Charles Darwin's views on a comprehensive theory of evolution.

A very careful reading and indeed a re-reading of ***On the Origin of Species*** is required in order to fully understand Darwin's view on Evolutionary Theory. The one thing that he did not claim is that his theory of natural selection was the full story of evolution. In his own words he states *I am convinced that natural selection has been the main but not the exclusive means of modification.* Darwin was a competitive scientist and in his great book he treads a fine line between expounding his theory in order to convince the public of its efficacy and pointing out the fact that it was an incomplete explanation of evolution. He knew that natural selection was a systematic mechanism but in order for it to create new species this mechanism required a constant supply of variation or new design. Unlike neo-Darwinism's reliance on the copying error as the source of variation Darwin was convinced that there was a system for generating variety which was non-random, *I have hitherto sometimes spoken as if variations were due to chance. This, of course, is a wholly incorrect expression, but it serves to acknowledge plainly our ignorance of the cause of variation.* At many points in his book he admits to this missing link in his theory. In chapter five for example he refers to *a tendency to vary, due to causes of which we are quite ignorant.* He coins the term *generative variability* to emphasize his belief in the existence of laws of variety-generation and talks of *an innate tendency to new variations.* But he admits that *Our ignorance of the laws of variation is profound.* He is convinced that *There must be some efficient cause for each slight individual difference.* When discussing the evolution of instincts he speaks of *variations produced by the same unknown causes which produce slight deviations of bodily structure.*

The "one mistake" of Richard Dawkins.

Charles Darwin, the greatest ever thinker on evolution was convinced that there would eventually be discovered the *laws of variation.* Why did twentieth century biology completely ignore Darwin's views on the source of variety? Neo-Darwinism refutes Darwin's ideas and claims that the incredible outpouring of new variety, which acts as the source of the raw material required by natural selection, is due to copying errors, a rather lame, non-scientific claim. The majority of modern thinkers on evolutionary theory seem to ignore the fact that evolution requires both a mechanism and the raw material required by this mechanism. This modern view was summarised by one of the greatest ever advocates for neo-Darwinism, Richard Dawkins, when in an article in New Scientist magazine he wrote, *Natural selection is quintessentially non-random, yet it is lamentably often miscalled random. This one mistake underlies much of the sceptical backlash against evolution. Chance cannot explain life. Design is as bad an explanation as chance because it raises bigger questions than it answers. Evolution by natural selection is the only workable theory ever proposed that is capable of explaining life, and it does so brilliantly.*

No, Mr Dawkins, natural selection, by itself, does not explain life brilliantly and no one is saying that natural selection is a random process. With the benefit of Darwin's insight we can now see that natural selection is an obvious and simple consequence of reproduction and overcrowding. It eliminates the less fit but it does not design or create new organisms. It works on what is already there and leaves behind organisms and their genes that are better survivors. It can only work when it has a variety of organisms to choose from. It does not create those survivors. It merely changes the average characteristics of future generations by eliminating some and letting others continue into the future. It is a pure mechanistic non-random process, but it does not design new organisms.

Derek Hough's new theory

The 20th Century version of the theory of evolution, namely neo-Darwinism, is incorrect; it is simply wrong. What is most surprising about this statement is the fact that so few academics recognize its validity and are therefore reluctant to consider alternative science-based explanations for evolution.

The first problem is that it is difficult to find a succinct and unambiguous definition of neo-Darwinism in any reputable book on the subject of evolution. With luck you might find one or two sentences giving a brief summary of the theory somewhere in the text and a trawl through the literature will give a definition of neo-Darwinism something like this:

Evolution proceeds by the action of natural selection (the mechanism) on the variety created by copying errors (the raw material).

Nobody is disputing or denying the efficacy of natural selection but it is the *copying errors* part of this theory which is questionable. Darwin himself would never have believed in neo-Darwinism. He was convinced that there were unknown *laws of variation* which were required to fully explain the variety of life on earth. When given two choices as an explanation of the origin of the most complex structures in the universe, firstly, the guiding hand of God, or secondly, the action of natural selection on an accumulated series of copying errors, then there is absolutely nothing to choose between them. Both theories are highly improbable and totally unscientific. For more than thirty years academics have had available to them access to computers with which to explore the world of evolution. They should now be able to understand that what we understand as evolution is in itself an evolved system.

