

mybiology

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Preface

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1 Introduction

1.1 Research question

One of the key questions that an evolutionary analyst can try to answer is what are the **mechanisms** that explain or direct the escalator of progress, whether this is the “struggle for existence” between individuals, nations, races, etc.

Another question that the evolutionary analyst can try to resolve is whether the individual **permits the struggle** to take place and, if not, to what extent this weakens the individual and, therefore, that the individual enters into a process of degeneration that leads to a replacement by another individual.

1.2 History

The concept of evolution, in the sense of a gradual development or change over time, has been a subject of contemplation and inquiry for civilizations throughout history. While ancient civilizations may not have had access to the scientific methods and knowledge that underpin modern evolutionary theory, they did observe and speculate about patterns of change in the natural world. For example:

1. **Ancient Greece:** The ancient Greek philosophers contemplated the origins and development of life, the diversity of species, and the process of change in the natural world, proposing early ideas that laid the groundwork for later theories of evolution. The pre-Socratic philosopher Anaximander proposed a theory of evolution where life originated from a primordial substance, the “apeiron”, which evolved over time through a process of spontaneous generation and transformation. He speculated that simpler forms of life gave rise to more complex organisms, anticipating the idea of a progression or development of species. Almost one hundred years later, Empedocles in his *Theory of the Four Elements* proposed that all matter was composed of four fundamental elements - earth, air, fire, and water. He suggested that living organisms arose from combinations of these elements, hinting at a process of transformation and change over time.
2. **Aristotle (384 – 322 BCE):** Aristotle proposed a scala naturae (Great Chain of Being), which depicted a hierarchical order of existence with all living beings arranged in a graded scale from simple to complex. While not a theory of biological evolution, Aristotle’s ideas influenced later thinkers and shaped medieval and early modern views of nature.

Atomist philosophers such as Leucippus and his student Democritus proposed a materialistic view of the universe, suggesting that all phenomena could be explained in terms of interactions between atoms. While their ideas differed from modern evolutionary theory, their emphasis on naturalistic explanations contributed to humanity's ongoing quest to understand the origins and development of life on Earth, and opened the possibility of variation and change in living organisms.

2. **Ancient India and China:** Ancient Indian and Chinese philosophies also explored ideas related to the origins and development of life. For instance, Hindu and Buddhist cosmologies include concepts of cyclical time and reincarnation, which imply a process of change and evolution, and they are early attempts to understand the natural world and humanity's place within it. While not explicitly addressing biological evolution, Daoist texts such as the "Zhuangzi" and the "Dao De Jing" contained passages that reflected a cyclical view of time and the continuous transformation of the natural world. Central to the Chinese cosmology is the Yin-yang theory, which posited the dynamic interplay between opposing forces. This concept of balance and change informed Chinese views of the natural world, including notions of growth, decay, and cyclical renewal. While early Buddhist texts did not discuss biological evolution, the idea of continual change and the cycle of birth and rebirth suggested a broader understanding of evolutionary processes. Hindu cosmology, as outlined in texts such as the "Puranas" and the "Bhagavad Gita," described cycles of creation, destruction, and rebirth spanning vast epochs of time. The concept of "yugas" or cosmic ages implied a process of change and evolution within the universe.
3. **Islamic Golden Age:** During the Islamic Golden Age, scholars like Al-Jahiz in the 9th century proposed a rudimentary form of natural selection in his work "Kitab al-Hayawan" (Book of Animals), where he speculated about how organisms compete for resources and adapt to their environments, suggesting that those best suited to their surroundings are more likely to survive and reproduce. Muslim philosophers such as Al-Kindi, Al-Farabi, Avicenna (Ibn Sina), and Averroes (Ibn Rushd) engaged in philosophical speculation and inquiry, drawing upon Greek, Persian, and Indian sources. They explored concepts such as the eternity of the universe, the nature of causality, and the possibility of spontaneous generation. Islamic scholars, including physicians, astronomers, and natural philosophers, observed and studied the natural world, including plants, animals, and celestial phenomena. While their inquiries focused primarily on practical and empirical aspects of nature, they contributed to a broader understanding of the diversity and complexity of life.
4. **Indigenous Cultures:** Indigenous cultures around the world often developed rich and diverse cosmologies, creation myths, and oral traditions that reflected their understanding of the origins and development of life, and about the diversity of species. These stories usually include elements of change, adaptation, and transformation over time, and offer unique insights into humanity's relationship with the natural world. Many indigenous cultures viewed time as cyclical rather than linear, with recurring patterns of creation, destruction, and renewal. This cyclical perspective encompasses the idea of continual

change and transformation in the natural world, including the evolution of species over time. Some indigenous cultures have interpreted fossils, geological formations, and natural phenomena in ways that reflect their cosmological beliefs and spiritual worldviews. These interpretations differ from Western scientific explanations but provide cultural perspectives on the history and diversity of life on Earth.

