Chapter 15: How Many Tries

Many scientists believe that the vast expanse of the universe and its extreme age offset the poor odds associated with the origin of life, but they never present calculations to support this conclusion. Instead, they assume that it must be true because life exists, and they rely on the naturalistic axiom to support their position. By definition this approach is science. Nevertheless, why not do the calculation?

For chemical evolution, both the vastness and age of the universe help. For biological evolution only time helps because if life exists on other planets it is extraordinarily rare. Biological evolution also benefits from large populations. This chapter will show that when large populations are given several billion years to evolve, the knowledge that they create is insufficient to explain the origin of many proteins.

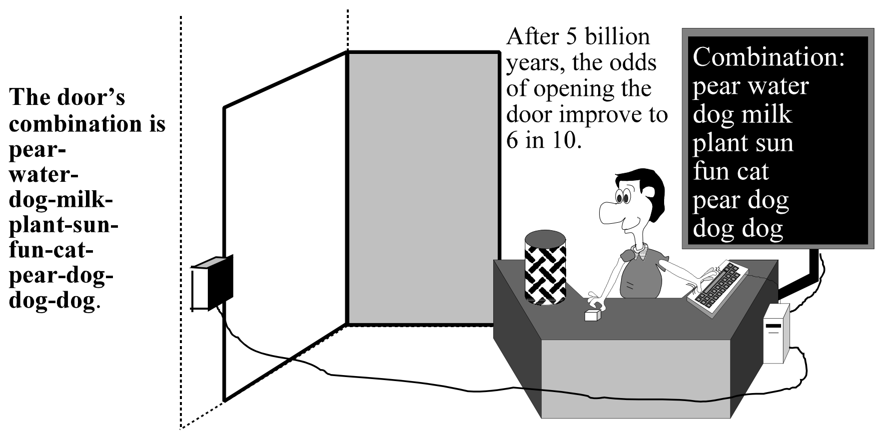
This chapter only considers two cases: 1) The evolution of the very first genes and proteins. These arose shortly after self replication evolved. 2) The evolution of molecules capable of self replication. Thus, the scope of this chapter is limited to the earliest stages of evolution.

How Does Time Factor Into the Equation?

Consider a trapped scientist with a 12-word combination. If the scientist enters 12 words every 30 seconds, then he will enter approximately 1 million combinations over the course of a year. If the scientist lives for 5 billion years, and his basket contains 20 blocks labeled with words, then the odds that the scientist will open the door are 6 times in 10 tries. So in this case, time will most likely solve the problem by allowing chance to overcome a step in knowledge. Each word contains 4.32 bits of information (see chapter 1). So the 12 word combination contains 52 bits of knowledge, 12 x 4.32 =52.

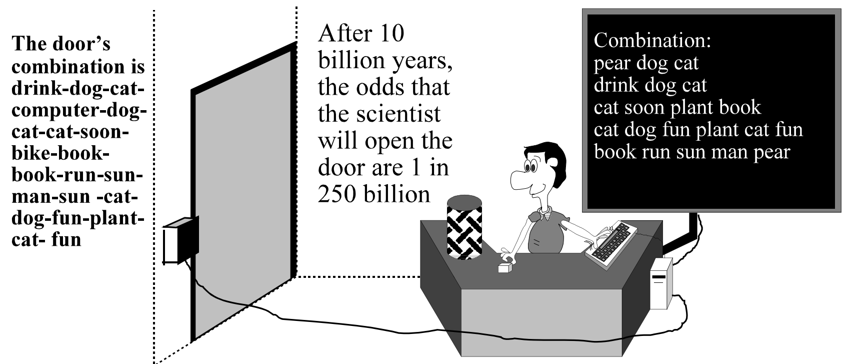
Thus, given 5 billion years and 1 million tries a year chance can probably overcome a 52 bit step in knowledge. The door in figure 15.1 is shown open because the scientist eventually enters the correct combination.

