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Twenty-thousand years ago, the earth was held in thrall by relentlessly probing fingers of ice – ice that drew its power from frigid strongholds in the north, and flowed southward to bury forests, fields, and mountains. Landscapes that were violated by the slowly moving glaciers would carry the scars of this advance far into the future. Temperatures plummeted, and land surfaces in many parts of the world were depressed by the unrelenting weight of the thrusting ice. At the same time, so much water was drawn from the ocean to form these gargantuan glaciers that sea levels around the world fell by 350 feet, and large areas of the continental shelf became dry land.

Imbrie and Imbrie (1979: 11)

The Pleistocene epoch, or Ice Age, is today dated from 2.6 million to 12,000 years ago, a period marked by repeated advances and retreats of great ice sheets. When glaciation was last at its maximum, little more than 20,000 years ago, the area that is now New York was covered by one or two miles of ice and snow. If there had been skyscrapers in Manhattan, most would have been buried, with only a few peeking out like islands in a white sea.

The Pleistocene Ice Age and the evolution of the genus *Homo* occurred simultaneously. Usually they are described separately, but as a sociologist and historian of natural history, I am treating them together. I will tell how savants/scientists of the past two centuries came to our present understanding of the ice ages, their causes and

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consequences – in that sense giving a history of scientific understanding. I also describe the changes themselves, how ice repeatedly came and went and how evolving humans responded to these conditions. Those of the Neanderthal type adjusted well to cold climates, having a very long tenure in Eurasia until replaced by modern people.

Of several *Homo* species whose fossils are known, there remains a single species that by the epoch's end occupied the presently inhabited world. Roughly 10,000 years ago, as the ice receded, surviving human communities switched from hunting and gathering to an agrarian lifestyle. Within a few thousand years more, some of these communities developed into the world's earliest civilizations, independently in the Middle East, China, and India, and somewhat later in the Americas. This is human history on the grandest scale. The story is credible only because we finally discarded traditional beliefs that were unquestioned for a thousand years.

In the eighteenth century, European and American savants had no notion that life had a far longer history than told in the Bible or that humans were late arrivals on the scene. They believed that Earth's surface was shaped primarily by a Great Flood and occasional volcanos. Sculpting by vast ice sheets was unimaginable. *Ice Ages* is the story of how, over little more than two centuries, an exciting series of discoveries, errors, controversies, and reinterpretations led to the accumulation of solid evidence for what is now taught in every university, a fascinating story of scientific discovery about the most recent Ice Age and the history of human life.

The last Ice Age lasted for a time barely imaginable before two centuries ago. Archbishop James Ussher (1580–1656) had famously calculated that Creation occurred in 4004 BC. It follows that Earth was 5,863 years old in 1859, the year Darwin published *On the Origin of Species*. This biblical dating, often ridiculed today, was not unusual or out of line with other estimates based on similar assumptions. The Judaic calendar, still in use for religious purposes, equates the secular year 1859 with the Jewish year 5619, counting from the beginning.

The Bible's enumeration of the generations since Adam – the who begat whom of the King James Version – gives sufficient information to tally the elapsed time from Adam's first breath to the birth of Noah as 1,056 years. Noah was 600 years old when water flooded the planet (Genesis 7:6). That dates the Great Deluge at 1,656 years after Creation, or 2348 BC, according to Archbishop Ussher's count.

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The longevity of the progenitors is striking. Adam lived to the age of 930, Methuselah to 969, and Noah to 950. Only 126 years separate the death of Adam from the birth of Noah. Nearly all the several progenitors were alive at the same time. They could have come together for the weekly day of rest, exchanging stories about times past.

I confess to astonishment that so many in the United States today think that the Bible with its 6,000-year-old universe is literally true. Yet surveys show a third of Americans believing that it is, word for word (Mazur 2008).

Even in centuries past, many scholars did not read biblical texts with that exactitude. Apart from the fact that many people could not read at all, there was no original Bible to read, nor even trustworthy copies of an original, nor any surviving document older than a few centuries before the Christian era. The fourth-century Catholic Church was sufficiently concerned about inconsistencies and errors among the various biblical manuscripts in circulation that Pope Damasus I commissioned his secretary, Jerome, to produce a standardized Latin translation of the New Testament. Working for twenty years, Jerome compared numerous texts in Hebrew, Aramaic, Latin, and Greek before settling on his own version, later known as the Vulgate Bible, the first book printed by Gutenberg and, to this day, the official text of the Roman Catholic Church. Some passages that made the cut might have strained Jerome's own monotheistic credibility, such as the account in Genesis (6: 1–4) of when the Nephilim were on Earth, when the sons of God went into the daughters of humans, who bore children to them: "These were the heroes of old, warriors of renown."

After Jerome produced the Vulgate Bible from discrepant sources, there remained inconsistencies. For example, Genesis opens with two successive accounts of Creation, one occurring in seven days, the other about the Garden of Eden. In the first story, humans appear on the sixth day, after plants and animals. In the second story, God creates a man (Adam) "from the dust of the ground," then creates plants in Eden where the man can dwell, then forms every animal and bird, and finally creates a woman.

Some traditionalists see the Bible's two stories of creation as a telescopic narrative, with the opening account giving the "big picture" while the story of Eden narrows the focus. Adam and Eve's tale is so

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engagingly different from the impersonal catalog of seven days that casual readers may not notice their contradictions. In the seven-days story, all vegetation including seed plants and fruit trees is made on the third day. All sea creatures and flying birds are made on the fifth day. All land animals from cattle to creeping things are made on the sixth day, and afterward God makes humans – male and female – to rule over these fish, birds, and animals, and to use the plants for food.