While these historical perspectives on evolution greatly differ from modern scientific understanding, they reflect humanity's curiosity and attempts to make sense of the natural world and its processes of change. The development of modern evolutionary theory represents a culmination of centuries of scientific inquiry, observation, and experimentation, building upon and refining earlier ideas and insights.

In the centuries preceding Charles Darwin's formulation of the theory of evolution by natural selection, several thinkers proposed ideas and concepts that contributed to the development of evolutionary thought. Some of the main thinkers of evolution in pre-Darwinian times include:

3. **Lucretius (c. 99 – c. 55 BCE):** A Roman poet and philosopher, Lucretius wrote “*De Rerum Natura*” (On the Nature of Things), in which he espoused a form of atomism and proposed ideas about the origins and development of life through natural processes.
4. **Georges-Louis Leclerc, Comte de Buffon (1707 – 1788):** Buffon, a French naturalist, proposed theories of transmutation and transformation of species in his work “*Histoire Naturelle*” (Natural History). He suggested that environmental influences could lead to changes in organisms over time.
5. **Jean-Baptiste Lamarck (1744 – 1829):** Lamarck, a French naturalist, proposed a theory of evolution based on the inheritance of acquired characteristics. He suggested that organisms could change over time in response to environmental pressures, and these acquired traits could be passed on to offspring.
6. **Erasmus Darwin (1731 – 1802):** Erasmus Darwin, an English physician, naturalist, and grandfather of Charles Darwin, proposed evolutionary ideas in his work “*Zoonomia*” and other writings. He suggested that life evolved from simpler to more complex forms through a process of gradual transformation.

These thinkers and others contributed to the development of evolutionary thought in pre-Darwinian times, laying the groundwork for Charles Darwin's theory of evolution by natural selection in the 19th century. While their ideas differed from modern evolutionary theory, they reflected early attempts to understand the origins and development of life on Earth.

In the centuries preceding the formulation of Charles Darwin's theory of evolution by natural selection, various ideas and concepts about the origins and development of life were proposed by philosophers, theologians, and naturalists. These pre-Darwinian ideas laid the groundwork for later evolutionary theories. Some of the main ideas about evolution in pre-Darwinian times include:

1. **Great Chain of Being:** The concept of the Great Chain of Being, prevalent in ancient Greek, Roman, and medieval Christian thought, posited a hierarchical order of existence, with God at the pinnacle and all living beings arranged in a graded scale from simple to complex. While not a theory of biological evolution, it implied a continuum of life forms and the potential for change over time within a fixed, predetermined framework.
2. **Transformational Theories:** Some ancient philosophers, such as Empedocles and Anaximander, proposed ideas of transformation and change in the natural world, suggesting that living organisms arose from combinations of fundamental elements or evolved from simpler forms over time.
3. **Vitalism:** Vitalism, a prominent idea in the medieval and early modern periods, proposed that living organisms possessed a vital force or essence that distinguished them from inanimate matter. While not explicitly evolutionary, vitalistic concepts contributed to debates about the nature of life and its origins.
4. **Spontaneous Generation:** Spontaneous generation, the belief that living organisms could arise from non-living matter under certain conditions, was a widespread idea in antiquity and the Middle Ages. This notion suggested a form of continuous generation and transformation of life forms but did not imply a process of biological evolution as understood today.
5. **Transmutation of Species:** Some naturalists in the 17th and 18th centuries, such as Jean-Baptiste Lamarck, proposed theories of transmutation or transformation of species. Lamarck's theory, for example, suggested that organisms could change over time in response to environmental pressures and that acquired traits could be passed on to offspring.

Overall, these pre-Darwinian ideas about evolution reflected early attempts to understand the diversity and complexity of life on Earth. While they did not constitute a comprehensive theory of biological evolution, they contributed to the intellectual foundations upon which Darwin later built his groundbreaking theory of natural selection.

1.3 Role Biology

The introduction of Biology has these forms, el conjunto de las cuales muestra una línea creciente de aportación a la profundidad del análisis económico y al papel más ligero o pesado en el que interviene en la resolución de problemas complejos:

- **Biology as a theoretical framework,** sienta las bases conceptuales y relacionales sobre las que iniciar un análisis complejo en ciencias sociales y en economía. Se trata de un marco teórico que sirve de inspiración para afrontar una primera explicación o una ampliación de la explicación de un problema social complejo sin tener que recurrir a un largo proceso de construcción teórica. Esto no significa que la teoría biológica sea

siempre asimilada por la económica, sino que esta última sirve como espejo sobre la que construir un andamiaje teórico de forma más robusta y rápida.

