

# IDENTITY

Carl Sagan's Cosmos-Star Stuff

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Matter is much older than life. Billions of years before the sun and earth even formed, atoms were being synthesized in the insides of hot stars and then returned to space when the stars blew themselves up. Newly formed planets were made of this stellar debris. The Earth and every living thing are made of star stuff. But how slowly in our human perspective life evolved; from the molecules of the early oceans to the first bacteria. The reason that evolution is not immediately obvious to everybody is because it moves so slowly and takes so long. How can creatures who live for only seventy years detect events that take 70 million years to unfold - or 4 billion? By the time one-celled animals had evolved, the history of life on Earth was half over. Not very far along to us, you might think but by now, almost all the basic chemistry of life had been established.

Forget our human time perspective from the point of view of a star. Evolution was weaving intricate new patterns from the star stuff on the planet Earth and very rapidly. Most evolutionary lines became extinct; many lines became stagnant. If things had gone a little differently, a small change of climate, say, or a new mutation or the accidental death of a different, humble organism, the entire future history of life might have been very different. Perhaps the line to an intelligent technological species would have passed through worms. Perhaps the present masters of the planet would have had ancestors who were tunicates. We might not have evolved. Someone else, someone very different would be here now in our stead. They would be pondering their origins. But that's not what happened. There was a particular sequence of environmental accidents and random mutations in hereditary material, one particular timeline for life on Earth in this universe.

As a result, the dominant organisms on this planet today, come from fish. Along the way, many more species became extinct than now exist. If history had a slightly different weave, some of those extinct organisms might have survived and prospered. But occasionally a creature thought to have become extinct hundreds of millions of years ago turns out to be alive and well; the coelacanth for example. For three and a half billion years, life had lived exclusively in the water. But now in a great breathtaking adventure, it took to the land.

But if things had gone a little differently, the dominant species might still be in the ocean or they might have developed spaceships to carry them off the planet altogether. From our ancestors, the reptiles, there developed many successful lines including the dinosaurs. Some were fast, dexterous, and intelligent. A visitor from another world or time might have thought them the wave of the future but after nearly 200 million years, they were suddenly all wiped out. Perhaps it was a great meteorite colliding with the Earth spewing debris into the air blotting out the sun and killing the plants that the dinosaurs ate. I wonder when

they first sensed that something was wrong. The successors of the dinosaurs came from the same reptilian stock but were able to survive the catastrophe that destroyed their cousins.

Again, there were many branches which became extinct. And again, had events been only a little different, those branches might have lived to the dominant form today. For 40 million years, a visitor might not have been impressed by these timid little creatures, but they led to all the familiar mammals of today and that includes the primates. About 20 million years ago, a space time traveler might have recognized these guys as promising bright, quick, agile, sociable, and curious. Their ancestors were once atoms made in stars then simple molecules, single cells, polyps stuck to the ocean floor, fish, amphibians, reptiles, shrews. But then, they came down from the trees and stood upright. They grew enormous brains. They developed culture, invented tools, domesticated fire. They discovered language and writing. They developed agriculture. They built cities, forged metal, and ultimately, they set out for the stars from which they had come 5 billion years earlier. We are star stuff which has taken its destiny into its own hands. The loom of time and space works the most astonishing transformations of matter. Our own planet is only a tiny part of the vast cosmic tapestry, a starry fabric of worlds yet untold.

Those worlds in space are as countless as all the grains of sand on all the beaches of the earth. Each of those worlds is as real as ours and in every one of them there is a succession of incidents, events, occurrences which influence its future. Countless worlds, numberless moments, an immensity of space and time and our small planet at this moment, here we face a critical branch point in history. What we do with our world right now will propagate down through the centuries and powerfully affect the destiny of our descendents. It is well within our power to destroy our civilization and perhaps our species as well. If we capitulate to superstition or greed or stupidity, we can plunge our world into a darkness deeper than the time between the collapse of classical civilization and the Italian Renaissance. But we are also capable of using our compassion and our intelligence, our technology and our wealth to make an abundant and meaningful life for every inhabitant on this planet, to enhance enormously our defending of the universe and to carry us to the stars.