For some years Derek Hough has laid out the logical arguments in favor of non-random mutations and has campaigned for an amendment to the definition of the Theory of Evolution. Any new definition would exclude any reference to the concept of the copying error and would be theoretically underpinned by the important phenomenon of the algorithmic process, an understanding of which is vital to an understanding of evolution.

The key principles of Derek Hough's thesis can be explained by following some of the stages through which life's genetic algorithm has passed since it first appeared, possibly four billion years ago. Each of the following stages (except the first) can be simulated and explored with the use of computerized genetic algorithms.

1. The origin of life. Inert chemicals happen upon self-replication.

2. Exponential growth in numbers soon leads to the *filling up* of any initial space available to these primitive replicators.

3. Competition for survival leads to improved copying fidelity and differential fitness.

4. There will be a tendency for the early biosphere to automatically *condense* into species. The creation of niches being driven by the elimination of *types* or extinction in a knockout competition; a phenomenon well understood and explained by Darwin in ***On the Origin of Species***.

5. Perfect copying fidelity would be a certain road to extinction. A species composed entirely of clones would soon be eliminated when faced with competition from any other species with the slightest advantage. Copying fidelity would now be selected against and regularly occurring copying errors that in any way create useful variety would be retained by natural selection and form the basis of a variety maintenance system. It is important at this stage to understand that Hough is talking about the retention of the mechanism for creating this useful variety and not the retention of the variety per se. Any such variety-generating mechanism must not violate the important principle of the selfish-gene.

6. The environment of each unit of inheritance is composed of all other units of inheritance. This environment is never stable. Each heritable unit is always faced with an endlessly varying or variable environment. With an environment that consists of a range of possibilities each species will maximise its fitness by maintaining an appropriate range of characteristics and skills. Genes that influence the outcome of reproduction will control the maintenance of this variety.

7. Design possibility is not unlimited and heritable units *learn*, in an algorithmic sense, that maintenance of variety around a specific, limited range of possibilities enhances the average survival chances of these units. There is an element of predictability in the large but essentially limited range of environmental variation, and life's genetic algorithm *learns* to predict some of this variation and each species can then cope better with the

vicissitudes of a varying environment by maintaining an appropriate degree of variety, either in its gene pool or via regularly occurring relevant mutations. The maintenance of variety is facilitated by *mutator genes* which, although not directly selected by the environment, survive because of their ability to maintain useful variety. Our own immune system presents us with a model for understanding how a species can quickly adapt to an environmental challenge. The limit to design possibility is exemplified in the phenomenon of ***Convergence***.

8. At the same time as heritable units are maintaining variety, they are also co-operating with other heritable units. Working in teams has proved to be an advantage almost from day one, and these twin characteristics of co-operation and variety maintenance lead to the creation of unique combinations of sub-units. These new combinations of sub-units will lead to the creation of unique organisms, which, whilst not directly demanded by the environment, will survive if there is an available niche. Empty niches will rapidly be filled and convenient niches will become rarer. But the niche requiring sophistication and complexity beyond anything previously achieved will always be available and will always be sought out by this algorithmic search. Evolution can then be seen as a systematic search through the expanse of design possibility or ***Design Space***.

Summary

The fundamental question asked by Hough is how do we get from simple organisms to complex ones over a period of 3-4 billion years. The next question is how does life achieve this without violating the important principle of the selfish gene. Natural selection plays an important role but, like Darwin, Hough recognises that there must exist *laws of variation* in order that there is always an abundant supply of variety from which to select.