- **Biology as a metaphor**, esto nos permite mejorar la explicación de los fenómenos económicos y reforzar nuestros argumentos al utilizar cadenas causales que ya están investigadas y demostradas en biología
- **Biology as a paradigm**, nos permite enfrentar el análisis económico teniendo delante un marco causal ya demostrado que podemos usar como referencia, tanto en el uso de los conceptos como en los flujos de interacción entre ellos. Digamos que el análisis económico no parte de cero ni necesita inventar un andamiaje metodológico y conceptual cada vez, sino que podemos recurrir a la biología para que nos aporte un marco de reflexión y pensamiento (que podemos ir adaptando a las estructuras y comportamientos que vamos descubriendo en economía) y que nos ahorra mucho tiempo y esfuerzo.
- **Biology as a canvas** to draw computational methods directamente aplicables a los procesos de resolución de problemas, i.e. captura de datos, modelos lógicos, procesamiento y funcionamiento de la información e interpretación de los resultados. Esto facilita y amplía nuestras capacidades a la hora de recurrir a herramientas que ya están diseñadas y han sido probadas en la resolución de problemas complejos y que podemos manipular y hacer crecer en un entorno computacional.

2 Methodology

The methodology uses the bases of a meta-theory and meta-history, parting from a seminal work in that of Marshall. From there the author draws and follows a timeline with which a progress in the motivations and contributions made by biology in economics and business studies can be traced. - How a seminal work is defined? - How the author decides to entertain around a certain seminal work and the works around it?

The meta-analysis is nit exhaustive not complete, The conclusions are extracted once saturation is achieved.

3 Description

It is important to clearly establish the differences that distinguish an evolutionary process from another of change or transformation. Although these are related concepts in evolutionary theory, they actually denote different processes that act on different agents, which is why they tend to be confusing even among some specialists.

Evolution is an overarching process that drives change in populations over generations. This means that evolutionary processes do not operate at the level of a specific individual or organism, which would only change or transform. **Evolution** therefore represents the cumulative effect of the inherited changes made by the characteristics of the individuals of a population, on which a selection process operates affecting the frequency of traits within a population over time. **Change** encompasses a broad spectrum of morphological or behavioral alterations within individuals from a variety of factors, including environmental pressures and reproductive patterns. Transformation suggests more profound or significant shifts in form, structure or function of individuals.

The idea of **individualism** is confronted with that of **populationism**. Darwin's theory is a mix of both: natural selection operates at the level of the individual organism, regulating the frequencies of traits within a population over time. **Populations are the units of evolution.**

Another important approach to take into account is the one that confronts the idea of **evolutionism** with that of **progressionism**. The first refers to a change that is non-directional, while the second implies a direction in evolution, usually following a teleological change.

3.1 Evolution

In the process of evolution is worth consider the role of **feedback loops** between mental and social evolution (as imagined by H.Spencer). For this author a more complex society is a stimulus for more mental development. This is the foundation of evolutionary psychology and of sociobiology.

How is the mechanism of evolution: **cyclic vs. continuous?**

The role of the organism to focus in new habits and become an **active creative agent** in charge of its own destiny is an idea of H.Spencer. This takes the evolutionary analyst to think

