On Evolution – A Different Perspective *

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Abstract:

Observations of recurrent evolutions have been noted for long suggesting that evolution prefers certain pathways. At the phenotype and genotype level it appears that evolution tends to arrive at certain solutions that suit environmental conditions present. Further, adaptive Laboratory Evolution studies on single celled organisms show that evolution is consistent and predictable when organisms are subjected to the same environmental Input. This paper presents a case from a different perspective and takes these observations as the starting point to propose a theory that Evolution on the whole is predictable. Only certain organisms are defined to exist as solutions in evolution space and only certain change pathways are possible and evolution necessarily proceeds along them. Presence of many regulatory networks in the organism is common knowledge supplemented by emerging understanding of Gene Regulatory Networks. Networks exist that control an organism right from birth, development, sustenance and survival. Extending this further, hidden regulatory networks are proposed to exist that activate and control organism change (speciation) as a response to environmental change. Evidence (possible cases) for such networks are proposed from literature. A key implication of this hypothesis is it eliminates the need of natural selection as a role player in Evolution. Instead the hidden networks proposed control Speciation. It proposes that beneficial mutations are the result of action of these hidden networks to initiate phenotype change (speciation).

Keywords: Evolution, Biological Systems, Evolutionary Biology, Genetics

1. Introduction

Biological systems, though they have evolved naturally, are still systems, not very different from a computer. They contain subsystems engaged in various functions within the organism. Unlike a computer these are natural systems which maintain sustenance through control networks that are part of the system (for e.g. the metabolic regulatory network). They change when the organism grows while continuing to remain stable. The method of transformation of such systems (i.e., the organisms) into a new species is the subject of the theory of evolution. Evolution states that the mechanism of change at the genotype level is random. The phenotype that is most suitable to survive sustains.

However it appears that Evolution at a broader level does not appear random. Cases of recurrent Evolution (convergent and parallel) are well documented (Cornway Morris, 2009; Wood et al, 2005). Organisms which have evolved through different lineages have shown similarity of traits. It appears that systems (representing organisms) tend to exist in certain forms only.

An explanation given about convergent evolution is by reference to Waddington’s fitness landscape where organisms fall into valleys in the rugged fitness terrain as they evolve. Is there an alternate perspective possible? This paper seeks to provide an answer.

2. Evolution in Understanding of Evolution

The understanding of Evolution has evolved over time since Darwin proposed it in 1859. The original set of ideas, in the words of Ernst Mayr (Mayr, 1982), are as follows (only the relevant points listed).

-Quote
- Individuals in a population vary significantly from one another (fact).
- Much of this variation is heritable (fact).
- Individuals less suited to the environment are less likely to survive and less likely to reproduce; individuals more suited to the environment are more likely to survive and more likely to reproduce and leave their heritable traits to future generations, which produces the process of natural selection (inference).
- This slowly effected process results in populations changing to adapt to their environments, and ultimately, these variations accumulate over time to form new species (inference).

-UnQuote

Variation among individuals is assumed to be inherent and heritable, which is acted upon by natural selection. Adaptation to the environment is thus achieved by the process of natural selection.

The Modern Evolutionary hypothesis further identified the source of variation to genetic variation among individuals in the group. Natural selection is a gradual process that acts on the group and slowly selects the fitter organism to create a new species.

With the invention of revolutionary techniques and methods in genetic engineering, the last two decades have seen a deeper understanding of the changes that occur at the genetic level when species adapt. Laboratory level tests on Evolution (Adaptive Laboratory Evolution – ALE) conducted on Bacteria under controlled environment conditions show changes in gene expression, appearance of specific mutations or sets of mutations that cause improvement in fitness levels to make the organism adapt to new environments (Cooper et

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al, 2003). Natural selection acts to weed out deleterious mutations and lets only the beneficial ones survive.

The technology used above lets scientists identify gene expression, the type of mutations after the mutation has taken place. The next level would perhaps be an attempt to understand the sequence of micro-events / reactions that lead up to the above changes. It would throw more light on the sub-processes involved and eliminate unknowns further or maybe altogether.

An offshoot of all these studies is that evolution appears to be more and more predictable. At the local level the nature of the narration has changed and it is accepted that adaptation trials in the lab are predictable. Microbes appear to be systems that respond in a certain defined way to environment input. There is less and less of stochastic effects mentioned.