Hough uses the term *mutator gene* as an aid to model building but in reality evolution has created systems of immense complexity which maintain variety within every level of life whether it be genes, proteins, metabolisms, individuals, populations or species. Perhaps the most important characteristic created by the early primordial replicator was the ability to survive in a variable or varying environment. Hough's ideas give more importance to pre-adaptation and he recognises that natural selection can only demonstrate its power to achieve improved levels of fitness when it is accompanied by variety-generating systems. These variety-generating systems create the astonishing plasticity of every physical and mental feature of an organism which ensures, as Darwin realised, that variety is always available when it is needed.

The essence of Hough's thesis is that it is not only organisms that are acted upon by natural selection but more importantly natural selection also ensures that the best systems for creating those organisms are also selected. One of the key points which investigators into evolutionary mechanisms must understand is that universal or partially universal inherited characteristics of life such as the functioning of cells, sexual reproduction, multicellularity and the genetic code itself have all been created by evolution. The system of maintaining variety from one generation to the next as outlined above is just another such universal characteristic and it is maintained because of its usefulness to life as a whole. The genes for such characteristics are not subject to the same environmental scrutiny as the genes for creating the physical characteristics of an organism. Derek Hough has previously described his thesis as the theory of the ***self-developing genome***.The idea that certain genes control the reproductive success of other genes has profound implications for evolution. It explains phenomena that sit uncomfortably with neo-Darwinism such as sexual reproduction and group selection, both of which seem to break the rule of selfish survival. The new theory also accounts for the rapid evolution of antibiotic resistance.

Natural selection will now exert a two-fold influence in order to maintain an appropriate level of variety within each species. It acts on genes that maintain the variety-generating system and it also acts on *body-building* genes to eliminate designs that sit uncomfortably at the edge of the fitness landscape. Occasionally, however, organisms of novel design escape from the straightjacket of the niche and jump into a new niche with their own fitness landscape, thereby facilitating speciation and evolution. The ***self-developing genome*** encourages pre-adaptive moves in ***Design Space*** whilst speciation separates out these new designs from the parental species and therefore allows the ***self-developing genome*** to drive further differentiation.

The most important consequence of Hough's idea is that evolution can now be seen as endowing life with the ability to automatically search for empty niches wherever they are available.

A wonderful emergent consequence of variety maintenance at the level of the sub-unit is the constant search for evolutionary novelty and complexity at the level of the organism.

Towards a new definition of the theory of evolution

According to Derek Hough's theory of the ***self-developing genome***, it is the rate and degree of variation that is being selected and this variation can be maintained in every organismic feature, from protein structure and neural connections to body size. Life on earth now has all the tools and building blocks required to explore all potentially available regions of biological ***Design Space***.

The evolution of variety-generating systems was driven by the competition engendered by the exponential increase in numbers of the original primordial self-replicators. These early replicators would have created messy and inaccurate copies of themselves. The initial competitive environment faced by these primitive organisms would have been incredibly variable. The first priority for this early algorithmic search would have been for the primitive self-replicators to make a good copy of themselves and the second priority would then have been to evolve characteristics that would enable these organisms to survive in a very variable biosphere. The ultimate success of any gene is for it to exist in every organism on earth. Such highly successful universal genes eventually achieve a degree of perfection and can't easily be improved upon and they are then able to dominate other selfish genes who continue to exist in a varying and variable competitive environment.

Hough explains that by following the twin axioms of firstly, genes (or systems) which influence the outcome of reproduction and secondly, co-operation between varying heritable sub-units, then evolution as we know it, including the evolution of increasing complexity, is inevitable. The would lead to a new definition of evolution something like this:

Life on earth constitutes an interrelated network linked by common descent and universal systems. Natural selection has evolved systems that endow organisms and their species with a degree of non-developmental (i.e. evolutionary) plasticity which facilitates adaptation to an ever-varying or variable environment as an alternative to extinction. These systems, which maintain a defensive degree of variation at the lowest level of inheritance, can ultimately lead to increasing complexity and evolution due to the fact that lower level heritable units combine and cooperate within genomes to create functioning organisms. In other words, the genes that code for individual characteristics, which have evolved to exist in a limited and useful variable state, combine at the level of the organism in unique combinations with the potential for the emergence of novel or more

complex characteristics. These new characteristics might become established in a vacant niche or could proliferate via natural selection. Evolutionary change is facilitated by the naturally occurring phenomenon of speciation.