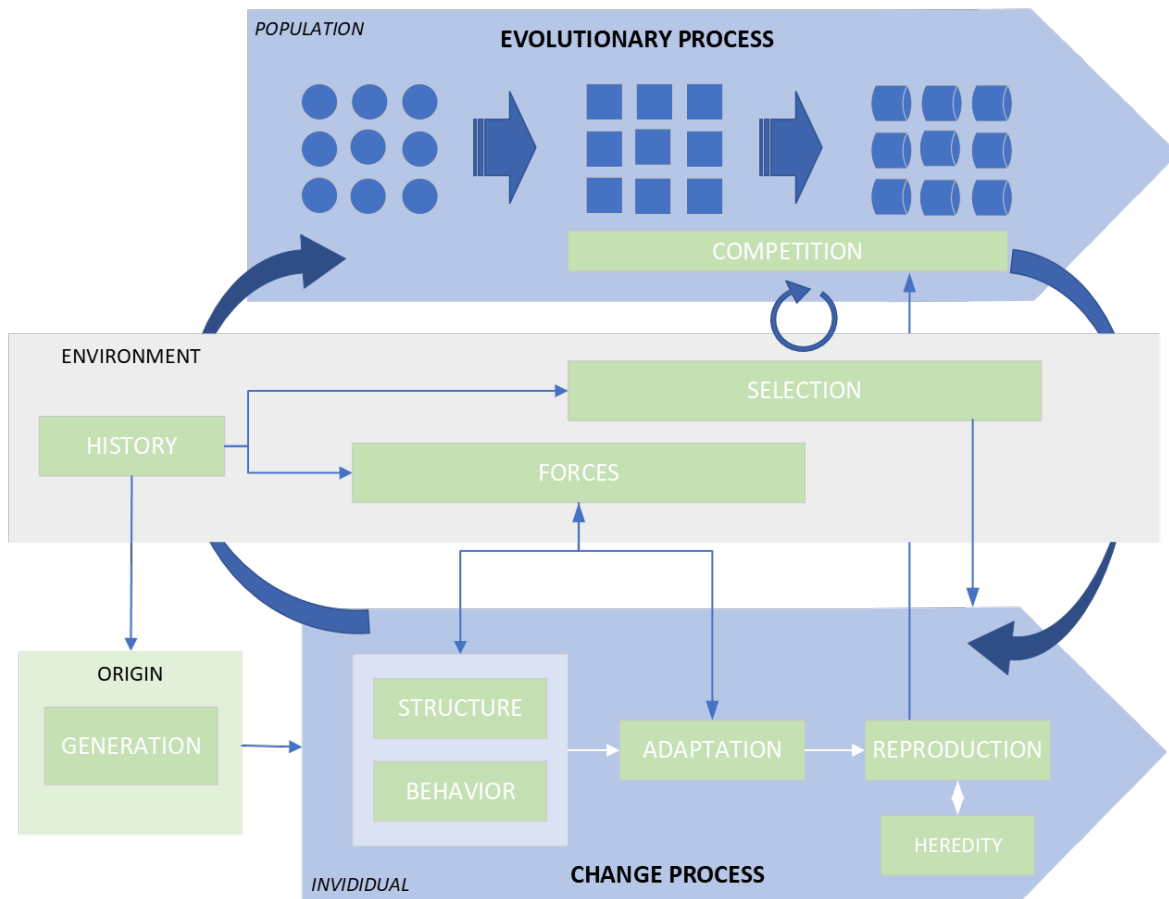


Figure 3.1: Fig1. Framework for evolutionary systems analysis. Source: own elaboration

about the role of **knowledge** and **learning** to change habits and create new instincts, in the end, to unfold a process of self-improvement (which is Lamarckian).

3.1.1 Competition

The evolutionary analyst must understand **competition** as that within an **ecology** based on **struggle**. These are three fundamental terms to understand the evolutionary analysis framework.

It is important to stop for a moment to understand the implications of the **concept of ecology** to explain an evolutionary system. To achieve this, a common approach has been to use biogeography as a way of knowing about the spread of relationships and how species compete to occupy territory.

3.1.2 Convergent evolution (parallelism)

This conception of the evolutionary process implies the existence of a parallelism between independent evolutionary trajectories.

The environmental challenges over species A and B, make those species develop the same structures and behaviors, which may have an impact on morphology, physiology, and life history traits. This continues forward with the same genetic pathways (even the same phenotypic traits), the consequence being on predictability/replicability of evolution, namely, the same solutions given to similar selective pressures.

3.2 Origin

The problem of the origin is associated with that of the “Problem of Generation” and its accompanying theories of generation. An analysis of the origin involves the need to explore for evidence of the past in search for a better system (what are the sources of evidence?).

The following are some of the theories to consider when addressing the **problem of generation** of the original structure:

- Spontaneous generation (often only for the simplest forms)
- Preformationism (forms that are predetermined)
- Pre-existence
- A mold that is fixed.

After the evidence of generation has become evident, the next step is to continue understanding the **trend** towards higher levels of complexity, and the material forces that have an influence on the trend.

When the evolutionary analyst deals with the problem of generation she must attend to the *developmental process*, and the constraints that it can impose on the rest of the evolutionary process. These constraints might introduce non-random variations, which can mean a way to direct the course of evolution.

It is especially useful for the evolutionary analyst to consider that the unit (species) has a limited number of developmental pathways available and that the selection process would therefore be limited only to the possibility of tinkering with the details.

3.3 Structure

The main issue when considering Structure is to establish what the **analytical unit** of the system is (and what its main basic components are). In the case of natural evolutionary theory, this unit has traditionally been the organism, but also the population and later, after modern synthesis, the gene. It is the analyst's job to determine as clearly as possible which is the "unit" on which the evolutionary analysis of the system will focus.

Thinking about population opened the door to a **statistical model of explanation**, which is opposed to the Newtonian view of law-based causation. This is the eternal debate between determinism and probabilism.

3.4 Environment

The environment surrounding the chosen unit of analysis exerts various types of forces that act on the structure to provoke a process of change, with greater or lesser intensity, and in one direction or another.

The forces of change originating in the environment force the unit to change, so it is essential that the analyst analyze the environment in depth as a key impact driver, understanding the role of the environment in the evolutionary process of the system.

The connection between the environment and the origin is a key issue as well, since the direction of the change, if it exists, and the intensity or depth of the change that may take place in the structure of the unit may sometimes depend on it.

It is important when analyzing the environment to specify the type of force applied to the structure, and its sources in said environment.