Random variation followed by natural selection is at the root of Evolution. While this is the present understanding is there an alternate way of understanding? Can natural selection be eliminated? Is it just the property of the bacteria to respond in a predictable way to the environment?

3. Definition of an Organism

It is well known that the organism has many regulatory networks in it, the metabolic regulatory system, the immune system, the nervous system to name a few. The Metabolic regulatory system ensures that the conditions within a cell are maintained (in a state of homeostasis) in spite of changes in its environment. In intrinsic regulation the network responds to changes in level of substrates within the cell while in extrinsic control it responds to signals from other cells which are part of the circuit. Proteins and hormones play the role of messengers of feedback and the whole system works in a coordinated and controlled manner to ensure stability of the organism's functions.

The immune system is a network spread across the organism and serves to detect foreign bodies in the system and responds by activating complex subsystems to fight and eliminate the bodies. The Gene Regulatory Network is an omnipresent network throughout the lifecycle of the cell regulating its character and properties right from its birth tills its death by controlling gene expression. This network again involves many sub-networks which interact with each other and regulate themselves not unlike the way an administrative setup of humans involving layers of management control.

In this presentation there is a fundamental assumption made of an organism,

Definition: Every organism is assumed to be a set of Robust Regulatory Networks coexisting together, defined henceforth as *Organism*.

The qualification of robustness comes from the observation that biological systems have shown tremendous consistency and stability over the 3.5 billion years life has evolved and flourished. Systems that make up organisms are stable in spite of variations in environmental conditions. Species last for many generations before they become extinct. Not only are systems robust a key requirement for such stability is that systems should be consistent across every individual of the species. Though it seems a simple observation the fact that every individual in a species whether it is an ant or an elephant have consistent structure and system is a significant fact that speaks of the consistency of the system and of the regulatory networks that make up the same. Though differences exist between individuals they are insignificant compared to the similarities.

4. Recurrence in Evolution

It appears that nature prefers certain evolutionary pathways. Recurrent evolution (convergent and parallel) has been documented which describes the independent evolution of similar features in species of different lineages (Cornway Morris, 2009).

The shell size of the land snail poecilozonites in Bermuda Islands has changed in size repeatedly in response to temperature changes (Olson and Hearty, 2010). They were larger during glacial periods and smaller again during warmer periods. This is possibly in response to larger predator size which populated the island which was larger in size during glacial periods and vice versa during warmer times. At least 133 transitions between dioecy and hermaphroditism have been reported in the sexual systems of bryophytes in response to environment changes (McDaniel et al, 2013). A preference of dioecy was noted as more transitions from hermaphroditism to dioecy was observed than the reverse case. In plants of different species lineages a particular type of photosynthesis, the C4 type, has evolved over 60 times by altering gene expression and adaptive changes in the protein coding regions in the genome (Christin et al, 2012).Many divergent eukaryotic lineages have recurrently evolved highly AT-rich genomes (Maeso et al, 2012).

Convergent evolution describes the independent evolution of similar features in species, which do not share a common ancestor. Many common traits evolved in the marsupial fauna of Australia and the placental mammals of the Old World though the two lineages are different clades which evolved in continents geographically separated. A well-known examples of convergent evolution is the camera eye of cephalopods (e.g., squid), vertebrates (e.g., mammals) and cnidaria (e.g., box jellies) which have similarities in structure though evolved from different ancestors (Kozmick et al, 2008).

Observation: There are certain standard phenotypes (and genotype) in nature that seem to evolve over and over again. There appear to be specific stable systems (representing organisms) that nature chooses over and over again. Based on this the following hypothesis is made.

Hypothesis 1: Only specific solutions (of *Organisms*) consisting of a set of specific subsystems can exist in *Phenotype space*. These make up a set called *OrganismGroup*.

OrganismGroup refers to the set of all natural solutions (*Organisms*) that can survive and are stable species (this includes all stable species that have ever lived and will live). Subsystems refer to elements that make up the organism – the body plan (limbs, eyes, etc.), the respiratory system, metabolic system, etc. This hypothesis suggests that organisms of only certain types can exist as stable solutions. Arbitrary combination of subsystems – 5 legged dogs, 3 eyed fishes, etc. are not possible. It emphasises that life solutions are not arbitrary and random. There are only a certain set of solutions possible though that number is large including all the species that ever existed and will in the future. Qualification of natural is to eliminate man made solutions like GM crops.

