

The Perspective that Age Brings

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We live in an extraordinary time, if you're willing to bend the rules a bit and include the last 500 years as "our time." We're now answering questions with a provable certainty that have been asked for as long as men have possessed language.

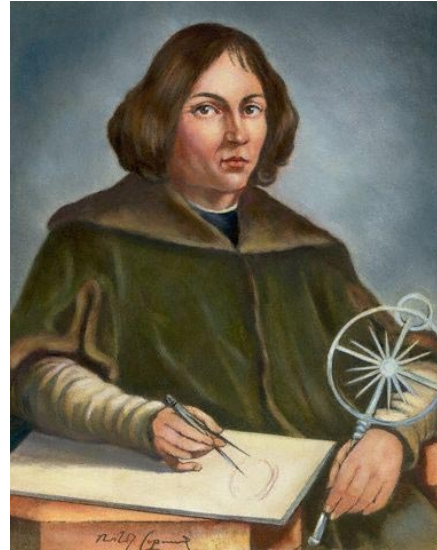
The beginnings of formal Western science can be traced back to a single point in time: the life and work of the physician Copernicus (1473-1543). His major work, *De revolutionibus orbium coelestium*, was published the year of his death, after more than three decades of thought, and a half century before Galileo first looked at the heavens with a telescope. "The Copernican Principle" is the philosophical statement that no "special" observers need be proposed to explain our position in the heavens.

We still conduct our science by invoking this principle: that the laws of physics and chemistry are the same everywhere, the only modification being that we now call this general line of thought the "Principle of Mediocrity." The Earth is now believed to be a mediocre planet, orbiting a mediocre star in a mediocre galaxy, occupying an infinitesimally small, mediocre corner of the universe.

The obvious extension of this principle is then to ask the question: "Are we alone in the universe?" Phrased another way, what is the probability that any of the billion billion stars we see at night similarly harbor life and intelligence?

Giordano Bruno, in 1584, answered the question in this manner, invoking Copernicus' Principle:

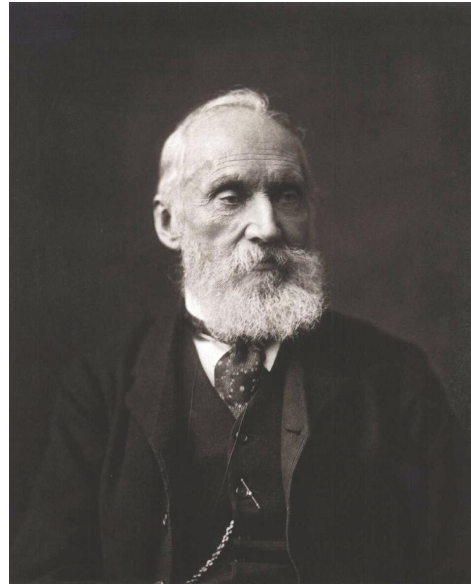
"Thus the earth no more than any other world is at the centre; and no points constitute definite determined poles of space for our earth, just as she herself is not a definite and determined pole to any other point of the ether, or of the world space; and the same is true of all other bodies. From various points of view these may all be regarded either as centres, or as points on the circumference, as poles, or zeniths and so forth. Thus the earth is not in the centre of the universe; it is central only to our own surrounding space.



Nicolaus Copernicus' epochal book, *De revolutionibus orbium coelestium* (On the Revolutions of the Celestial Spheres), is commonly regarded as the defining epiphany that began the Scientific Revolution.

If this is so, and after 400 years of observation and investigation we have no reason to doubt that's it not, then we cannot believe that there is anything special about the Earth or the life that inhabits it. If one earth exists, then there must be many. Some of the most fundamental questions in this line of inquiry then became: "How old is the Earth?" "How long it did take life to evolve here on Earth?" and "How old is the Universe itself?" It's from the answers to these questions that we can begin to get a sense of how likely there is extraterrestrial life and intelligence elsewhere in the Universe.

The first person to calculate the age of the Earth scientifically was Lord Kelvin (1824-1907). Kelvin was a devout Christian, and because of that, he was also an ardent anti-evolutionist. However, due to his calculations, which he performed repeatedly over his 50-year professional career, slowly moving his estimates of the age of the Earth from 200 Myr to 100 Myr to 20 Myr, he managed to make everyone he knew irritated with him. Both the young Earth Biblical literalists and professional biologists and geologists, were furious with Kelvin. His estimates were far too old for the Creationists, so much so as to be sacrilege. Simultaneously, his estimates were far too young for the processes that the biologists and geologists were seeing.