15.1: A Barrier That Chance Can Overcome



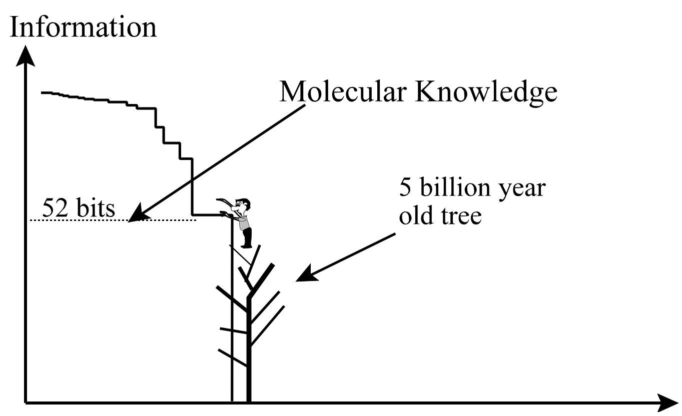
Now suppose that the door's combination is 21 words. This combination contains 21 x 4.32 = 91 bits of knowledge. The odds of opening the door are now 1 in 2.5 x 10^{27}. After 10 billion years with 1 million tries a year, the odds that the scientist will open the door improve to 1 time in 250 billion tries. The door stays shut.

Figure 15.2: A Barrier That Chance Cannot Overcome



Time can be represented as a growing tree (figure 15.3). The tree grows very slowly. After 5 billion years, the tree is almost 52 bits high. This allows the scientist to climb the tree and jump onto the ledge.

Figure 15.3: Time Represented by a Tree



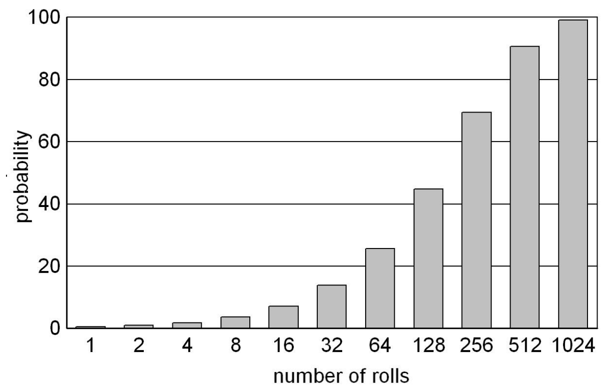
How Fast Does the Tree Grow?

Suppose that a scientist is given three dice and told to roll them until he throws triple fives. The odds that he will throw triple fives on the first roll are 1 in 216 (the dice have 6 x 6 x 6 = 216 possible outcomes, and only one is triple fives). What are the odds when the scientist throws the three dice twice? Many readers may think that the odds double. But this is only an approximation, and the approximation is only accurate if the odds are poor. The equation required to calculate the odds is as follows: odds of triple fives = $1 - (215/216)^{\text{number of rolls}}$. So with one roll the odds are $1 - (215/216)^{1} =$ 1/216 or 1 in 216. The odds with 2 rolls are $1-(215/216)^{2}=$ 1/108.25 or 1 time in 108.25 tries. Notice that the odds did not quite double

Rolls	Probability	Odds
1	0.46%	1 in 216
2	0.92%	1 in 108.25
4	1.84%	1 in 54.4
8	3.65%	1 in 27.4
16	7.2%	1 in 14
32	13.8%	1 in 7.2
64	25.7%	1 in 3.9
128	44.8%	1 in 2.2
256	69.5%	1 in 1.4
512	90.7%	1 in 1.1
1024	99.1%	1 in 1.01

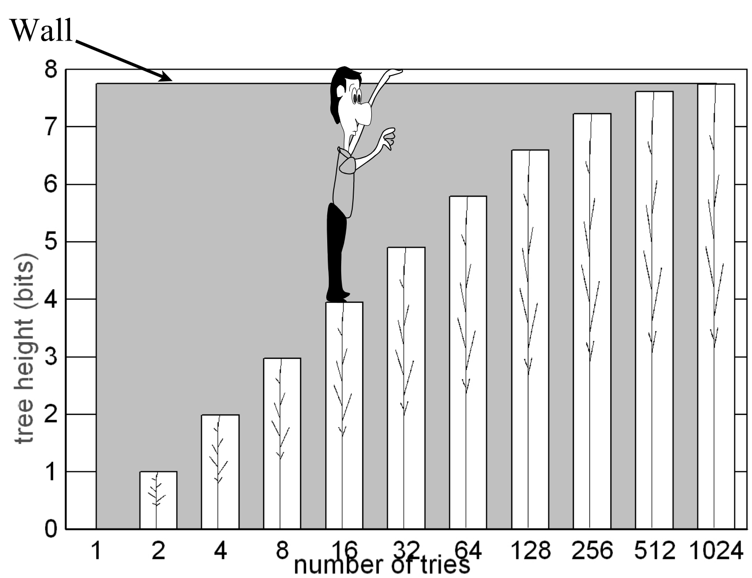
Figure 15.4 uses a bar to represent the probability of rolling triple fives. The numbers along the bottom represent the number of tries. When the bars are short, each successive bar is almost twice as high as its predecessor. Once the probability is greater than ten percent, doubling the tries no longer doubles the probability. The probability for success will never be equal to 100%, but after 1024 tries, it is very close.

