BLOG • 10 MINS

Errors in Human Origins Dates

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June 29, 2020

One of the most common inquiries posed to Reasons to Believe scholars can be expressed by this pair of questions:

- When did humanity originate?
- Can you be precise?

Producing a scientific date for the origin of human beings is not easy and is far from precise and reliable. All scientific methods used for dating human origins, as opposed to the hominids that significantly preceded humans, involve both big statistical and even larger systematic errors.

Kinds of Errors
Statistical errors, also known as random errors, refer to the imprecisions in making measurements. *Systematic* errors refer to environmental and instrumental factors that could shift all the measurements up or down in value.

In some cases, the environmental and instrumental factors are known and scientists can determine the range of possible alterations of the values of the measurements. In other cases, the environmental and instrumental and instrumental factors or they cannot identify any of them.

Distinguishing Errors in the Simple Sciences vs. Life Sciences

In the simple sciences, like astronomy, physics, physical chemistry, and geophysics, often the environmental and instrumental factors are well understood and scientists are able to determine a range of values for possible alterations of the measurement values. Hence, when these scientists publish a research paper, their results will include an average of their measurements ± the probable statistical error ± the probable systematic error. Unlike the statistical error, the plus and minus for the systematic error may not be the same. If not stated, the probable error in each case is a 67% certainty that the actual value does not fall outside the stated error range. However, scientists working in the simple sciences will often present the statistical and systematic errors in their results where the certainty level is 95 or 99%.

A rule of thumb in the simple sciences is that no published result is to be trusted unless the author(s) identify the full range of possible systematic effects and demonstrate how they determined the range of possible alterations to their measurements by the systematic effects. Even then, caution is in order. There are many examples in the astronomy and physics journals where subsequent papers have pointed out an overlooked systematic effect.

In the life sciences, the subject matter typically is so complex that researchers are not able to identify the full range of possible systematic effects, let alone the range of alterations to their measurements such effects might make. Hence, life scientists typically only publish their statistical errors.

Even scientists who regularly read the life science research literature often place far more confidence in the published results than the results warrant. The lay public, even more so, can fall prey to trusting published results more than they should.

Systematic Effects in Carbon-14 Dating of Human Origins

The most reliable dating method for humans origins is carbon-14 dating. It is the only radiometric tool that is useful for dating human remains and human artifacts. Carbon-14 dating measures how much time has passed since a living organism has stopped breathing in carbon molecules from the atmosphere. In other words, it measures how long an organism or a tissue from an organism, for example, papyrus, has been dead.

5,715 or one-seventh of 5,715). For carbon-14 that date range is 800–40,000 years ago. Any sample older than 40,000 years cannot be reliably dated using carbon-14.

Cosmic Ray Rate

Carbon-14 dating, however, is not free of systematic effects. Carbon-14 in the atmosphere is produced by cosmic rays striking nitrogen-14. One systematic effect in carbon-14 dating is that the rate of cosmic rays striking the atmosphere can change over time. Cosmic rays predominantly come from the remnants of supernova eruptions. During the past 44,000 years there have been four supernova events within 360–820 light-years from Earth.[2] Those distances are close enough to alter carbon-14 dates, but usually by no more than about 10%.

Location of Organism

Another carbon-14 systematic effect is the location of the organism when it was alive. If it was at a high altitude, the air it was breathing would have been exposed to more cosmic rays. If it was underground or living under a dense forest canopy, the air it was breathing would have been exposed to fewer cosmic rays.

Radioisotope Exposure

Yet another carbon-14 systematic effect is the exposure of nitrogen-14 to radioisotopes like uranium-235, uranium-238, and thorium-232. Such radioisotopes can transform small amounts of nitrogen-14 into carbon-14. It is such radioisotopes in Earth's crust that explain, for example, why zircons and diamonds that are billions of years old register carbon-14 dates of about 58,000 years.

Fortunately, the systematic effects in carbon-14 dating can almost always be identified and the resultant systematic errors determined. Therefore, carbon-14 dating, where it is applicable, is the method anthropologists prefer in investigating human origins and human artifacts. It is the only reliable dating method at their disposal and is useful only for human remains and artifacts younger than 40,000 years.