The existence of universal variety-maintaining genes or systems can have profound effects on the usual rules of selfish survival and can lead to selection at a higher level than individual genes. Life on earth, as we now have it, could not be possible without the evolution of variety-generating systems. Copying errors are destructive and perfect copying fidelity is the road to extinction. There are still unknowns to be explained if we are to fully understand evolution. Firstly, how did the original primordial replicator come into existence and secondly, how did it evolve into the incredible DNA-based duplicating machine that is first seen in the fossil record? It is said that we are within fifty years of solving the first problem and then the solution to the second problem might be amenable to simulation by computer.

Thomas Kuhn, the philosopher of science, might have had something interesting to say about the reluctance of the academic establishment to let go of the copying errors theory and he might have suggested that we will have to wait for the next generation of bright young biologists before encountering the inevitable *paradigm shift*

Critique of Douglas Futuyma's book *Evolution*.

There are many excellent text books for undergraduates on the subject of evolution. One of the best is by Douglas Futuyma and is titled ***Evolution***. The book is beautifully written. It is clear, concise, well-argued and all the salient points logically explained. It is almost a latter-day ***On the Origin of Species*** written for the genetic age.

How does Futuyma define the currently accepted version of the theory of evolution? Straightaway in chapter one he states that *mutation and natural selection together cause adaptive evolution: mutation is not an alternative to natural selection, but rather its raw material.* We could find similar definitions in other literature but it is important here to understand the exact meaning of the word *mutation.* When trying to explain the evolutionary route from simple organisms to human beings we clearly need more than a re-mixing of established genes and a crop of regularly re-occurring mutations. What is needed is a steady supply of novel genes which could give rise to novel features. This is where the concept of the *copying error* would come in.

In 2009 The Royal Society in London produced a small booklet to celebrate the 150th anniversary of the publication of ***On the Origin of Species*** and in this booklet the meaning of *mutation* in this context is made very clear: *We know that inherited variation is caused by changes in gene sequences of organisms, called mutations. They can arise from errors introduced when DNA is copied, and from damage due to background radiation or chemical reactions.* And then as if to re-emphasize the point they go on to say *Sometimes errors result in the duplication of a gene…such that new functions can arise. Many examples of this process are known.*

So, we can be in no doubt that the currently accepted theory of evolution is about natural selection acting on the variety created by copying errors. Are there in fact any examples of this process? Let us now return to Futuyma. In chapter eight he states *Mutations occur at random.* He explains that they are random in the sense that they are not influenced by the environment in which they would be advantageous. This is fine. But then he goes on to say .... *although we may be able to predict the probability that a certain mutation will occur, we cannot predict which of a large number of gene copies will undergo the mutation.* Futuyma gives examples of mutations in the text but all his examples are of regularly re-occurring mutations. Surely, mutations that regularly and reliably re-occur need not be viewed as copying errors?