Figure 15.4: Probability of Rolling Triple Fives



With quite a bit of mathematical manipulation, figure 15.4 can be converted into figure 15.5.

Figure 15.5: A Growing Tree Helps the Scientist Climb the Wall



In figure 15.5, each bit represents one foot. Because rolling triple fives corresponds to a 1 in 216 chance, the initial height of the wall in figure 15.5 is 7.75 bits (information = 3.32xlog(216/1) = 7.75 bits) or 7.75 feet.

After two rolls, the height of the wall is given as follows: information = 3.32 x log(108.25/1) = 6.75 bits. Rather than shrink the wall, which is hard to draw, figure 15.5 shows the scientists standing on a tree. The height of the tree is the initial height of the wall minus the new height of the wall. Thus, after two rolls the tree is 7.75- 6.75 = 1 foot high.

After 16 rolls, the odds improve to 1 in 14. Thus, the new height of the wall is equal to 3.32 x log (14/1) = 3.8 bits or 3.8 feet. To compensate the tree must be 4 feet tall (7.75 - 3.8 = 3.95).

The scientist is standing on the tree that corresponds to 16 rolls. He only has a 1 in 14 chance of climbing the wall. After 1024 rolls, there is almost no chance that he will not be able to climb over the wall.

To relate this example to evolution, each roll of the dice corresponds to a try, and each try corresponds to a reproductive event. So how fast the tree grows depends on reproductive rates. Animals that have large populations accumulate many more tries than those with small populations. Animals that reproduce slowly like elephants will accumulate fewer tries than animals that reproduce quickly like rabbits. Since it takes time to accumulate tries, the number of tries can easily be converted into years. If the scientist rolls the dice once a year, then the x-axis in figure 15.5 can be written in years, and it will take the tree that the scientist is standing on 16 years to grow.

This technique is not limited to biological evolution. It can also be used to model chemical evolution. Every time a chemical polymerizes in the primordial soup, the odds of creating a self-replicating molecule roughly double. Furthermore, every planet in the universe may have its own primordial soup. Both of these factors will significantly improve the odds of a self-replicating molecule evolving somewhere in the universe.

How Many Stars

How big is the universe? One study from Australia places the number of stars that man can see from earth with the most powerful telescopes at 7×10^{22}. This number was determined by calculating the number of stars in a small section of the sky and relying on the uniform nature of the universe to fill in the rest.

The true number is unknown. There could be stars in the universe whose light has not had a chance to reach earth yet. For the purpose of this discussion, assume that there are 7×10^{22} stars.

How Many Primoridal Soups

The conditions required for a primoridal soup to exist are special. A typical puddle of water does not qualify. Thaxton defined the conditions as follows: 1) the atmosphere above the puddle needs to contain no oxygen. 2) The puddle must be shielded from UV rays 3) it must have a way to continually evaporate and replenish its chemicals. 4) It must not contain a high concentration of salt (this rules out sea water) and finally 4) It needs to be near an energy source.[8]

So now assume that every star has ten planets and that each of these planets has 1,000 primordial soups. Thus, at any given time the universe has 7×10^{26} primorial soups. As some of these are destroyed, others replace them. Assume that every soup produces organic polymers (chains of amino acids, RNA bases, +other chemicals) at a rate of 1,000 Kg a year, and that 0.1% of the polymers produced are long enough to have some function (for example, 50 RNA bases strung together to form a chain counts, 3 does not, because 3 RNA bases cannot perform the function of a ribozyme, whereas 50 bases might be a ribozyme). This leads to the production of 1 Kg of suitable polymers per year per soup. If the average polymer weight is comparable to 30 amino acids, then each soup will produce 2×10^{23} organic polymers of reasonable size per year.

