

## EVOLUTION AND THE LAW OF ENTROPY

Ever since the first appearance of Charles Darwin's book "On the Origin of Species" in 1859 which expounded the thesis that man evolved from earlier species through natural selection there have been arguments between the majority of the scientific community who supports this view and those few who oppose the thesis and try to bring in the concept of Divine Intervention. It is now quite clear that Darwin was right and that natural selection can account for the very slow changes in the DNA of living things, including man, over time. The basic idea behind the Theory of Evolution is that those members of a species having certain randomly appearing mutations which are of advantage for survival, such as a larger reproduction rate, larger brains, and traits allowing for a better adaptation to changes in the environment, are more likely to survive and spread these favorable genes to subsequent generations. In layman's terms this is referred to as "survival of the fittest" Those individuals with detrimental mutations will fall by the wayside while those with beneficial mutations will thrive and have more advantaged offspring. The process of change is an extremely slow one and can take thousands of generations. The complicated DNA of modern man and chimpanzees differs only by a few percent yet the branch splitting between these two species is estimated to have occurred over ten million years ago. If we look at man, his early ancestor primates first appeared about 75 million years ago, with Homo-Erectus first found about 1.5 million years ago, and the first appearance of Homo-Sapiens coming about 200,000 years ago. Present day man is descended from the earliest Homo-Sapiens and separated from them by about 6,000 generations. Modern man and the cave painters of Lascaux, whose intellectual capabilities are believed to have been about the same as that of modern man, existed some 20,000 years ago which equals some 600 generations. The theory that modern man migrated out of Africa about 70,000 years ago and populated the rest of the world is still a hypothesis which leaves many questions unanswered especially in regard to how there are such distinct differences in people throughout the world after just 2,000 generations. Evolution is unlikely to have had time to account for such differences. It suggests rather that man most likely evolved along different branches of a common ancestor well over 10 million years ago with the origin not necessarily being the Lake Rudolph region of Kenya.

Now let us get to the main topic of how evolution relates to entropy. Those of you who have taken any elementary physics course know that the Law of Entropy states that any ordered system (low entropy) will degenerate in time to a state of disorder (high entropy). This is a consequence of the law of diffusion in gas dynamics and is perfectly valid for things like two chambers filled with different gases and connected to each other through a small hole. In time the original ordered system (two compartments filled with different gases) will become

disordered (Gases mixed perfectly in the two chambers). Keeping this as evidence for the validity of the Entropy Law in mind, it would appear that life and the accompanying evolution should not be possible since the entropy flow appears to be reversed since only an increase in entropy with time should be allowed. The catch here is that one has to consider the entropy for the entire system including that of oxygen-carbon dioxide exchange in the breathing process and the nourishment intake and heat rejection by the body. When this is done there will be a net entropy increase with time. Thus one can conclude the obvious that life and evolution are indeed possible and likely at the expense of the environment. An interesting discussion of life and entropy can be found in Erwin Schroedinger's 1944 book "What is Life". If the food or oxygen supply is cutoff the consequences to human life are obvious. The upshot is that evolution is highly probable in the right type of environment were nutrient and environmental conditions are favorable. As I have discussed in another note, life can be expected to be found at other places in the universe provided the right conditions to sustain life are present. My estimate is that there are probably 600 or so planets within our own milky way were species more advanced in technology than man have evolved. The trouble is that for an even distribution of these civilizations throughout our galaxy it would place our nearest super-intelligent neighbor at about 3000 light years away. That is, a rocket ship travelling at  $1/10^{\text{th}}$  the speed of light would take some 30,000 years (or the equivalent of 1000 generations) to get there. Even radio transmission would take 3000 years. That is, if Aristotle in ancient Greece could have sent a radio message it would not be received until this time on the designated planet and then take another 3000 years before a reply could be received back on earth.