And surely Futuyma is viewing these phenomena at the wrong level? After all, we are not sat around looking at an individual gene in order to measure evolutionary change. We must view the whole population of that gene. This discussion concerning the exact meaning of the word *mutation* may seem like just a case of semantics but this is a vitally important point. Radio-active decay may be a random process when viewed at the level of an individual atom but when a large population of atoms is viewed then radio-active decay proceeds at an incredibly reliable, predictable, non-random rate measured in half-life's. Surely, Futuyma must have at least considered the idea that the mutations required as the raw material for natural selection are actually non-random in their nature? He could then have considered the possibility that evolution does not rely on copying errors but is in fact an evolved, automated system. He seems to accept most of the tenets of Hough's theory of the ***self-developing genome***. He recognizes that mutations are the raw material of evolution. He accepts that there will be *mutator genes*, genes that influence the rate of mutation. He accepts that natural selection can act to maintain variety. He acknowledges that *neither natural selection nor genetic drift accounts for the origin of variation.* He accepts the idea of the varying or variable environment. But he rejects the idea of the universality of mutator genes because *the mutator allele is likely to decline in frequency because copies of the allele are permanently associated with the mutations they cause, and far more mutations reduce than increase fitness.* And here is the last hurdle for Futuyma to jump over before entering the brave new world of automated evolution. Hough's theory of automatic variety generation pays no regard to deleterious mutations. In the main these do not affect evolution and usually would get eliminated. His new theory relies on the existence of mutator genes that create useful variation. These mutator genes have been selected because this limited, useful variation, at the lower levels of inheritance, is maintained in order to cope with environmental variation that the heritable unit has previously encountered during its evolutionary history. The selfish, variety-maintaining mutator genes can overcome the selfishness of body-building genes which no longer have it all their own way. Complexity evolves because varying heritable units can combine in unique combinations and could create pre-adapted organisms which will prosper if an empty niche exists to which they are better suited. At least Futuyma concedes that such mutator alleles do actually occur and he cites the example of such genes seen in E. coli.

Futuyma's book is a work of immense scholarship. It covers evolution in great detail and does not hesitate to introduce the reader to some difficult arithmetic concepts but nowhere in this great book does he mention the all-important phenomenon of the algorithmic process. Hough claims that it is only by studying the outcome of a competition between millions of separate genetic algorithms that we can understand where this process leads to. Hough's conclusion is that this competition leads to the evolution of a system which is the very thing that we refer to as evolution. His contention is that systems for variety-generation and variety-maintenance were evolved at a very early stage in the history of life on earth. These systems, which endow organisms and their species with a degree of plasticity, allow them to morph their way to survival. Copying errors or random mutations are simply not necessary (although chance and probability play a part). The really complex part of evolution ended way before the ***Cambrian explosion*** when systems were evolved which allowed organisms, over time, to change from one form to another in an attempt to avoid extinction.

Futuyma's book is littered with examples of the ability of organisms and their species to morph from one form to another and he lists the numerous ways in which genomes can rearrange themselves but he refuses to acknowledge that an evolved system may be behind this plasticity. He often describes the ease with which new species can evolve in rapid radiations or can repeatably converge on the same idea but he does not recognize that systems exist to facilitate these phenomena. He accepts that the existence of variety within a population is vital for evolution and even quotes Lewontin and Hubby who asked *Do forces of natural selection maintain this variation?* but he refuses to acknowledge that there exists a system that automatically creates this variety and therefore makes evolution possible. He sticks to the opposite idea that mutations are random and *are generally thought to be not an adaptation, but a consequence of unrepaired damage.* Futuyma is wrong to state that Darwin believed in *random, purposeless variation.* Darwin was convinced that there were unknown *laws of variation.* Futuyma recognizes all the evidence for the existence of variety-generating systems; *many populations contain enough genetic variation to evolve rapidly when environmental conditions change, rather than having to wait for new favourable mutations* and furthermore he says, *Species contain genetic variation that could easily serve as the foundation for the evolution of many characteristics and that many or most characteristics should be able to evolve quite rapidly - far more quickly than Darwin ever imagined.* He even talks of the evidence for *evolution of mutation rates.* Futuyma's book chronicles the reliability of variety-generation when viewed from different perspectives. Surely he can see that this phenomenon of variety-generation must be explained by a most fundamental characteristic of all living organisms? His book describes the classic experiment on penicillin-resistance but Hough's theory would say that this experiment does not demonstrate how a genetic copying error endows anti-biotic resistance but it demonstrates that E.coli learnt the trick way back in its evolutionary history when it was previously exposed to this enemy. The variety-generating system created by evolution then ensures that anti-biotic resistance will always occur occasionally as a safeguard against the species being entirely eliminated. Similarly, the classic study of black and white moths in industrial Britain, as cited by Futuyma, is not an example of evolution at all. It merely demonstrates the existence of a system for variety-maintenance created by evolution.