Each year all of the soups combined will produce 1.4 x 10^{50} polymers. Over the history of the universe (15 billion years), this equates to 2.1 x 10^{60} polymers. Clearly, this helps chemical evolution. Each polymer created is a try, so the techniques used earlier in this chapter can now be applied to chemical evolution. The goal is to figure out if a self replicating molecule can ever evolve given that the universe is quite big and has been around for a long time. The other goal is to figure out if an enzyme like G3PD can evolve.

RNA Self Replication

In chapter 10, each RNA base added to a random chain was shown to add 6 bits of primoridal information. So the odds of creating an RNA molecule with 50 bases is now 1 in $2^{50 \times 6}$ or 1 time in 2 x 10^{90} tries.

With 2.1 x 10^{60} tries, evolution has a 1 in 10^{30} chance of creating a single RNA molecule with 50 or more bases. This number accounts for the size of the universe. It also accounts for the age of the universe. Given that this RNA molecule is just a random sequence of RNA bases, it is almost inconceivable that it would know how to self-replicate. So the true odds are much more remote. Furthermore, the 6 bits is only true if cytosine, ribose, adenine, guanine and uracil are the principle components in all 7 x 10^{26} soups (see the favorable assumptions made for the soup on page 189). Given the experimental evidence presented in chapter 9 concerning prebiotic synthesis of these chemicals, the idea of a self replicating RNA molecule should be laid to rest. Life did not originate in this way.

Protein Evolution

The other component required for the origin of life is a method to tap a plentiful energy source and use this to drive replication. In chapter 14, the molecular knowledge associated with the evolution of G3PD in the primordial soup was estimated to be 515 bits. The odds of its evolution are therefore 1 in 10^{155}. The vastness and age of the universe improve the odds. They improve to 1 time in 5x10^{94} tries.

The idea that the vastness of space and the extreme age of the universe can offset the low probabilities associated with the origin of life is a myth. The scientists who subscribe to the myth have never bothered doing a single calculation to support their view.

Upper Limit on Number of Tries

Once self replication evolves, the number of tries is determined by population size and time. The number of stars in the universe does not play into evolution once life is on its way.

The only opportunity to accumulate tries is during reproduction. Thus, the number of tries that any animal or plant accumulates each year is proportional to how many offspring it produces.

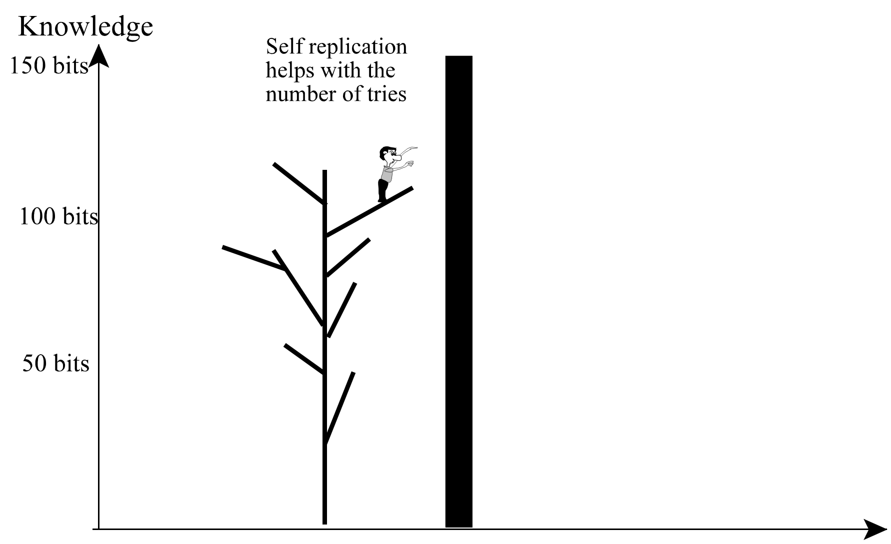
The most abundant, fastest reproducing organisms accumulate the most tries. The unquestionable leaders are bacteria, and the numbers are staggering. For every insect on the planet there are 500 billion bacteria. For every star in the universe, there are 10 million bacteria. Furthermore, when conditions are optimal one bacterium can split into two bacteria in a matter of minutes. One study estimates that 1.7×10^{30} bacteria are born each year.[6]

Constraints on the First Self Replicating Molecule

Assume that the first self- replicating system is able to reproduce at the same rate as bacteria. Further assume that this system is a single RNA molecule. Can such a system evolve?

