

GENETIC MUTATIONS AND NATURAL SELECTION – STEPS ON THE PATH OF EVOLUTION

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Abstract. It is nowadays considered that mutation is one of the most important sources of variety existent in nature. We may therefore consider that the diversity of the living world is the result of a long process of successive adaptations to the actions of the environment and that these adaptations were defined by natural selection as morphological and functional features of both animal and vegetal species.

INTRODUCTION

A mutation is a fortuitous event that doesn't have an intentional direction. It may occur anywhere, on any locus, either under the influence of environmental factors or spontaneously. It has no discernible purpose. It occurs irrespective of its consequences but its destiny is dependant of the outcomes it brings about. If we were to judge mutations by their phenotypic manifestations, they are in their immense majority, detrimental and will be therefore eliminated, together with their bearers.

We may still wonder: how is it possible that a random mutation could generate organisms that are so complicated and yet, so well adapted to their surrounding environment?

Mutations were the raw matter of evolution, the broth, the core out of which the whole diversity of the living world emerged. They are random but do not become part of the genetic permanence of a species unless they are either useful, capable of ensuring their bearers a selective advantage or neutral, that is neither advantageous nor disadvantageous from the point of view of natural selection.

Once encoded in the genetic universe of the individual, that singular and unpredictable accident will be explained and “reproduced in millions and billions of identical copies. Once extracted from the realm of the mere random, they pervade that of necessity and uttermost certainty.

As a matter of fact, selection operates upon a product of sheer hazard and has no other means of “feeding” itself but from its own field of operation that is that of rigorous exigency from which any accident is excluded.”

The opinions of geneticists have increasingly shifted in that they no longer challenge the importance of mutations but ascribes them other roles. From a classical standpoint, genetic mutations took unequal part to defining the species. In the case of those mutations that only superficially affected and modified the functions of some proteins, these events had a major contribution to the diversity of the world we witness today. On the other hand, wouldn't it be possible that they also were the starting point to the definition of the species? Difficult question to answer.

To the understanding of classical thinking on genetics, selection is the ultimate judge of evolution. It decides which mutation will be eliminated and which mutation will be included in the genetic permanence of a certain species.

Nevertheless, we should always keep in mind that selection does not operate on the genes *per se* but on the resulting individuals, thus deciding whether a certain individual should live or die.

Many a time have a lot of hypotheses been raised including the one according to which natural selection favors only the individuals that are best adapted to the environment. As G.G.Simpson put it in 1996, these hypotheses were dangerous semi-truths. Natural selection regulates evolution by means of a far simpler and more effective mechanism.

Modern genetics has given up the brutal, gladiator-like image established during the last century. The individuals that are most gifted from an evolutionary point of view have nothing more spectacular about them than the quiet, often unnoticed colleagues of them who, instead of wasting their time fighting, give birth, feed and bring up a large family of offsprings” (Carson, L.H, 1963, Heredity and Human Life, N.Y.)

Selection merely orientates the evolution but for a certain price. A population adapts itself to the environment in unequal proportions. While an ever-greater percentage of that population manages to survive, a variable percentage of individuals who are endowed with a less favorable genetic structure or suffering from detrimental mutations, will be eventually extinct. We should not forget the fact that a mutation can turn advantageous in one environment and disadvantageous, in another.

Darwin introduced the concept of “natural selection” and Hugo de Vries- that of mutation. De Vries formulated the theory of evolution based on mutations. Almost instantly, the evolution started to be considered from a solid factual perspective.

In the beginning of the XXth century, it was generally admitted that evolution was conditioned by continuous variations, by discontinuous variations and by natural selection. The discovery of genes directed evolutionism on new paths. The first methods to study the frequency of genes thus started to take shape. Fischer (1939), S. Wright (1931) and G. Haldane (1932) understood that evolution meant a shift in the frequency of genes and that it is the product of the interaction between a series of factors – mutation, random genetic processes, migration and natural selection.

The great achievements of genetics started in the middle of the XXth century and were a direct consequence of the development of the molecular genetics, of the cell genetics and of superior mathematics.

Geoffroy Saint-Hilaire insisted in the first half of the XXth century (1839) that the monstrosities - that we nowadays call congenital malformations – appear unexpectedly and sometimes have a hereditary character. He was even more surprised when he came to the conclusion that the malformations detected in one population are present as common features in other populations.

Darwin cited numerous sudden hereditary variations that may have been the bases of appearance of certain vegetal or animal species.