Phenotype space refers to all possible solutions of every combination of subsystems, which is arbitrary and infinite. It will include such examples as above – 5 legged dogs, which may be possible to be created in the laboratory. It also includes organisms born with mutational defects (for e.g. Siamese twins).

Hypothesis 2: There are only specific subsystems that make up solutions in the *OrganismGroup*

Subsystems encompass all traits that make up the organism.

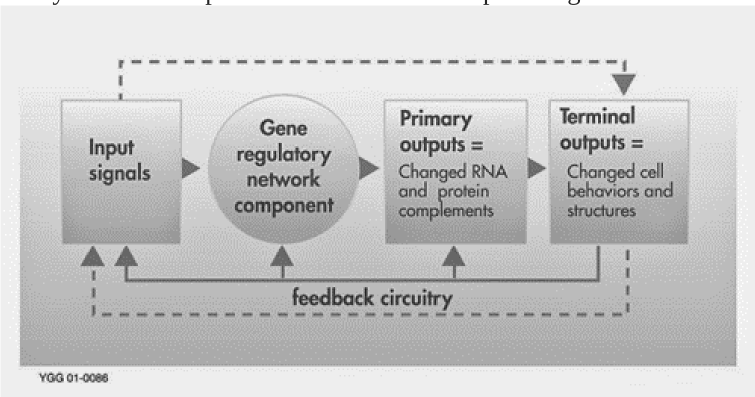

Figure 1 : Model of a Gene Regulatory Network

These include body plan, types of regulatory systems of metabolism, respiration,etc, methods of mobility, methods of defence from prey (like camouflaging etc.), methods of predation, methods of foraging, etc. which make up the stable functioning of the organism. This hypothesis emphasises that the set of these subsystems is not arbitrarily large and random. *OrganismGroup* consists of only specific sets of these subsystems (not all possible combinations of these subsystems).

5. Observation of repeatability in trials of artificial evolution
Many laboratory trials on evolution on microbes (bacteria, yeast) reveal repeatability in gene expressions. Lenski and Travisano (1994) studied adaptation in lab trials on 12 lines of Escheria coli in a Glucose limited minimum salts medium over 10000 generations. All the 12 populations had similar trajectories of cell size and fitness over time. This work was extended by Cooper et al (2003) over 20000 generations and observed parallel changes across all strains. They also tracked gene expression changes and found them to go in parallel. They observed that parallelism extended to gene level in 8 of the 12 populations. Fong et al (2005) found that quantitative measurements of the growth phenotype throughout evolution revealed a generally convergent growth phenotype at the end of adaptive evolution despite apparent divergent evolutionary paths. Stroebel et al (2009) observed that strains adapt with a repeatable pattern by up-regulating a single pair of genes on the periphery of a regulatory network, suggesting that regulatory networks may evolve novel structures in a rapid and predictable manner.

Observation: The implication of this is that Evolution in the laboratory is consistent and repeatable.

This observation is taken as the basis to propose that, it is a basic property of *Organisms* in the *OrganismsGroup* to respond in a specific manner to specific environmental Inputs.

Hypothesis 3: Only specific solutions-of-change, *ChangeSolutions*, (from one *Organism* to another) exist for specific environmental Input. The set of such *ChangeSolutions* make up the set *ChangeGroup*.

This says that under a given environmental input a solution A (say species A of an organism) will change only to solution B (say species B of the organism) under a given environmental Input C. Change of organisms is not arbitrary.

6. Regulatory Networks

The presence of many regulatory networks in the Organism was discussed. Of particular significance is the Gene Regulatory Network knowledge of which is increasing with increasing focus on genome studies. These are networks inside the cell which regulate the functioning of the cell by controlling gene expression. They are complex networks which are modular, hierarchical and interconnected. The networks rely on feedback to control themselves or communicate with each other. Most such signals would be in the form of proteins that sometimes travel through cells to a distant location to complete the network action.

Figure 1 shows a typical Gene Regulatory Network. There are many functions of such networks.

a. Networks controlling gene expression within a cell executing its regular function. Genes are turned on or off controlling protein generation in response to cell condition and environment giving the cell its physical properties.

b. Networks that control cell differentiation during the development phase of an organism. During embryogenesis they regulate gene expression which effectively controls which cell takes what form at which location and at what time during development.

c. Networks that control and ensure that cell identity is passed on during cell replication in adult cells.

d. Networks that control survival by responding to changes in environment as reported in Bacterial Regulatory Network studies.