Systematic Effects in Other Human Origins Dating Methods

Typically, anthropologists lack the luxury of being able to employ carbon-14 dating. The most common alternate dating methods they use are thermal and optical luminescence.

Limitations of Thermal and Optical Luminescence

Heat and light cause certain chemicals in tissues to fluoresce. Thermal and

For example, in optical luminescence, when a crystalline grain, such as quartz, is buried and cut off from sunlight, the radioactive decay of uranium and thorium in surrounding rocks and soil will knock electrons in the crystal out of position. Some of these electrons build up over time in defects in the crystal. Optical luminescence dating measures the degree of buildup to determine how long ago the crystal was buried.

Thermal and optical luminescence have obvious systematic effects that can prove to be quite large. The intensity of the heat or light before the sample was buried can be high or low depending on the environment in which the sample existed. The burial process may not be immediate. Rather, it might be stretched out over a significant time period. Another big systematic effect is how many times and in what ways the burial was interrupted or disturbed.

In thermal and optical luminescence researchers date one or more mineral crystals in an artifact, not the remains of an organism. One must assume that the artifact was placed in its current location by, for example, an ancient human and not by some other means. There also is the problem of distinguishing between a crystal associated with a relatively recent burial or an artifact from other crystals that were buried earlier. Furthermore, it is possible for an artifact buried in sediment of a relatively young age to be moved by a variety of geological processes or the actions of other creatures—for example, the digging activity of a bear—into a sediment layer of an older age.

A famous example of the enormity of possible systematic errors in thermal and optical luminescence dating are the artifacts in the Jinmium Rock Shelter in northern Australia. A thermoluminescence date of aboriginal artifacts was cited as evidence that humans had occupied Australia for at least the past 60,000 years.[3] A later carbon-14 analysis showed that the oldest artifacts were only 3,000 years old.[4] In the words of the authors of the later analysis, the earlier date was off "by more than a order of magnitude."[5]

This reassessment of the Jinmium artifacts does not rule out human occupation in Australia before 3,000 years ago. However, it does reduce the date for the earliest evidence for the occupation of Australia by humans by a factor of about two. Other sites in Australia where both radiocarbon dating and atomic mass spectrometry have been applied yield dates for human artifacts of about 30,000 years ago.[6]

Figure: Luminescence in Rock Crystal Samples

Limitations of Electron Spin Resonance and Uranium-Thorium Dating

Two other frequently used dating methods employed by anthropologists are electron spin resonance and uranium-thorium. The electron spin resonance is a sophisticated version of the thermal and optical luminescence methods. The method measures the amount of unpaired electrons in a sample previously exposed to natural radiation. For this method to yield a reliable date, a researcher needs to know the past natural radiation rates to which the sample was exposed. Hence, electron spin resonance dating is subject to the same systematic effects that plague thermal and optical luminescence dating.

The uranium-thorium dating method measures how long ago a sample has first been precipitated from water. The method is based on the fact that thorium is not soluble in water but uranium is. One of the rare isotopes of uranium, uranium-234 decays into thorium-230 with a half-life of 245,000 years. (Uranium-234 exists on Earth despite the 4.567-billion-year age of Earth because it is an indirect decay product of uranium-238, which has a half-life of 4.468 billion years.) Hence, determining the ratio of thorium-230 to uranium-234 in a sample yields the time since its precipitation if, and only if: (1) one knows that the sample is entirely from a single rapid precipitation event, and (2) the sample subsequently has not suffered any significant disturbances or contamination.

DNA Dating

Two of the most frequently cited tools for dating the origin of human beings are mitochondrial DNA analysis and Y-chromosomal analysis. All humans get their mitochondrial DNA exclusively from their mothers and all male humans get their Y-chromosomes exclusively from their fathers. Therefore, geneticists can determine the time back to one woman and one man from whom we are all descended by the following process:

1. measuring the genetic diversity in the present human population

2. assuming mutation rates for mitochondrial DNA and Y-chromosomal DNA

researchers. Others are more subtle. Scientists know that the mutation rate is not the same for all humans at all times and all geographical regions. While certain environmental and social factors are known to substantially impact the human mutation rates, a host of others have not yet been studied.