3.4.1 Selection

Is (natural) selection an **episodic or a continuous** process?

Are there periods of stable life where (natural) selection does not operate? or, Is (natural selection) always operating even in a stable environment?

A related approach is the one which considers **selectionism vs. saltationism**, and the extension with the role of mass extinctions. This would open the debate about evolution not always being progressive, and the acceptance that species could **degenerate** in less challenging lifestyle.

Is the (social) behavior programmed into us by natural selection? This would take us to the question of the **development of social instincts**.

The idea of struggle and death might have a positive purpose to keep species well adapted to a challenging environment (this is an utilitarian perspective). They might have a creative role (along with sex reproduction).

How evolution can produce **advance in several directions** (and not only towards humanity)?

The **notion of selection** used in this paper is that of having a balance between different characters within a population and not about the development of a murderous or aggressive instinct.

3.5 Behavior

Behavior is the way in which the structure articulates a response to the pressure exerted by environmental forces. Behavior establishes the boundaries within which the structure is capable of absorbing the forces of the environment and giving an adaptive response to the new situation or challenge posed by the environment.

The result of the behavior, which takes place within the boundaries established by the structure of the unit, can give rise to three types of adaptive responses by the system:

- New system qualities (traits)
- Loss of system qualities (traits)
- Modification of system qualities (traits)

3.6 Change

Both the structure and the behavior are permanently immersed in a process of change, since the unit is always sensitive to the forces exerted on it originating in the environment. The overall evolutionary process of the unit will depend on the way in which these forces affect the unit.

The **characterization** of the change process must be carried out considering the following key dimensions, all of them closely related:

1. The direction or trend of the change process. This question has historically been part of the discussion on evolutionary theory, with different approaches given by different authors.
2. The change driver, whether it is a single one or a set of drivers that configure the change process.
3. The mechanics of the process, whether gradual and slow, or sudden and in jumps, or any intermediate alternative in the continuum formed by these two extremes.
4. The time scale on which the change process takes place. This can develop over a vast amount of time or a small amount of time, or somewhere in between.

Some important considerations to keep in mind are that the process of change always implies **progress**, but it can also involve regression. Therefore, the evolutionary analyst faces both forward and backward movements. This goes hand in hand with the idea of **continuous** progress, as opposed to progress in **jumps or saltation**.

Mutations play a role in the process of change, specifically they provide a source of random variation, but they do not generate new species. It must be taken into account that not all genes that undergo a mutation produce drastic changes in the organism (individual); in reality, most mutations are neutral and do not produce noticeable changes. The evolutionary analyst will have to take into account that the environment plays a role in determining which mutated characters are those that spread in the population (this is nothing more than the phenomenon of **selection**).

Maybe the concept of mutation is for more drastic transformations leading to new species, accepting that adaptation and selection might be irrelevant.

Can the evolutionary analyst evaluate the idea that there might be **internal forces** generating characters unrelated to the organism's needs? A related consideration may take us to consider that evolutionary changes occur in a predetermined manner driven by internal factors (this is called "directed evolution"). This is what has historically been called **orthogenesis** (F.Eimer).

The above opens involves **fixity** of direction, and if variation is also considered as not random, therefore there is no need for adaptation. According to this vision the environment would

not have any role in evolution. Evolution might come to happen beyond what is functionally needed and not because environmental factors.

Does “**overdevelopment theory**” apply (A.Hyatt)?

3.7 Reproduction

Currently there is a generalized consensus in accepting the **reproductive success** of the unit as the main driver of selection, that is, the ability to transmit the genetic load of the unit to the offspring (this perspective has been criticised by Stephen Jay Gould). This modern vision of evolution has not always been like this, so less than 100 years ago success was considered to be found in the ability to adapt to the environment.

Selection based on reproductive success has opened the doors to new avenues of interest and study, which now focus more on sexual selection, in the case of natural systems, or on the **reproduction** mechanisms of any other system. An interesting factor that every evolutionary analyst may want to analyze is the role of **geographic barriers** to explain the way in which species multiply.

Let us also think that the selection process that takes place in the environment is continuous and is not interrupted even when the environment is stable. In other words, competition between some units and others for scarce resources never stops, even if the environment appears stable. The analogy of the **Red Queen hypothesis**, introduced by Van Halen Van Valen (2014) to denote that in the evolutionary race between organisms species must constantly adapt and evolve just to maintain their relative fitness within an ever-changing environment, it is good to explain that units must remain constantly improving or, otherwise, they will be outstripped by their rivals.

3.7.1 Developmental constraints

The concept of **developmental constraints** affects in shaping the course of evolution. This is because the embryonic development process imposes a series of limitations on the types of changes that can occur in organisms over time. Patterns and constraints of embryonic development can provide insights into the mechanisms underlying evolutionary change and diversification.

