a sophisticated system of tying strings of knots, called khipu to keep records. Khipu used a decimal system and allowed the Inka to share data related to taxes, the census, the calendar, and military organization… And the khipu might have worked a bit like a writing system, too, at least some of the time. Just as linguists are still decoding the hieroglyphs of the Maya, researchers are still trying to understand just what the khipu mean. In fact, the latest breakthrough, linking khipu record-keeping to a colonial-era Spanish census, was made by an undergraduate! The Spanish and other colonizers devastated cultures native to the Americas. Reducing the complexity of thousands of years of history into a small number of paper sources and a few dozen monumental stone buildings and artworks. Nature reclaimed entire cities, and historians are left to scratch their heads. Many people of Mayan, Aztec, and Inkan heritage are alive today, but the Spanish genocide created a decisive break with ancient Mayan, Aztec, and Inkan civilizations, distinct from those of Europe and elsewhere. Next time—we'll explore the infrastructural engineering with the ancient Romans. Crash Course History of Science is filmed in the Dr. Cheryl C. Kinney studio in Missoula, Montana and it's made with the help of all this nice people and our animation team is Thought Cafe. Crash Course is a Complexly production. If you wanna keep imagining the world complexly with us, you can check out some of our other channels like Nature League, Sexplanations, and Scishow. 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