The history of mutationism began with Hugo de Vries. He was the one to introduce both the concept and the term of “mutation.” A survey on his discoveries proves that, sometimes, facts that are interpreted wrongly may lead to correct conclusions.

Mutation has started as one of the greatest passions of genetics. It was Morgan whom we owe the first conclusive evidence to. In 1910, he studied the first vinegar fly (*Drosophila melanogaster*) that had abnormal wings. During the following years, the number of the mutant flies increased. This way, it was not difficult for him to establish their main characteristics. Here how they were mentioned by classical genetics: “they appear unexpectedly and become manifest from the very beginning; they can affect all organs or metabolic processes”

So, what consequences does natural selection really imply? Answers to this question can also be found the past attempts to explain how natural selection really works. Edward Blythe stated that natural selection ensures the stability and not the transformation of a species whereas Darwin supported the idea that it was natural selection that acted as an agent of transformation. Still, both of them were equally right: natural selection is, indeed, both stabilizing and directing of evolution.

It would far more natural to admit that all populations are at any moment subject to mutations and that most of these mutations will be sooner or later eliminated. A small percentage though will become permanent. The game will then start again; each mutation will be swiftly lost by some population, only to fixate itself permanently in another population.

Considering matters from a classical, Darwinian point of view, we should feel compelled to admit that evolution had reached its end. Each species, be it animal or vegetal, has already established its own genetic universe and any new mutation could only have unfavorable effects.

By adopting neutralism, what we would really stick to would be a new vision on the evolution of life. Evolution is an ever-changing process that started with the formation of the first living cell and will last until the end of life. Evolution permanently enriches the genetic universe of species.

According to this modern view, evolution is to a final extent, plain random. Since the genes are no longer subject to natural selection, their frequency varies from one generation to the next only by pure hazard. Evolution may take one path or another, making complete abstraction of the environmental factors. All things considered, neutralism still raises a series of confusions.

R.C. Lewontin considers that what really evolves is a chromosome fragment, together with all its genes. Thus, the gene as an individual unit would cease to exist. It would evolve as if its effects were of no significance. J. Jacquard wondered in 1975: “Wouldn't it be that everything happens as if evolution were dictated by pure hazard?”

And yet, the mechanisms of evolution as seen by geneticists are now starting to get clearer and clearer definition. It would be risky to stand up and state that we have almost grasped the envelope of the truth and what has remained are just the details. Quite on the contrary, it is almost certain that evolution will go through transformations parallel to the general genetic acquisitions.

Evolution will never go back to square one as it is implacably irreversible. Moreover, evolution is not recurrent. Each new species is a result of unique circumstances- so numerous and particular that a reappearance of the same conditions would be practically impossible.

Evolution has never been “after” the emergence of new, flawless species as well-deserved results of billions of years of “efforts”. It simply chose from what was at hand, from what random and necessity had created.

Huxley (1974) analyzed the notion of evolution more closely: “evolution may be defined as a natural process of automatic, irreversible transformation that, during this entire process generates novelty, greater variety and complexity and, to a final extent, a higher level of mental or psychological activity and we discover that the whole surrounding reality is, in a perfectly legitimate sense a sole, broad process of evolution.” As Huxley put it, this broad process is naturally divided into three sectors. The first sector comprises the physical and chemical interactions that resulted in the evolution of chemical elements, of the nebulae, of stars and planetary systems. The second sector is that of biology, operating through automatic natural selection and which, overwritten on chemical and physiological processes, lead to the evolution

of vegetal and animal species. The third sector is that of mankind and of psychosocial development that over imposed on the natural selection factor lead to human societies and their human products.

This characterization of evolution emphasizes a series of features of utmost importance such as transformation, irreversibility, diversity, complexity of organization and, from a strictly biological point of view, it emphasized the essential role played by natural selection in the evolution of plants and animals.

CONCLUSIONS

The evolution of species has always been the main concern of biology. Even if people today no longer doubt the fact that the species in existence today derived from less evolved organisms that appeared during pre-historic geological ages, the way evolution has unfolded during the last billions of years has not yet been elucidated.

Of all the sciences related to biology, genetics has marked one of the greatest contributions to clarifying the sinuous path taken by species in evolution.

Mutation is a permanent reality in nature and has always been both the road to evolution as well as the raw matter, the essential core from which the whole diversity of the living world has evolved.

To the entire genetic thinking, selection is the ultimate judge of evolution. It alone decides which mutations will be eliminated and which - written down in the permanent code of a species, be it vegetal or animal.

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