3.7.2 Evo-devo approach

This approach, abandoned by current biologists, states that “**ontogeny recapitulates phylogeny**”. To understand it we must apply an “evo-devo” approach, meaning that embryological processes are part of evolutionary systems. This approach presents the idea of “**blending**” as the most convincing explanation of reproduction.

The “evo-devo” approach is based on Von Baer’s laws of embryology, which establish the following:

1. The basic structures of the body are established before specialized features appear
2. Embryos progress from general to specific characteristics as they develop

Homology vs Analogy. These concepts establish that similar structures in different organisms are derived from a common ancestor.

In the case of **homology**, a common ancestor A gives rise to a divergent pattern of species B and C that are specialized and have a different formation.

The pattern in the case of the **analogy** is convergent, since two species A and B present the same organ with the same function.

3.7.3 Speciation and Specialization

The problem of **speciation**, that is, the division of a parent into several descendants. This is related to niche **specialization** and **adaptation**. Speciation is a fundamental mechanism of **biological diversification**.

Speciation leads to opportunities for specialization. Specialization within populations can contribute to reproductive isolation and promote speciation. It can also drive specialized traits that lead to divergence of populations over time.

In specialization a constant force, natural selection, determines the level of specialization, posing a pressure to specialize on species (in line with Adam Smith thought). The level of specialization influences the level of adaptation, which drives a divergent process of speciation.

Types of specialization: genetic, behavioral or ecological.

Role of geographical isolation of speciation There are two considerations in regards of the role of geographical isolation for speciation. One considers that specialization emerges without the need of geographical barriers, this is called **sympatric speciation** and is a rapidly evolving type of speciation. Whereas **allopatric speciation** is much less rapid and more accepted today, and considers geographical barriers at the initial stage of species separation.

3.8 Heredity

Species have a **gene pool** that contain a large pool of genetic variability, in which many of these genes are simply useless or harmful. This gene pool is the raw material for **selection**.

An important task of the evolutionary analyst will be to determine if there are **modifier genes** (W.Castle) that influence the genes responsible for phenotypic characters.

Some Lamarckian stances might be worth an analysis. For example, the evolutionary analyst might consider that not all **inherited acquired characteristics (IAC)** are inherited by or as a response to changes in the environment.

The above might take of to the question if all evolution is mere **trial-and-error**, and how much is a **deliberate choice** of new habits in response to changes in the environment? Current thinking considers that not all needs to be inherited, so (to what extent) Can the environment influence heredity? (W.Bateson). But be advised that genetics is hostile to this idea.

Mendelian rule of “one single unit” in the germ plasm being responsible for determining the character and transmitting it to offspring. This would lead us to have to elucidate which genes (alleles) are dominant and which are recessive. This would lead us to have to elucidate which genes (alleles) are dominant and which are recessive, and thus explain that there are discontinuous characters (Bateson).

3.9 About the Evolutionary Analysis Model

The analysis model for evolutionary analysis must **balance** theory with observation (Herschel). In reality, theories derive their power from their ability to establish connections with other areas of study.

(In Structure) Thinking about population opened the door to a **statistical model of explanation**, which is opposed to the Newtonian view of law-based causation. This is the eternal debate between determinism (causation) and probabilism (statistical).

Other discussions apart from determinism vs probabilism established by evolutionary analysis are these:

- Predictive vs descriptive
- Reductionist vs holistic
- Macroscopic vs microscopic

The method of evolutionary analysis is that of a **patient observer** (Darwin), who poses some hypothetical situations and then uses the deductive method to try to verify them.

4 Discussion

4.1 On Evolution

When addressing the study of an evolutionary system, it is of paramount importance to first elucidate what **the unit** of the system will be, on which the entire conceptual and methodological apparatus of evolution will be applied. This is a discussion that has changed over time, having moved from the individual organism to what is currently considered a more correct approach, the gene. What the above means is that instead of prioritizing “adaptive fitness” in the analysis, today it seems more appropriate to focus on the reproductive success of the individual. This new perspective has given rise to the movement of ultra-Darwinism.

The analysis of evolutionary **stratigraphy**, that is, the analysis of the evolutionary process cut into layers, can provide valuable evidence and insight about the evolution followed by each stratum, as well as the relationships that exist between strata. Additionally, it may also be valuable to study the global stratigraphy of the system, that is, the system of layers resulting from aggregating lower-level strata into higher-level strata, since this can suggest new stratal relationships that previously remained hidden from view of the evolutionary system.

The geological **law of superposition**, which states that in any sequence of undisturbed sedimentary rocks, each layer of rock is younger than the one below it and older than the one above it, can be used analogously in the analysis of an evolutionary system, thus establishing that each lower layer manifests a behavior on which the behavior of the upper layer is based.