Lord Kelvin (William Thomson) was the first to rigorously calculate the age of the Earth using scientific principles. He refined his calculations over the whole of his scientific career. His only failure was that he was catastrophically wrong in his estimates.

Kelvin based his estimates on the newly discovered rise in temperatures measured in the deep mines that were then just being dug at several locations in the world, and on the new mathematics of heat transfer of Jean Baptiste Joseph Fourier, a French thermodynamicist. The standard story, one told in almost every college classroom, is that Kelvin's calculations were greatly in error because he didn't know of the sequestration of nuclear isotopes in the molten core of the Earth. However that story isn't complete or even correct. Recently, in January 2007, a short historical paper was published in *GSA Today* demonstrating that this popular story is incorrect.

Introducing the known distribution of radioactivity into Kelvin's calculation doesn't invalidate his conclusions, as is often stated. But the internal convections of the molten Earth do. In 1895, before the discovery of radioactivity, another geologist, John Perry, showed that convection in the Earth's interior would make a mess of Kelvin's estimate for the age of the Earth, but Kelvin's stature was such that Perry's analysis was neglected or forgotten.

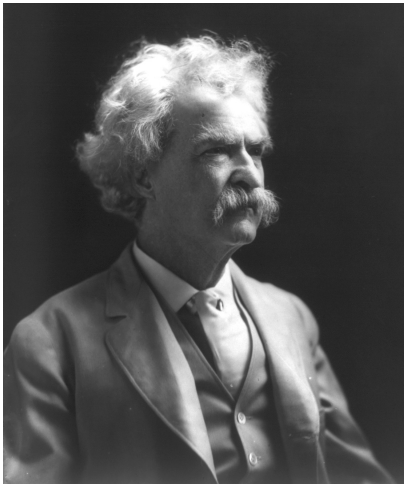
The scientific story of the geologists and biologists vs. Lord Kelvin is often told as a David vs. Goliath epic, Kelvin's reputation being as unassailable as it was. Surprisingly, one of the people most associated with dethroning Kelvin's conclusions was Mark

Twain. Twain's life (1835-1910) paralleled the rapid development of geology and paleontology in the late 19th and early 20th centuries and the introduction of the societally disturbing new paradigms of deep geologic time and Darwinian evolution. Twain's use of geological and paleontological references in his writing evolved along with the science.

Twain's most important essay appears below. When you read it, read it as if you're reading a scientifically literate version of Dave Barry. Twain has all the basic facts quite correct; he just makes up some of the organismal names. Ammonites and trilobites are real. Ganoids, asteroids and alkaloids aren't.

In the abstract for his talk at the 2002 Geological Society's annual meeting, Stephen Rowland (UNLV) described Twain's essay in this manner:

"In his 1903 essay 'Was the world made for man?' Twain discussed, without the sarcasm of earlier years, the views of Charles Lyell and Lord Kelvin about the age of the Earth. In this case he used these views to satirize the biblical perspective that the events of earth history occurred specifically to prepare earth for humans. The evolution of Twain's use of geology and paleontology reflects, and helped to bring about, an increasing credibility and respectability for these fields within American society..."



Mark Twain's 1903 essay on the age of the Earth was instrumental in the public's acceptance of the new sciences of geology, paleontology and evolutionary biology.

"Was the World Made for Man?"

Mark Twain
1903

"Alfred Russell Wallace's revival of the theory that this earth is at the center of the stellar universe, and is the only habitable globe, has aroused great interest in the world." – Literary Digest

"For ourselves we do thoroughly believe that man, as he lives just here on this tiny earth, is in essence and possibilities the most sublime existence in all the range of non-divine being – the chief love and delight of God." – Chicago "Interior" (Presb.)

I seem to be the only scientist and theologian still remaining to be heard from on this important matter of whether the world was made for man or not. I feel that it is time for me to speak.