Astronomical Uncertainties

Even the environmental and social factors that are known can involve enormous uncertainties. Examples would be mutations generated by cosmic rays from past supernova eruption events and mutations generated by past major solar flares. During the past ten thousand years there have been no supernova eruptions closer than 5,000 light-years away.[7] There were four supernovae eruptions 22,000–44,000 years ago that were 320–820 light-years distant and nine more 35,000–115,000 years ago that were 350–700 light-years distant.[8] Similarly, there have been no major solar flares during the past 10,000 years and probably several 10,000–115,000 years ago. Failure to consider the impact of supernova eruptions and major solar flares alone implies that the published DNA dates for the origin of humans may be seriously overestimated.

Human Reproduction Uncertainties

Likewise, nobody really knows with precision the times between birth and reproduction throughout human history. However, present-day values that incorporate widespread birth control and long career launch times (before childbearing) certainly put that time at the high end.

From a biblical perspective, it is possible that when God created Eve he endowed her eggs with a diversity of mitochondrial DNA. In that case, the calculated time, based on mitochondrial DNA analysis, back to the first woman from whom we are all descended could be much greater than it actually is. Similarly, the shortening of potential human lifespans that occurred after Noah's flood may have involved God's alteration of Y-chromosome DNA.

Dating the Prehuman Hominids and Their Artifacts

For prehuman remains and artifacts, a few more reliable dating methods are available. For example, argon-argon dating and paleomagnetic dating can be employed on samples ranging from 250,000 years ago to several million years ago.

These methods are not without systematic effects. However, the possible systematic errors measure much below the methods used for dating human

Four Cautions for Interpreting the Scientific Dates for Human Origins

How, then, should we evaluate and interpret the scientific dates for human origins and/or artifacts attributed to early humans? First, readers need to beware of edge-of-the-error-bar bias. An example of this tendency occurs when scientists, journalists, and internet bloggers claim that humans date back to at least 200,000 years ago based on a published calculation that mitochondrial Eve lived 157,000 ± 40,000 years ago. A date of 200,000 years ago (the edge of the error bar) is not the same as a date of 117,000–197,000 years ago (the range).

Second, readers need to realize that many published dates for human origins and artifacts attributed to early human activity include only the statistical errors. Often these probable errors are less than 10% of the claimed age. Readers can look at such a small statistical error and conclude that the claimed age can be trusted as reliable when in fact the systematic error could be larger than +/– 1,000%.

Third, readers need to recognize that with the exception of carbon-14 dating, it simply is not possible for scientists to determine a value for the likely systematic error. This incapacity explains why anthropologists never publish both statistical and systematic errors for their age measurements. However, anthropologists will sometimes, not always, identify likely systematic effects in their peer-reviewed papers without putting a value on such effects. Such authors are to be complemented for their caution. Nevertheless, readers need to exercise their own caution, recognizing that anthropology is of such an extremely complex nature that it is not yet possible for any anthropologist to identify all likely and possible systematic effects.

Fourth, the systematic effects for age measurements relative to anthropology almost always are much larger on the minus side than they are on the plus side. That is, the age is much more likely to be substantially more recent than it is to be earlier. Therefore, where it is known that the systematic effects likely are large, the reader may be wise to interpret the stated age as an approximate upper limit.

An appreciation for how statistical and systematic errors affect human origins dates gives scientists reason for tentativeness and humility. Though scientists love learning and solving difficulties, it appears for now that determining precise dates for humanity's origin remains elusive.

Endnotes

2. R. B. Firestone, “Observations of 23 Supernovae That Exploded <300 pc from Earth During the Past 300 kyr,” *Astrophysical Journal* 789, no. 1 (July 2014): id. 29, doi:10.1088/0004-637X/789/1/29.

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4. Richard Roberts et al., “Optical and Radiocarbon Dating at Jinmium Rock Shelter in Northern Australia,” *Nature* 393 (May 28, 1998): 358–62, doi:10.1038/30718.

5. Roberts et al., “Optical and Radiocarbon Dating.”

6. Bruno David et al., “New Optical and Radiocarbon Dates from Ngarrabullgan Cave, a Pleistocene Archaeological Site in Australia: Implications for the Comparability of Time Clocks and for the Human Colonization of Australia,” *Antiquity* 71, no. 271 (March 1997): 183–88, doi:10.1017/S0003598X00084672.

7. Firestone, “Observation of 23 Supernovae.”

8. Firestone, “Observation of 23 Supernovae.”