This system certainly gets plenty of tries $\sim 10^{30}$ per year. How much information can it create given a billion years if each replication event counts as one try? In one billion years, this self-replicator will accumulate approximately 10^{39} tries. Such a system has a 63% chance of generating 130 bits of molecular knowledge. Figure 15.6 illustrates how self replication and the number of tries that it generates help the scientist to climb a wall of knowledge. Perhaps more impressive, self-replicators (like bacteria) can create 100 bits of knowledge in a single year! This looks encouraging for evolution.

Figure 15.6: Self Replication Helps Increase the Number of Tries

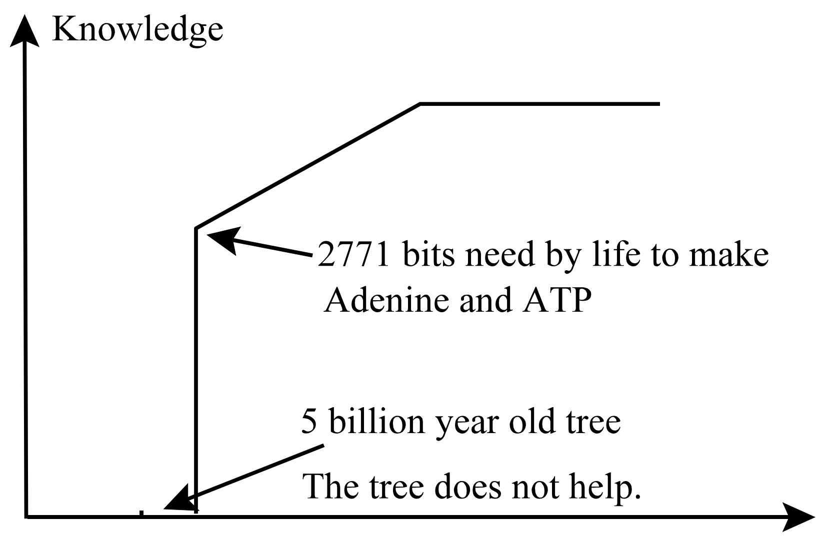


The Trees Help, but . . .

Self replicators cannot accumulate ~10^{30} tries per year unless they can replicate this many times per year. This replication will undoubtable require an almost unlimited supply of adenine, cytosine, ribose, uracil, and thymine. Given that these are so difficult to synthesis in the lab under plausible pre-biotic conditions, in order for the self replicators to accumulate ~10^{30} tries per year, they must be able to at least synthesize adenine and ATP. Thus, there is no clear path for evolution.

Chapter 14 calculates the molecular knowledge of the enzymes responsible for adenine synthesis and ATP at 15,364 bits in the soup and 2,771 bits with the genetic code. These enzymes are required by the self replicators to make adenine so they can self-replicate. Nevertheless, assume (as all evolutionists have) that perpetual motion machines are acceptable when they are needed to explain the origin of life. With this assumption, the self replicators still get ~10^{30} tries per year, and evolution still fails (see figure 15.7).