In the second story, Adam comes first, “when no plant of the field was yet on the earth.” Then plants are created in Eden. Then every animal and bird is formed. Finally, Eve is made from Adam’s rib.

Was the first man created before plants and animals and birds or afterward? Did birds appear before land animals or at the same time? Early readers within both Hellenistic and rabbinic traditions recognized these inconsistencies. The sequences agree on only two points: (1) vegetation preceded animals and birds and (2) the first woman was created at the end of the process. There is little correspondence between either of the biblical sequences and our modern understanding of life’s history, but ancients did not need that knowledge to recognize that the two accounts are not logically consistent.

After Cain slew Abel, he went to the Land of Nod to the east of Eden and there married. Where did his wife come from? Was she his sister? Noah brought into his ark a pair of each kind of animal (6:17–22), but elsewhere we are told he brought in seven pairs of all clean animals and birds (7:1–5). The Flood lasted forty days and nights (7:4, 12, 17), but elsewhere “the waters swelled on the earth for 150 days” (7:24). Other passages tell of the ark coming to rest on the mountains of Ararat five months after the onset, with Noah and his family and the animals emerging after a year of confinement (7:11, 8:4, 14–16).

The Catholic position has always been that the Bible must be understood in accord with Church interpretation. (This sometimes changes, as when the Vatican accepted the sun-centered solar system and now accepts the evolution of life.) Not until the Protestant Reformation did breakaway denominations emphasize that whatever the Scripture said was true and that each literate person could read it for himself, without relying on interpretations pronounced by the corrupt Vatican hierarchy. Nonetheless, many Protestant scholars, while accepting religious and moral precepts of the Bible, had long disregarded its natural history as incorrect or implausible in detail. After all, the first five books of the Bible, which Jews call the Torah and Christians the

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Pentateuch, were traditionally said to be authored by Moses, yet they include events before his birth and after his death. How could that be? (Perhaps by divine revelation.) As Old Testament scholar Richard Friedman puts it, “[T]he primeval history is barely capable of being considered from the point of view of historicity, given its conception of a finite universe surrounded by water, a talking snake, ‘sons of God(s)’ having relations with human women, a box [ark] containing the whole of animal life, and simultaneous creation of languages” (2003: 620).

There is little reason to think that many eighteenth-century savants – the word “scientists” was not yet in use – believed Archbishop Ussher had truly dated the beginning of the universe. Some even wondered whether Earth or the universe had a beginning at all. Apart from the Genesis account, there was no reason to assume a creation event or a worldwide deluge. Perhaps Earth always existed pretty much as it was, without dramatic interludes, and always would.

The Scottish Enlightenment philosopher-farmer-physician James Hutton (1726–1797), a deist often called the “father” of modern geology, ignored biblical stories about a Creation and Flood, instead postulating that the past history of the globe must be explained by processes that we can see happening now, or to have happened recently. Hutton did not only speculate at his desk but, like others at the time, went into the field, examining the landscape first-hand, which became the essential investigative model for geologists of the next two centuries.

Hutton saw no compelling reason to give Earth any birth date and believed sufficient time had elapsed for commonplace forces such as erosion and deposition, punctuated by volcanic eruptions and earthquakes, to create the ever-changing landscape. He explained that marine fossils were sometimes found far from the sea because a gradual uplift of land had caused recession of the shoreline, so that animals once living in the ocean were now buried high and dry. For Hutton, the world was in a steady state, changing gradually with “no vestige of a beginning, no prospect of an end” and therefore no significant history of great events or cataclysms. It was a world, he thought, eternally habitable by humans.

On the other hand, for savants who did believe in a finite Creation, whether or not as told in Genesis, there was no reason to think it occurred a vastly longer time before there were humans on the scene. Apart from Bible stories, how would anyone know?

It is often said that two great revolutions transformed our sense of place in nature. First was the Copernican Revolution, which demoted Earth from the center of the universe to one among other planets revolving around the sun; this solar system was eventually recognized as one locale in an enormous galaxy, which itself was one among billions of galaxies. The second revolution was Darwinian, placing *Homo sapiens* within the tree of life, still special in our own way but at base simply one of endless forms, most beautiful and wonderful, that have been, and are being, evolved.

The preeminent historian of paleontology, Martin Rudwick, points to another revolution between the Copernican and Darwinian revolutions, equally important for our place in nature but less recognized: enlarging the timescale of Earth and, by implication, of the universe.

In earlier times, most people in the West had taken it for granted that the world had started, if not precisely in 4004 BC, then at some such point in time, only a few millennia ago. After this revolution it became equally commonplace to accept that the Earth's timescale runs at least into millions of years, if not billions . . . The “young Earth” of the traditional picture was also an almost wholly human Earth. Apart from a brief opening scene . . . it was a human drama from start to finish, from Adam through to some future Apocalypse at the end of the world. In contrast, the “ancient Earth” first discovered and reconstructed by early geologists was largely non-human because it was almost completely pre-human: our species seemed to have made a very late appearance on the world stage. (2014: 2)

Realizing the long time span gave Darwin the time needed for natural selection to work. More importantly for present purposes, it was the foundation for a history of Earth itself – changing land masses, uplift and erosion of mountains, long-term changes in climate, and the formation of continent-wide ice sheets.

We begin with an account of how European savants came to realize that Earth is far older than 6,000 years, and that humans were late arrivals on the scene. I hope the reader will enjoy this story as much as I did in bringing it into narrative form.