I stand almost with the others. They believe the world was made for man, I believe it likely that it was made for man; they think there is proof, astronomical mainly, that it was

made for man, I think there is evidence only, not proof, that it was made for him. It is too early, yet, to arrange the verdict, the returns are not all in. When they are all in, I think they will show that the world was made for man; but we must not hurry, we must patiently wait till they are all in.

Now as far as we have got, astronomy is on our side. Mr. Wallace has clearly shown this. He has clearly shown two things: that the world was made for man, and that the universe was made for the world – to steady it, you know. The astronomy part is settled, and cannot be challenged.

We come now to the geological part. This is the one where the evidence is not all in, yet. It is coming in, hourly, daily, coming in all the time, but naturally it comes with geological carefulness and deliberation, and we must not be impatient, we must not get excited, we must be calm, and wait. To lose our tranquility will not hurry geology; nothing hurries geology.

It takes a long time to prepare a world for man, such a thing is not done in a day. Some of the great scientists, carefully deciphering the evidences furnished by geology, have arrived at the conviction that our world is prodigiously old, and they may be right, but Lord Kelvin is not of their opinion. He takes a cautious, conservative view, in order to be on the safe side, and feels sure it is not so old as they think. As Lord Kelvin is the highest authority in science now living, I think we must yield to him and accept his view. He does not concede that the world is more than a hundred million years old. He believes it is that old, but not older. Lyell believed that our race was introduced into the world 31,000 years ago, Herbert Spencer makes it 32,000. Lord Kelvin agrees with Spencer.

Very well. According to Kelvin's figures it took 99,968,000 years to prepare the world for man, impatient as the Creator doubtless was to see him and admire him. But a large enterprise like this has to be conducted warily, painstakingly, logically. It was foreseen that man would have to have the oyster. Therefore the first preparation was made for the oyster. Very well, you cannot make an oyster out of whole cloth, you must make the oyster's ancestor first. This is not done in a day. You must make a vast variety of invertebrates, to start with – belemnites, trilobites, jebusites, amalekites, and that sort of fry, and put them to soak in a primary sea, and wait and see what will happen. Some will be a disappointments - the belemnites, the ammonites and such; they will be failures, they will die out and become extinct, in the course of the 19,000,000 years covered by the experiment, but all is not lost, for the amalekites will fetch the home-stake; they will develop gradually into encrinites, and stalactites, and blatherskites, and one thing and another as the mighty ages creep on and the Archaean and the Cambrian Periods pile their lofty crags in the primordial seas, and at last the first grand stage in the preparation of the world for man stands completed, the Oyster is done. An oyster has hardly any more reasoning power than a scientist has; and so it is reasonably certain that this one jumped to the conclusion that the nineteen-million years was a preparation for him; but that would be just like an oyster, which is the most conceited animal there is, except man. And anyway, this one could not know, at that early date, that he was only an incident in a scheme, and that there was some more to the scheme, yet.

The oyster being achieved, the next thing to be arranged for in the preparation of the world for man, was fish. Fish, and coal to fry it with. So the Old Silurian seas were opened up to breed the fish in, and at the same time the great work of building Old Red Sandstone mountains 80,000 feet high to cold-storage their fossils in was begun. This latter was quite indispensable, for there would be no end of failures again, no end of extinctions – millions of them – and it would be cheaper and less trouble to can them in the rocks than keep tally of them in a book. One does not build the coal beds and 80,000 feet of perpendicular Old Red Sandstone in a brief time – no, it took twenty million years. In the first place, a coal bed is a slow and troublesome and tiresome thing to construct. You have to grow prodigious forests of tree-ferns and reeds and calamites and such things in a marshy region; then you have, to sink them under out of sight and let them rot; then you have to turn the streams on them, so as to bury them under several feet of sediment, and the sediment must have time to harden and turn to rock; next you must grow another forest on top, then sink it and put on another layer of sediment and harden it; then more forest and more rock, layer upon layer, three miles deep – ah, indeed it is a sickening slow job to build a coal-measure and do it right!

So the millions of years drag on; and meantime the fish-culture is lazying along and frazzling out in a way to make a person tired. You have developed ten thousand kinds of fishes from the oyster; and come to look, you have raised nothing but fossils, nothing but extinctions. There is nothing left alive and progressive but a ganoid or two and perhaps half a dozen asteroids. Even the cat wouldn't eat such. Still, it is no great matter; there is plenty of time, yet, and they will develop into something tasty before man is ready for them. Even a ganoid can be depended on for that, when he is not going to be called on for sixty million years.