Bacterial Regulatory Networks:

Bacteria are able to survive in various environment conditions – inside mammals (in the lower intestine), in sewers, in rotten food, where nutrient availability and temperature are very different. They regulate their metabolism in response environment conditions to survive. Nobel laureates François Jacob and Jacques Monod (1961) showed that bacteria respond to environmental signals by expressing (turning on) or repressing (turning off) certain genes, by a process known as transcriptional regulation. The presence or absence of small molecules (e.g., nutrients, salts, and molecular species) or physicochemical states (e.g., temperature, redox potential, and osmolarity) are sensed by Network elements which coordinate the cell response. For example, in E. coli, Salmonella typhimurium, and some bacilli, low concentrations of oxygen function as a stimulus for aerotaxis (chemotaxis to oxygen), whereas high concentrations work as a signal to activate aerobic respiration. However, very high oxygen concentrations impose an oxidative stress on bacteria, thus activating specialized systems to cope with stress. If the stress-adaptation systems fail or the oxygen levels continue to increase, then the cell will cross a point of no return and it eventually dies (Cases and de Lorenzo, 2005).

Observation: Regulatory Networks thus exist for controlling an organism from birth, growth, sustenance and survival.

Extending this further it is suggested that such Networks exist that control change of one organism to another in response to environmental input.

Hypothesis 4: Hidden Regulatory Networks, *ChangeRN* exist within the organism that control *ChangeSolutions* of the *ChangeGroup*

Hidden Regulatory Networks, called *ChangeRN*, exist within the *Organism*, that control change from one phenotype to another (during speciation) for all *ChangeSolutions* that make up the *ChangeGroup*. Hidden, in this case, means that these networks are normally dormant and get activated only by specific Input from the environment. These are described in more detail below.

7. Mutation

Mutations can be of many types, beneficial, neutral or deleterious. While by definition an strand of DNA can be subjected o mutation, the existence of mutational hotspots within the genome which cause significant phenotype changes is noted in literature (Rogozin and Pavlov, 2003). Hotspots are specific regions in the DNA, the change of which causes large changes in the phenotype. Further Cis-regulatory elements are also frequent targets of mutations resulting in varied morphology (Stern and Orgogozo, 2008). Only certain beneficial mutations cause change of phenotype while other mutations are either neutral or neutralised through DNA repair. Stern and Orgogozo (2008) have suggested that the evolution of morphological traits proceeds primarily through regulatory mutations, while the evolution of physiological traits more often involves functional mutations to coding sequences.

Observations: Changes in the phenotype are traceable to specific beneficial mutations, either regulatory or functional.

Hypothesis 5: Specific beneficial Mutations which affect gene expression and function are the targets of the mechanism of *ChangeRN*

Since the *ChangeRN* achieves phenotype change by targeting genotype changes beneficial mutation is an obvious candidate for the same and hence the hypothesis.

8. Hidden Networks

This theory suggests that such networks exist within the system itself for obvious reasons. The reason they are called Hidden networks is because they are not active normally and would come into picture only when the relevant change input is sensed. It is important to note that there is no 'whole more than sum of parts' effect or any other effect that is outside the laws of physics that is suggested. Every interface between the elements and the interaction that happens between are to be within the norms of science. It is not different from how a seed, a dry and apparently lifeless stone-like piece of matter suddenly springs to life shooting out a stalk and roots when it comes in contact with water. Apparently the system of life is well in place in the seed and requires just a last joining element to make the system get going.

In order to propose the mechanism of the *ChangeRN* reference is taken of the construction of the Bacterial Regulatory Network. A set of networks work to control the response of Bacteria to environment changes. Sets of genes, the operons, the regulons and modules form a heirarchical structure that governs gene expression. These are coordinated by Global Transcription factors to achieve a common goal (Gottesman, 1984), transcription regulation being a key component of this network.