Hough's ideas give no hint of Lamarckian-type evolution. There exists no design goal or aim but what has evolved is a tool kit to enable change to happen in any possible direction. The types of building blocks are limited; what creates complexity is the fact that individual cells co-operate to build organisms and sometimes this co-operation can create new and unique combinations. Futuyma's book does not tackle the most important overall question of how life navigates from simple single-celled organisms to things like humans and butterflies in a step-by-step process in which each useful step has to hit on a target which is hidden within an unimaginably large number of possibilities. The question of why evolution inevitably climbs a ladder from simple organisms is not answered in Futuyma's book but at least he provides every possible clue to the solution to that problem.

Altruism and Group Selection

Arguments have always raged on the issue of whether altruism can easily evolve and whether group selection can somehow facilitate the evolution of this trait. The opinions of Richard Dawkins and the late John Maynard Smith both lean towards the idea that selfish genes, within the group, will always overcome any advantage that altruistic genes gain due to the altruists' contribution to group fitness. Indeed they argue strongly against the importance of group selection as an evolutionary driving force generally.

Wikipedia gives an example of how altruism might be favoured. The article on Group Selection asks the reader to imagine a group composed of four selfish organisms and one altruistic organism. When a selfish organism meets the altruistic organism he wins 6 units of fitness whilst the altruist gets only 4 units of fitness. But the selfish organisms avoid other selfish organisms (because they know that they will do badly) and instead queue up for a meeting with the sole altruistic gene. In this scenario each selfish organism only gets 6 units of fitness but the altruist, because he has met selfish organisms 4 times, actually does better with 4 times 4 units of fitness. In the survival stakes, his 16 units easily outcompetes the 6 units of each selfish individual and his genes for altruism comfortably get into the future. This scenario, as outlined in the Wikipedia article, is not only highly contrived but it is also not sustainable because sooner or later an even more selfish gene will come along which, in the meeting with the altruistic gene, will take all the fitness units for himself leaving the altruist with zero fitness units. Selfish genes will always eventually win out; they will not be thinking of the survival of their species; sheer, instant brutality will always give an individual an immediate advantage.

So far, advantage Dawkins and Maynard Smith.

It is easy to demonstrate with the use of routine computerised genetic algorithms that any advantage that altruistic genes might give to themselves because of their contribution to group fitness cannot overcome the gene-level or organism-level brutality of selfish genes. Any advantage an altruist is given because of group selection will eventually be eliminated by the evolution of an even more vicious degree of brutality by selfish genes. This advantage, which is due to the presence of the altruists, is eliminated simply because the altruist himself is eliminated. Again, in this scenario, selfish genes always win out. Selfish genes easily overcome the group-level advantage given to altruistic genes because the altruists are eliminated at a faster rate than group selection can increase their numbers.

It sounds like game, set and match to Dawkins and Maynard Smith.

But surely we do observe altruism in nature? And not only due to kin relatedness. How on earth can it evolve? The answer lies with Hough's new theory. All that is needed is the appearance of a mutator gene, a gene that works behind the scenes, to ensure that the outcome of reproduction is, for example, always 50% selfish organisms and 50% altruistic organisms. The routine computerised genetic algorithm as mentioned in the previous paragraph would now need to be amended to include genes that affect the outcome of reproduction, i.e. mutator genes. Unlike the scenario outlined above, where within-group selection is more powerful than between-group selection, the odds in favour of the altruists are now improved because selfish organisms within groups cannot eliminate mutator genes hidden inside other selfish organisms. New altruistic genes can always appear because of the ever-presence of these mutator genes. In the organism versus organism competition natural selection is blind to these mutator genes. As well as natural selection, the presence of mutator genes ensures that the laws of probability now play a part in the survival of specific characteristics. We can easily envisage the extreme case of two groups, one with mutator genes (and therefore with some altruistic organisms) and one without. Because of the units of fitness which the altruists now contribute at the group level the groups containing mutator genes will now be selected along with their potential for creating more altruistic genes. The groups without mutator genes (and therefore without the accompanying altruistic genes) have no such advantage. This differential advantage, at the group level, will continue to be created and the fitness of the groups can be gradually ratcheted up via group selection. What are really being selected are the mutator genes and groups without them will be eliminated. Mutator genes survive because of their presence in both winners and losers in competitions between organisms; they do not get eliminated because they are not exposed to competition in the same way as the genes that directly create differentiated bodies and behaviours Even with the existence of these mutator genes selfish genes will never abandon their attempt to eliminate the altruistic genes. In the example as outlined above where the presence of the mutator gene ensures reproductive output of 50% selfish organisms and 50% altruists the altruists will always remain as a minority within each group. Although selfish organisms continue to outcompete altruistic organisms, the existence of altruistic genes is always guaranteed by the presence of mutator genes. If there is an advantage at the group level leading to selection for an even higher proportion of altruistic genes then these selective pressures can ultimately lead to the selection of genetic systems of the kind seen amongst social insects. All the above scenarios can be explored with computerised genetic algorithms.