Once the evolutionary system has been sliced into strata and the evidence that each one individually provides, as well as that of the global stratigraphic system, has been analyzed, the evolutionary analyst will be able to infer the **hierarchical structure** of evolutionary elements that characterize the system under observation.

When studying the evolution of a population, building a **classification or taxonomy** of units (species) becomes relevant. This requires discipline and deep analysis into the building blocks and the relationships (or degrees of relationships) that stand between individuals. By formulating a classification/taxonomy, new avenues can be opened that allow the evolutionary analyst to trace (and understand) the past of the units and make it easier for him to foresee the next steps that the unit will go through.

The idea of the extent to which the **history of “life”** has been progressive but in an irregular way.

The idea of “**emergent evolution**” (Lloyd Morgan) which highlights the new high-level properties that appear as evolution reaches a certain level of complexity.

4.2 On the Origin

The idea of the Origin is consubstantially associated with the idea of an **end**, since everything that begins must necessarily have an end.

The problem of origin is closely related to the **problem of generation**, thus the evolutionary analyst must elucidate whether the origin of the unit is spontaneous, preformationist, etc.

An alternative perspective to the problem of origin can be raised from **biogenesis** (life arising from non-living matter) and the “**primordial soup**” (Oparin), that is, the combination of elements that gives rise to the synthesis of compounds “organic” after adding energy to the system (from lightning, UVA radiation, volcanic activity, etc.)

4.3 On the Environment

4.3.1 On the Forces

We do not know the forces (and their sources) that operate driving the process of change in the individuals of a population.

Apart from the forces that operate at the level of individuals, it is necessary to know what the transmission mechanisms are like from the environment to the individual, between individuals, and vice versa, from the individual to the environment.

What is the materiality of the pressure for change exerted by an environmental force?

4.3.2 On Selection

One of the most difficult questions that every evolutionary analyst must face is how the **selection process** imposed by the environment actually works, and to what extent different alternative selection approaches can help explain the evolutionary course of the system.

We refer to the selection process not as the blind application of a closed paradigm that we know a priori will provide an explanatory response to the evolution of any system, but rather the analyst evaluates to what degree alternative selection models can provide insight into our understanding of the evolution of the system. It is about better understanding how rival visions can have a place in our understanding of the evolutionary phenomena of the system, even in an open and simultaneous way.

4.4 On the Structure

4.5 On the Behavior

To what extent is the system's behavior governed by inherited **instincts**? And to what extent can the selection process alter instincts? Are instincts constraints to the development of behavior and the process of change, or are they not such constraints?

What behavioral traits can be considered **innate** and which are constructed with the interaction with the natural and social environment? What are the environmental stimuli that might help explain the individual instincts?

Perhaps the analyst, in addition to (the above) behaviorist approach, might approach the analysis of the behavior by exploring the internal processes inside the individual that trigger observable responses in the individual.

Can individual behavior be **predicted**? Furthermore, can behavior be controlled by manipulating the environment and creating a stimulus-response association in the individual? The evolutionary analyst might also focus on how the individual learns through the association of stimuli with specific responses.

To what extent can **learning** and **technology** affect instincts to the point of making them heritable?

The problem of **hierarchy** can also affect behavior to the point that the evolutionary analyst can try to elucidate what the behavioral hierarchy is (e.g. intellectual, social, moral, etc.). How are these behavioral faculties created?

It is important for the evolutionary analyst to assess to what extent there is the possibility that we have the ability to **control genes** and, therefore, that we can control how human behavior can be controlled (The Blind Watchmaker- R.Dawkins)

4.6 On Change

We know what an individual is today, but we do not know how an individual became what it is today. This necessarily raises the need to study the **historical past** as a source of knowledge to understand the process of change or evolution followed.

It is necessary to know which components of the individual's structure (or flows) the **forces of the environment** act on, or on which behaviors the forces of the environment have an impact.

Also relevant is the question of how the **development process** of an individual is like, both before conception (embryonic development) and during its life period.

Does the change caused by forces in the environment respond to any **goal or objective**? Is there any direction, goal or trend? And if there is one, what is the justification for it to exist? Is there any type of constraint associated with the development of the individual that conditions or limits the process of change? Can we rule out that the individual's process of change does not have a teleological character (e.g. a guiding principle, a force, etc.) towards a specific end/goal?

In the analysis of **evolutionary dynamics**, it is interesting to know if the system becomes stable and in equilibrium, stable and not in equilibrium. Finding out this situation allows us to better understand the nature of the evolutionary process and try to predict the next steps in the evolution of the system.

What are the **change mechanisms** used by units to respond to environmental forces? Some may be:

- 1) Hybridization
- 2) Recombination
- 3) etc.

To what extent is the **timeline** for the adoption of changes a key factor that determines the individual results of the change? When analyzing change it is key therefore key to elucidate the timeline in which it unfolds.