Figure 2 shows a schematic representation of the modular nature of a Bacterial Regulatory Network network. (Freyre-Gonzalez et al, 2008). "Four components shape the functional

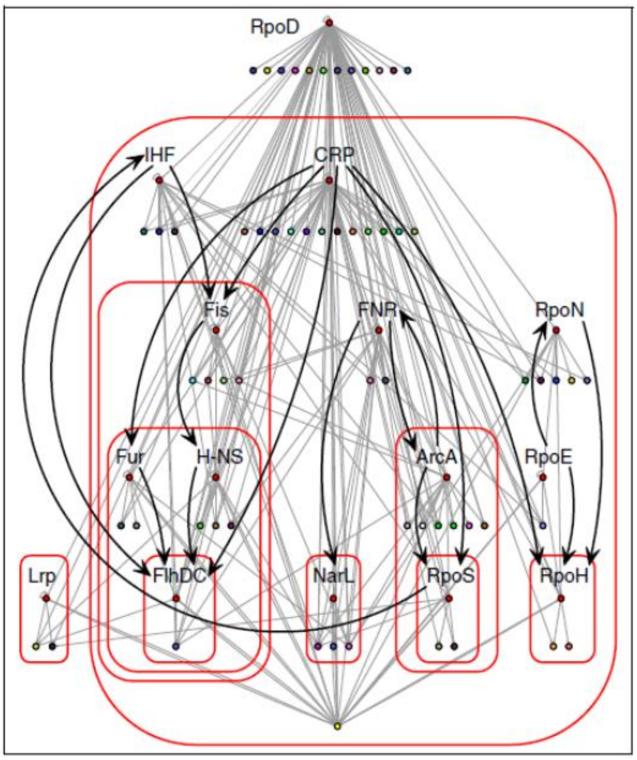

Figure 2: Hierarchical modular organization map of subroutines comprising the genetic program in E. coli. Each color represents a module, while hierarchical TFs are shown in red. Black arrows indicate the regulatory interactions between hierarchical TFs

architecture of bacterial regulatory networks: 1. global transcription factors, which are responsible for responding to general signals and for module coordination; 2. strict, globally regulated genes, which are responsible for encoding products important for the basal machinery of the cell and are only governed by global transcription factors; 3. modular genes, which are modules devoted to particular cell functions; and 4. intermodular genes, which are responsible for integrating, at the promoter level, disparate physiological responses coming from different modules to achieve an integrated response. All these functional components form a nonpyramidal, *matryoshka*-like hierarchy exhibiting feedback. In this functional architecture, well-defined independent modules are globally coordinated by global transcription factors, whose disparate physiological responses are integrated, at the promoter level, by intermodular genes." (Freyre-Gonzalez et al, 2010).

Networks of regulation in the Bacteria have a modular and hierarchical structure, with modules executing dedicated functions and higher order modules coordinating the lower ones. They would respond to Input, exchange feedback, with a higher order unit ensuring stability of the network and controlling its response.

The *ChangeRN* is proposed to have a similar formulation but with the aim of sensing Input, integrating the response and passing it on to the next generation. A conceptual sketch of the network is proposed below

1. The *ChangeRN* would consist of many Basic modules (BasicM) for local sensing and feedback
2. There would be a main coordinator module (Co-ordM) which would control the interaction between modules and integrate their feedback
3. Input from the environment may be sensed by the BasicM or the Co-ordM.
4. The BasicM gives response feedback (based on Input) to the Co-ordM which coordinates the overall response of the organism
5. The *ChangeRN* responds by causing change in the genotype depending on the Input from the environment and ensures that it is then passed on to the next offspring
6. In a complex multi-cellular organism there could be multiple sub-networks nested inside the BasicM and CoordM ensuring control and integrating its response.
7. There may be more than one *ChangeRN* in the organism whose actuation will depend on Input. Some may coordinate fine adaptations targeting regulatory genes in response to fine environment changes and some may coordinate major physiological changes (change to a higher order form) targeting toolkit genes in response to significant changes in environment.

The *ChangeRN* works like an open loop type controller without feedback (since feedback can be acquired only by the next generation). The level of response would depend on the level of Input and would be intended to make the organism work with that Input. Though that is the intention it is important to make clear that the *ChangeRN* does not have a goal at the outset. Each reaction is an inbuilt response to Input. Thus the new Generation might be suitable to work with an Input that may quite well be less than the actual Input. So the *ChangeRN* again comes up with a response, this time of a lesser magnitude (since the difference between expected Input and actual Input would be less now). Thus the change would follow an asymptotic curve which is reported by Lenski and Travisano (1994). This is also in agreement with the known fact that adaptation is a gradual process.

The *ChangeRN* reaction, however, may be spontaneous in case of a genus change. The author believes this *ChangeRN* network may be a different network and responds only to a specific set of Input when it would trigger a major reaction which would cascade a set of reactions to change the physiological makeup of the organism. It would probably have the toolkit genes as its target. Once the organism is born it would then slowly adapt to the environment by the work of the Adaptive *ChangeRN*.