Figure 15.7 - Time Does Not Help When The Odds Are This Poor

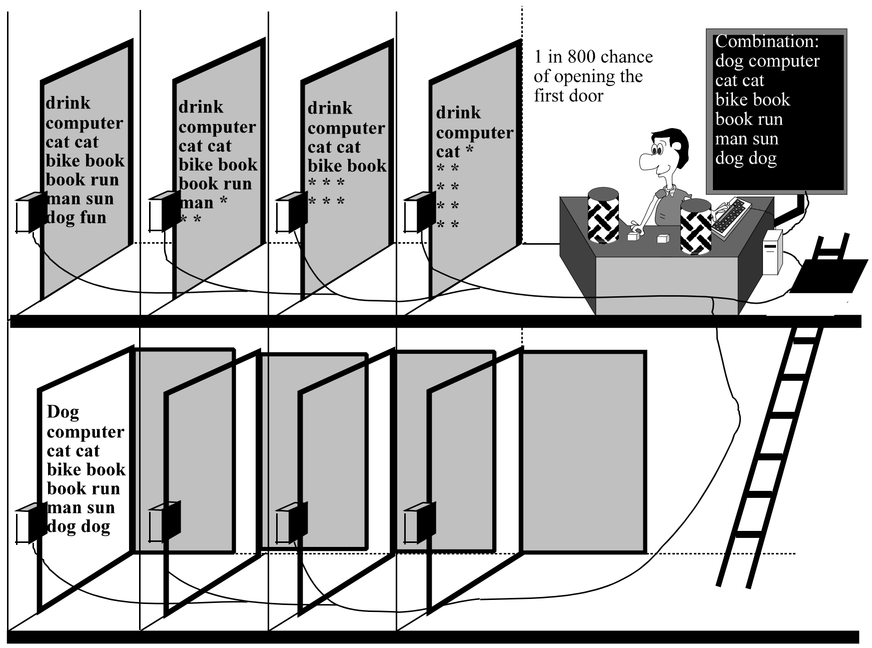


This entire discussion boils down to the chicken or the egg paradox which came first. Evolution needs large populations that replicate quickly to create knowledge. But self-replicators cannot replicate quickly unless they can synthesize adenine, ATP and host of other chemicals. This first step is so large that even with the perpetual motion assumption evolution fails, and it only gets worse from here.

Natural Selection Limits the Number of Tries

In the proceeding analysis, the effects of natural selection were ignored. To understand how natural selection affects the results consider the following example. Suppose the trapped scientist is now in a two-story building. The computer starts with a message already in it, and this message contains the knowledge to open all of the doors on the first story. The combination is dog-computer-cat-cat-bike-book-book-run-man-sun-dog-dog. The scientist is given two baskets. One contains 20 blocks labeled with words, and the other contains 12 blocks labeled with the numbers 1 through 12 (figure 15.8).

Figure 15.8: Natural Selection Preserves Existing Genes



The scientist is instructed to draw one block from each basket. He is to use the number that he draws to locate a position in the door's combination, and he is to change the existing word at that position to the new word which he draws. For example, on the first try, the scientist draws the number *12* and the word *cat*. The original combination has the word *dog* at position 12. So the scientist replaces this word with the word *cat*. When he makes this change, the last door on the first floor slams shut because its combination is no longer correct. The scientist climbs down the ladder and realizes that he is trapped. He becomes very agitated. He changes the word *ca*t back to *dog*, and the door opens.

He leaves and refuses to participate in any further experiments. He has no desire to be trapped in the room, and his refusal to participate preserves the combination that opens the first floor doors.

In this example, the combination that opens the doors on the first floor represents a gene, and the scientist represents natural selection. The scientist preserves this existing gene by refusing to participate in the experiment.

If protein A is represented by the bottom doors, then this protein is preserved by natural selection. If the upper doors represent protein B, then this protein will not evolve. The reason is simple. The preservation of the combination that opens the first story doors prevents the top floor combination from being found.

This Simple Example Shows that Evolution Does not Work Quite Like Darwin Imagined

When Darwin introduced the theory of evolution, he envisioned everything being guided by natural selection. The following quote conveys his thinking:

"If it could be demonstrated that any complex organ existed which could not possibly have been formed by numerous, successive, slight modifications, my theory would absolutely break down." - Charles Darwin