Speaking about the timescale of the change processes, it is interesting to find out if the system is constrained by certain structural limitations, or that they have their origin in its own development, and that explain why the changes occur. This would allow the evolutionary analyst to estimate the particular evolutionary “**clock**” of the system. The idea of the clock is to explain traits that evolve at a constant rate overtime, due to underlying molecular mechanisms. In other words, that would explain the rate of change at which changes accumulate over time.

It is evident that the clock idea would not offer precise information similar to that currently used in the field of molecular biology or genetics to provide insight into the the tempo and mode of evolutionary change, but it could be a qualitative approximation to the temporal factors that intervene in the rate of evolution of a system.

A possible model that explains the evolutionary process that should be seriously taken into account is known as **punctuated equilibria**”. According to this model, species remain relatively stable and in equilibrium with their environment for long periods of time. During this time they register small changes in their morphology or level of adaptation. However, at certain times, sudden changes occur that trigger evolutionary episodes of changes (punctuation) associated with events that are accompanied by speciation. These periods of rapid change would be interspersed with long periods of stasis.

4.7 On Success

5 Implications

5.1 Evolutionary analyst

One of the practical benefits derived from the present proposal of formulating an evolutionary systems analytical framework is to determine the need to have professionals with an evolutionary analyst profile. An evolutionary analyst is understood to be an academic or professional who has a clear and deep understanding of the evolutionary functioning of systems and who is capable of using rigorous analysis and tools to determine the factors that explain their essence and elements of change.

5.2 Prediction ability

If we are able to acquire a deep understanding of the functioning of the evolutionary system, its components, behaviors and flow of changes, we can then better foresee in which direction the evolutionary system is moving and glimpse whether the system has the capacity to survive or, on the contrary, is doomed to disappearance.

It is worth considering the possibility of whether, based on increasingly deeper knowledge of the evolution of a system, it would be possible to act on the future of the system. In other words, if it could be feasible to design your own plan and carry it out based on the knowledge generated about the evolution of the system.

To what extent is the system under observation random in change or does it evidence a logic that can be known and even altered based on our desires or needs?

5.3 Manipulation of the system and its programmability

If they were really able to manipulate the system as we wish, on what elements would it be most feasible to do so? Would it be possible to act on both the structural and behavioral elements, only on one of them? Being able to act on a known evolutionary system would open new and great opportunities to design systems that meet a wide diversity of needs.

The above would necessarily entail having to assess the ethical problems of altering the course of nature and the new problems that would emerge by distorting the natural mechanisms of

the functioning of life and society. The opposite position would be to conclude that the system is unalterable and we cannot intelligently design it to satisfy our desires.

Society would go from a stage in which social systems are considered elusive to another in which we would be able to know to what extent their evolution is random, to what extent there is causality and to what extent they are programmable.

5.4 Inform and activate policies

An evolutionary analysis framework can serve to inform who cannot support themselves, namely, who is more likely to survive and continue competitive, and who is threatened by disappearance.

Identifying who dominates over whom, that is, elucidating the relationships and power structures has great significance, but it is also a way to understand how species advance. In fact, the process of replacement or extinction of species is an essential aspect to understand human progress.

The level at which the analyst expects to inform policy, or the level of contribution expected by decision makers from an evolutionary model, is a factor in determining the level of analysis to be used in the “struggle for existence.”

Additionally, if education (education policies) could improve individuals, the benefits could perhaps be passed on through inheritance (this is a Lamarckian view).

5.5 Overcoming the barriers that prevent systematic struggle

From the RQs: Another question that the evolutionary analyst can try to resolve is whether the individual **permits the struggle** to take place and, if not, to what extent this weakens the individual and, therefore, that the individual enters into a process of degeneration that leads to a replacement by another individual.

This leads us to the recommendation, in some circumstances mediated by policies, that the struggle does not have constraints that condition it. Thus, as the environment continues to pose challenges that must be faced (resolved) by the individual, progress will continue.

5.6 Eugenics of individuals

The above leads us to the problem of eugenics, and the reflection on to what extent the system must ensure that the selection produces and there are no barriers for it to unfold its effects.

5.7 The connection with complex systems

The analysis of evolutionary systems demonstrates a connection with complex systems, such that species should be seen as complex systems with an enormous amount of variation, stimulated by selection.

6 Conclusion

The evolutionary analysis of systems fundamentally requires generating much more extensive and precise knowledge about individuals and populations, as well as about the periods and places in which they develop. This is self-evident when it comes to obtaining a deeper understanding of the reasons for change and diversity.

We also know today that systems do not evolve smoothly and continuously over long periods of time but do so based on pulses between periods of interruption that cause disruptive changes and the mass extinction of units.

Knowing the sequence of events that have shaped the evolutionary processes opens new analytical dimensions to the study of the evolutionary phenomenon and allows us to confront elements considered unpredictable until now in the course of evolution.

References

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