What could form the Input: The Input obviously would include the environmental condition, the food habitat and predator condition. The Input could be internal (defining the state of the organism). The Input could be external through the organism's sensors. The Input could be a collection of sensory Inputs. It could be a set of Inputs accumulated over time. The Input could be related to stress (difficulty the organism faces in acquiring food) or it could be pleasure when the organism engages in playful activity (when there is food surplus).

a. Group Input may be possible. When a group changes form, after a particular percentage of individuals change the group change input may be sensed by others to complete the change. This Input could be in the form of a visual input or a stress call.
b. Learning of the present life may serve as Input to the *ChangeRN* to calibrate its response.

Where is the *ChangeRN* likely to be located?: It could be located over a large area in multicellular organisms with its arms extending into key subsystems. In single cell organism would it lie somewhere in the Gene Regulatory Network?

Is there evidence of this type of Network?

The author suggests a candidate for this type of a network in single celled organisms. It has been reported by many researchers (Irma Lozada-Cha´vez et al, 2006 ; Conrad et al, 2011) that regulatory mutations or mutations of Transcription Regulatory Networks (TRN) cause maximum change in phenotype expression. Domkiaer et al (2013) emphasise the importance of regulatory mutations, which result in reorganization of cellular networks in such a way that beneficial phenotypes are maintained. Elena and Lenski (2003) note that, many of the evolutionarily important mutations are found in global regulatory genes rather than in genes that might improve single enzymatic steps.

It appears that most adaptive mutations target the TRN. Since the TRN appears to be active in responding to environment changes it is suggested **that the *ChangeRN* of single celled organisms reside in the TRN**. Mutations that are reported above are caused by the TRN. As a response to environmental input the TRN directs changes in its own structure by causing mutations.

What are the Implications?

There are four key implications

1. Natural selection (selection of fittest among natural variants) is not needed to explain speciation. Fitness change is controlled by *ChangeRN* which ensures the fittest organism evolves.
2. Change in genotype (Mutation) is caused and controlled by the *ChangeRN*.
3. Every reaction to Input exists as a predefined Solution. There is no purpose or goal in the *ChangeRN* actions.
4. That the tree of life is predefined comprising all the solutions of OrganismGroup.

The third point is critical and also provides an explanation of development of symbiosis or ecosystems. Every *ChangeRN* response is dependent on environment input. If *ChangeRN* response of two (or more) organisms of an earlier generation happen to aid each other such that the Input in the present generation meets each organism's present expectation then the system of both the organisms stabilise and they exist symbiotically. The same applies for ecosystems. Considering that all *ChangeRN* reactions are defined it should theoretically be possible to arrive at Solution sets of such Organism combinations which can exist stably.

The last implication appears incredulous -- that the path of change of all living systems is predefined. They change from one to another only under certain environmental conditions. When a group of laurasiatheria changed form to become bats millions of years ago they responded to certain environment conditions that prompted their *ChangeRN* to act. In this theory this is the way that Organism is set to be – to change under certain specific conditions and there is no other explanation to it.

This may sound strange. But one way this can be addressed is by the line of debate that – if one accepts the existence of a plant sapling, with all the complexity of its regulatory system, the genetic regulatory networks, the DNA sequence, etc as normal, then one might as well accept the complexity that the whole tree of life represents. Either accept complexity of life in nature in full or don't, there cannot be a middle case (a variant of the law of the excluded middle). Similarly, if we accept adaptation in the lab as a predictable reaction to specific environmental input (however complex the processes involved are) then we might as well accept the whole list of transformations of all organisms to environmental input, of all speciation events, of all phenotype changes that occurred in history and will in future.

However there is plenty of order in evolutionary systems and it should only be natural that there should be patterns in the types of transformations of organisms.

Hypothesis 5: That the methods of *ChangeRN* should be classifiable and reducable

This is pertinent to this theory as a change direction is proposed to exist for every type of input to the organism. This would make an enormous list. Every time an insect meets with stress it would respond– this theory says that for a given input of stress the *ChangeRN* would respond by giving a direction to, say, camouflage in a particular way (to be executed by its offspring). This would apply for every response of every organism, the beak of the finch, the finger layout of a monkey's hand and so on. The list is huge.