Anyone interested in evolution should write their own simple programs for research. It is both rewarding and fun!

Kettlewell's Moths

In pre-industrial Britain, peppered moths were nearly all of white coloration and when they settled on the white colored lichen that covered the trees they were well and truly camouflaged. This camouflage was crucial to their survival as the moths are a tasty part of the diet of birds. However, the industrial revolution brought with it pollution which killed off the lichen and left the dark coloured bark exposed thus neutralising the camouflage advantage of the white moths. Fortunately the original moths were not all white and there was the odd black one in the population and these black ones now had the advantage of camouflage over the white ones. Natural selection was now able to swing into action and black moths survived at a much higher rate than white moths and therefore genes for black coloration were passed onto future generations at an ever increasing rate at the expense of genes for white coloration which were rapidly reduced in the gene pool. The technical name for these moths is Biston Betularia but they are commonly known as Kettlewell's moths in deference to the biologist who carried out the original field research. This classic study of natural selection in action has all the ingredients for academic discussion - change of environment, mutant black moths, struggle for existence, survival of the fittest - what a marvellous vindication of Darwin's Theory. But is it? The change from white to black in peppered moths was not an example of evolution; it was an example of a survival mechanism which evolution has created. Similarly the development of bigger muscles as a result of manual labour is also not an example of evolution but merely an example of a short-term survival mechanism conferred by evolution. The study of the peppered moth does not help us understand the evolution from simple organisms to human beings; the change from white to black demonstrates no advancement at all, it is really just a sideways movement. In fact, if the white lichen returned then the moths would revert to their white color and back to square one. In this particular example the environmental change did not encourage the evolution of the new trait of blackness. The trait was already there; the genes for that trait were already present in the gene pool even before they were needed. Interesting though it is, the ability of peppered moths to change from black to white and back again gives us no definite clues in our quest to understand evolution. If the hierarchy from simple organisms to humans can be regarded as vertical then the example of the peppered moth is a horizontal phenomenon, half way up the vertical ladder.

Of course, biologists will still jump up and down saying that the peppered moths of Kettlewell's research are a fine example of the power of the environment. I would agree that changes in the environment of the moths had a definite effect on their average characteristics but natural selection can only act on available variety. Biologists will still have to explain the source of the raw material that is essential to the well-understood mechanism of natural selection. Selective breeders rely on variety stored within the gene pool. If random mutations or copying errors are an unlikely source of this variety then what other possible mechanism could be responsible for this indispensable variety generation? In the absence of neo-Darwinian dogma there is no logical reason why we must assume that the order of events in evolution is first, environmental change and second, the occurrence of suitable mutations. The field research on peppered moths in fact demonstrates the exact opposite - suitable black coloured mutants first and environmental change second. Clearly the genome could not possibly predict the future so why do we so often find that suitable variety in ready and waiting in preparation for environmental change? The above story of the peppered moth is, like the occurrence of anti-biotic resistance, an example of the variety-creating mechanism of evolution which Derek Hough has named the ***self-developing genome***.