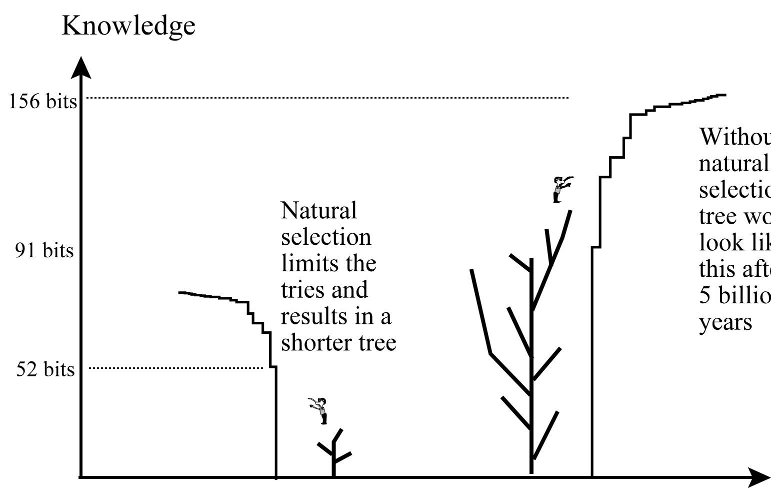
Darwin should be applauded for this particular statement. This quote is right on target. Darwin wanted to explain evolution with small continuous steps. He took a very simplistic approach. The legs of reptiles can gradually over many generations evolve into wings. The fins of fish can gradually evolve into legs for reptiles. He thought all of these changes were guided by natural selection. This simplistic approach is still taught in high school and college biology. Whether true or not, it is a great way to teach evolution because it minimizes the role of chance and makes the theory seem more reasonable.

Some biologists do not realize that useful information (any door's combination) is locked by natural selection. The fins of a fish are not free to evolve into the legs of a reptile. The legs of a reptile are not free to evolve into the wings of a bird, and it is natural selection that makes this a certainty.

Natural Selection Reduces the Number of Tries

Earlier a tree was used to represent the passage of time. As the tree grows, the scientist is able to climb it, and this allows him to climb steps in knowledge. The effect of natural selection on the tree's growth is shown below. The tree is now much shorter; as a result, the steps that can be overcome by chance given several billion years are much smaller.

Figure 15.9: Natural Selection Reduces the Number of Tries



As radical as this concept may seem to some readers, it is not really in dispute. Very few molecular biologists would disagree with this particular point. Many have already stated it very clearly.

"We have no trouble understanding how natural selection can maintain a functional single-copy gene like globin or insulin. If the gene product is defective in any serious way, the organism producing it will be immediately subjected to a selective disadvantage; it will either die prematurely or produce fewer progeny that its unmutated siblings" - Molecular Biology of the Gene, Watson et al, 1987.

"As long as a particular function of an organism is under the control of a single gene locus, natural selection does not permit perpetuation of mutations which result in affecting the functionally critical site of a peptide chain specified by that locus. Hence, allelic mutations are incapable of changing the assigned function of genes." - Evolution by Gene Duplication, Ohno.

"Gene duplication must always precede the emergence of a new gene having a new function." - The Neutral Theory of Molecular Evolution, Kimura."

Small changes are cumulative only when they optimize an existing protein. Natural selection guides this optimization. Once optimized, the changes don't stop, but they are no longer cumulative because natural selection's role switches from one of optimization to one of preservation. Thus, large changes are not expected even if evolution is given millions of years to operate. One of the best examples of the preserving power of natural selection is insulin. Insulin in fish is almost identical to insulin in humans.

To summarize, natural selection prevents evolution from happening like Darwin envisioned. Darwin's small changes only optimize information.

Implications for the Self replicating RNA Molecule

The implications for the self replicating RNA molecule are profound. Its primary structure (the sequence of RNA bases that enable self-replication) must always preserve self-replication. This greatly reduces the number of tries. Instead of accumulating ~ 10^{30} tries each year maybe such a system of self replicators only accumulates a few billion. Its tree is very short, and even given a billion years to evolve not much will happen. Very little if any new information will be created.

In conclusion, this chapter made some important calculations. These calculations show that the size and age of the universe do not offset the poor odds associated with the origin of life. These calculations also show that the first self-replicating RNA molecule would have quite a bit of trouble creating new information as its structure and function are preserved by its need to self- replicate.

Perhaps the most interesting calculation in this chapter is that proteins and genes contain quite a bit of molecular knowledge. Even fast replicating systems (like modern bacteria) may have trouble creating new proteins.

Science can hide behind the naturalistic axiom for only so long. It does not have a good explanation for the origin of life, and it does not appear that one is forthcoming anytime soon.

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