However Conway Morris' extensive study on Convergent Evolution (Conway Morris, 2009) reports that evolutionary convergence is far more widespread than is generally appreciated, with the implication that the number of functional solutions is limited. He suggests that "one consequence is that much of the Tree (of Life) may have what is effectively a pre-determined shape". And that there is perhaps a limited number of adaptive solutions upon which the processes of optimization is employed.
This author interprets this as indicating that there are probably a lot of commonalities in the *ChangeRN* solutions. Organism (or the system that it represents) of different types seem to be made up of similar subsystems. This could be a reflection of the constraints (at the genotype level) of generating Stable systems which can survive. So it is possible that the list of *ChangeRN* solutions may not be abnormally large.

Further questions remain, a) Do all the organisms in the group change only when the trigger is actuated in every individual or change of group of organisms itself provides a trigger for others to change? b) Does the input consist only of the input from the typical sensors in the organism of sight, smell, sound or does it involve some other form of sensing that is not part of the above? c) Is the mechanism of change different for evolution of a genus and higher level classes? Are there different networks for genus change? Will positive living conditions – surplus availability of food and availability of excess time cause a different set of Input to trigger a network for genus change? Do these networks remain dormant most of the time or are they active most of the time?

9. A Relook at the Approach

A fundamental aspect of Evolution is that all variety (across species, genus, etc.) seen in organisms start with uncontrolled stochastic variations at the genetic level on which natural selection works. Instead an alternative is suggested that this change is controlled or defined for each type of change for each type of environmental input. There are three arguments on which this theory is based,

Physical limitations of Complex systems

Here the author is making a case that it is logical to expect existence of only certain solutions (or organisms) of living systems in systems space and also certain transformations from one to another.

It is fair to make a statement that Evolution at some point in time would need to be explained to the last molecular detail when all the mechanisms involved would be understood in complete detail based on the laws of Physics. Physics on which all of science is fundamentally based proceeds in two directions (author's classification). The first is the depth-wise direction, where the attempt is to discover fundamental connections among different laws and arrive at generalized laws which apply under certain conditions. For example the Weinberg-Salam ElectroWeak force theory unites the Weak force and Electromagnetic force at temperatures of the order of 10^15 K. At normal temperatures the forces manifest as separate forces.

The second direction is the system-wise direction where the behaviour of systems of particles or objects are studied. The types of solutions possible, the behaviour of such systems (represented by variables for each element), etc are derived by arriving at solutions to differential equations representing the system. Laws constraining the behaviour of the system, like conservation of energy, momentum or mass are used to derive equations predicting behaviour of group variables like temperature, pressure. Such equations predict the possible states the variables can be in and the change in state that happens over time. Natural systems like weather or behaviour of ocean currents belong to this class. Also belonging to this class are living systems, multicellular or single cellular organisms, subsystems within organisms, all of which are classified as self organizing systems though they are far too complex to be reduced to differential equations.

As one looks at such systems, is there an observation that can be made regarding the states they can exist in? And the limitations of change from one to another. By state of a system is meant the state of its different parameters. For example the humidity, temperature and pressure define the state of the weather at any moment.

Systems with more and more strong interacting elements have less number of stable states compared to systems with less interacting elements. So also, the change paths from one state to another also get reduced in systems with stronger interacting elements. It is only natural that more and more constraints force systems to take only certain states.

This can be explained with an analogy. Let's start with the case of two billiard balls on a billiards table. Let them have a starting velocity and let us neglect friction. Defining a state as the coordinates the balls would be at a given instant, would they visit all possible coordinate sets on the table if one waits long enough? Instead of yes or no as the answer let us say the number of states would be very high. Now let us charge the balls with opposite charges of high strength. Unarguably one can say that this will limit the number of states. Over time either they will join together or keep circling each other like binary star systems.

Self organizing systems are those with high level of interaction among constituents and would tend to occupy only specific states or solutions in evolution space. It follows naturally that the change paths from one to another would also be specific – under certain input state A would only change to state B (or C or D) for Input P. For example when the above system is in the binary-star mode, say, the charge is suddenly reduced. They would probably settle into a different orbit (a different state).

Data of convergent evolution (in paleontological studies) and repeatability in lab studies on evolution support this observation.

So a case is being made that there are only certain types of organisms possible and only a certain type of change from one to another in evolution space under certain environmental Input. So Evolution has a particular route laid out which it takes and the route is influenced only by the environmental conditions.

Repeating Observations a law?

Here the author is making a case that patterns of repetitive observations of, say, speciation in the laboratory need be enshrined as laws just like it is in other faculties of Science.