The Palaeozoic time-limit having now been reached, it was necessary to begin the next stage in the preparation of the world for man, by opening up the Mesozoic Age and instituting some reptiles. For man would need reptiles. Not to eat, but to develop himself from. This being the most important detail of the scheme, a spacious liberality of time was set apart for it – thirty million years. What wonders followed! From the remaining ganoids and asteroids and alkaloids were developed by slow and steady and pains-taking culture those stupendous saurians that used to prowl about the steamy world in those remote ages, with their snaky heads reared forty feet in the air and sixty feet of body and tail racing and thrashing after. All gone, now, alas – all extinct, except the little handful of Arkansawrians left stranded and lonely with us here upon this far-flung verge and fringe of time.

Yes, it took thirty million years and twenty million reptiles to get one that would stick long enough to develop into something else and let the scheme proceed to the next step.

Then the Pterodactyl burst upon the world in all his impressive solemnity and grandeur, and all Nature recognized that the Cainozoic threshold was crossed and a new Period open for business, a new stage begun in the preparation of the globe for man. It may be that the Pterodactyl thought the thirty million years had been intended as a preparation for

himself, for there was nothing too foolish for a Pterodactyl to imagine, but he was in error, the preparation was for man, Without doubt the Pterodactyl attracted great attention, for even the least observant could see that there was the making of a bird in him. And so it turned out. Also the makings of a mammal, in time. One thing we have to say to his credit, that in the matter of picturesqueness he was the triumph of his Period; he wore wings and had teeth, and was a starchy and wonderful mixture altogether, a kind of long-distance premonitory symptom of Kipling's marine:

*'E isn't one O'the reg'lar Line,
nor 'e isn't one of the crew,
'E's a kind of a giddy harumfrodite [hermaphrodite] –
soldier an' sailor too!*

From this time onward for nearly another thirty million years the preparation moved briskly. From the Pterodactyl was developed the bird; from the bird the kangaroo, from the kangaroo the other marsupials; from these the mastodon, the megatherium, the giant sloth, the Irish elk, and all that crowd that you make useful and instructive fossils out of – then came the first great Ice Sheet, and they all retreated before it and crossed over the bridge at Behring's strait and wandered around over Europe and Asia and died. All except a few, to carry on the preparation with. Six Glacial Periods with two million years between Periods chased these poor orphans up and down and about the earth, from weather to weather – from tropic swelter at the poles to Arctic frost at the equator and back again and to and fro, they never knowing what kind of weather was going to turn up next; and if ever they settled down anywhere the whole continent suddenly sank under them without the least notice and they had to trade places with the fishes and scramble off to where the seas had been, and scarcely a dry rag on them; and when there was nothing else doing a volcano would let go and fire them out from wherever they had located. They led this unsettled and irritating life for twenty-five million years, half the time afloat, half the time aground, and always wondering what it was all for, they never suspecting, of course, that it was a preparation for man and had to be done just so or it wouldn't be any proper and harmonious place for him when he arrived.

And at last came the monkey, and anybody could see that man wasn't far off, now. And in truth that was so. The monkey went on developing for close upon 5,000,000 years, and then turned into a man - to all appearances.

Such is the history of it. Man has been here 32,000 years. That it took a hundred million years to prepare the world for him is proof that that is what it was done for. I suppose it is. I dunno. If the Eiffel tower were now representing the world's age, the skin of paint on the pinnacle-knob at its summit would represent man's share of that age; and anybody would perceive that that skin was what the tower was built for. I reckon they would, I dunno.

Despite the errors, Kelvin's calculations nonetheless had significant scientific value. While the numbers were wrong, for the first time, the Earth came to be believed to have a

finite age. Up until Kelvin's line of argument, many geologists had believed that the Earth was exceedingly old, perhaps infinitely so.

This same argument would come roaring back in the 1950's with Fred Hoyle's "steady-state" universe and his dismissal of the "Big Bang," a term he derisively used for the idea of a finitely-aged Universe, but that controversy similarly proved to be exceedingly valuable to our understanding in calculating the probabilities of life evolving elsewhere.

Next month: The evolution of Life, the Universe and Everything.