Science at the basic level is about observing order or patterns of observations and framing laws explaining them. Boyle's law is the result of the observation that pressure increases with temperature in a given volume. Though the mechanism behind the law is not immediately apparent a law is proposed still. Observations on living systems need be no different.

A most significant observation would be repeatability in species' change when exposed to the same environmental Input. Organisms, like Drosophila Melanogaster, when subjected to the same food habitat probably tend to take the same form (of species). If this is seen in trials then this is no different from observations in the bubble chamber by particle physicists of repeatability in the behaviour of certain particles under certain initial and boundary conditions, which makes them propose a theory of existence of a new particle. Let us assume for arguments sake, over the course of time that many such consistent and repeatable observations are made of speciation (of different types of organisms). Probably the most apt observation would be to recognise this and call it a law (of repeated behaviour in evolution space). The mechanism at the root of this law would be a subject of subsequent study – to understand which input is causing what change. This, in the authors opinion would be a more clear approach than explaining this finding (of such order in living systems) by proposing an explanation of a stochastic process deep down which was acted upon by another process (natural selection) to produce the final ordered form.

Why not control network for change?

Living systems abound with order. There are many regulated sub-systems (of metabolism, reproduction, respiration) that are being detected everyday by numerous researchers in various organisms. It is amazing to read about the complexity observed in natural systems reported in Bio-Technology research as well as BioMedical research while at the same time appreciating the order that goes into the control networks that ensure their stability. The Genetic Regulatory Network regulates gene expression during the life cycle of a cell including morphogenesis. The Bacterial Regulatory Network which is an extension of the GRN regulates the organisms survival by responding to changes in its food habitat. Effectively this means there are regulatory networks at every stage in an organism from birth (in the form of a single cell) till death. Can we extend this to say such networks exist that regulate the structure of the cell that is yet to be born?

Living systems from a larger perspective show more order than disorder. This theory proposes that there is order all the way through which includes the mechanism of transformation of organisms.

10. What is the point of departure from Darwins theory?

A fundamental aspect of Evolution is that all variety (across species, genus, etc.) seen in organisms start with uncontrolled stochastic variations at the genetic level on which natural selection works. At the fundamental level Darwin's theory almost starts with a blank slate with any kind of organism being theoretically possible and any kind of change possible. However there are only certain types of organisms seen and only certain types of their change. This is explained with an analogy of Waddington's fitness landscape where organisms tend to fall into valleys in the fitness terrain.

The proposed theory does not use this analogy and instead attempts to give an alternate explanation where the organism is not considered to be an equilibrium solution, that a passive system stabilises into (among natural constraints). It takes a diametrically opposite view and says that organisms are fundamentally active systems that change form (predictably) in response to input much like how water moves from a solid (ice) form to a liquid (water) form in response to the input of heat. And they are stable in each form unless the environment changes drastically. They are networks that move from one state to another under certain Input. Equilibrium is only achieved amongst a group of different organisms forming an ecosystem.

11. Is this theory falsifiable?

It is falsifiable by establishing that evolution is not consistent – that, when species exposed to the same environment input do not change to the same form.

By establishing the absence of hidden networks or a control system that controls change. This can be done, for example, if all the molecular changes that occur as a single cell organism changes form is explained as due to an uncontrolled process. This sounds weird, but nevertheless, in principle is possible and so the theory can be falsified.

On the other hand it can be proven if hidden networks of control are found to control change in organisms. In fact in the author's opinion the best approach would be to identify networks that regulate change in speciation in single celled organisms. If they are found to exist then before proceeding to multi-cellular organisms it may be better to understand the limits of these networks by varying the environmental input by large extents.

12. Summary

- A new theory is suggested where phenotypes and their transformation paths are proposed to be specific and finite solutions in evolution space.
- Hidden networks are hypothesised to be present in organisms which react to environmental stimulus, initiate and control transformation of an organism from one species to another.
- These transformation paths are proposed to replace natural selection (following mutation and other genotype variation) as the process of speciation.
- This theory can be proved by discovery of such networks during speciation studies in the laboratory.

Acknowledgements

A confession: This author is from an entirely different field, Automobile Engineering. There may be shortcomings in the presentation for obvious reasons in terms of the extent and details of literature quoted. However the author believes they do not affect the crux of the argument and the proposal. This is a presenation of an idea from the perspective of an outsider and the author hopes the reader would understand this and would like to acknowledge the reader first.
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