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THE "HISTORY" OF BIODIVERSITY. A BERGSONIAN LOOK AT THE THEORY OF EVOLUTION

1. Introduction

The Darwinism of our times is based on two principles: natural selection as a mechanism that explains evolution; the gene as the unit on which selection acts. From the initial conditions – the genes that tend to reproduce through the organisms they program, and the environment in which these organisms develop and struggle for existence – one can deduce, through the mechanism of "natural selection", the way in which these organisms will evolve, that is, the genes that have been selected. Hence Richard Dawkins was able to say that evolution is almost fully understood today. And it is true that most of the questions about adaptation can be answered: i.e. how a species with such and such characteristics can evolve under such and such a condition.

Stephen Jay Gould, on the other hand, considered evolution to be a phenomenon about which almost nothing is known. Indeed, Gould was less interested in the mechanisms underlying adaptation, which indeed seem to be explained by the combination of Darwinism and genetics, than in the form taken by biodiversity: Why this form and not another? Why this organization and not another? While Neo-Darwinism may provide an explanation for the sexuality of Thyme, it does not tell us why pigs have no wings. Certainly, the metaphor of the "selfish gene" shows what is maintained throughout Evolution, and natural selection provides an adequate description of a large part of evolutionary change, but they do not give an understanding of why there is change, let alone to predict the form it will take. Bergson had already formulated this critique in 1907 in *Creative Evolution* against the evolutionary theories of his time: they do not allow to grasp the formation of novelties in evolution because they do not conceive of duration. It is because Bergson brings to light the temporal aspect, this memory of the evolutionary process, that his theory seems to highlight, even today, the problems posed by evolutionary explanations. By making biology a world strictly determined by necessary laws, Neo-Darwinism in fact misses the historical dimension of evolution which Darwin himself tried to account for through the all too often forgotten "principle of divergence". What does it mean to claim that biological evolution is history? What does that bring to the understanding of evolution?

2. Evolution is not a Panglossian tale

To begin with, it must be understood that evolution is not the history of adaptations towards an optimum: it does not work like a Panglossian tale. Voltaire's character believes «that things cannot be otherwise, because everything being made for an end, everything is necessarily for the best end. [...] Noses were made for wearing glasses, so we have glasses» [Voltaire 1759/2017, 4]. For Pangloss, the history of the world looks like a tale where obstacles lead to a crisis situation that exists only through its resolution, which brings about a more desirable state. All characters and events are oriented towards this optimal situation. What is the relation between Panglossian finalism and the theory of evolution by natural selection?

For Darwin, in *The Origin of Species*, the adaptation of organisms to their environment is the problematic phenomenon. To explain that, Darwin starts from domestic selection: our pears are juicier than Pliny's because over the centuries man has replanted the seeds of the juiciest pears not the blandest: pears were selected to be juicier. From that, he deduced the existence of variations between individuals and the possibility of a natural selection of these variations, in other words, the preservation of useful variations in the struggle for existence, however small the advantage provided, and the disappearance of the harmful ones. But it led some interpreters of Darwin to adaptationist explanations: the use of the organ could make it possible to deduce the reason for its genesis. Darwin proposes natural selection as an explanation for adaptation; adaptationists propose to explain the appearance of the trait by its adaptation, which implies that one can ask what a trait is selected *for* and give the reason for its appearance based on this purpose. Thus, if seagulls have wings it is because they are «excellently adapted for flight in a medium having the specific density and viscosity of the atmosphere within a thousand meters or so of the surface of the Earth» [Dennett 2014, 197]. Adaptations are understood as answers to the problems raised by the medium, and the similarity between living beings on different phyla by the similarity of the problems encountered. Hence, under the guise of a strictly mechanistic explanation by natural selection, it is the old finalism that we find. This implicit recourse to the finalism inherent in evolutionary theories was already the subject of Bergson's criticisms at the beginning of the twentieth century:

> If there is [...] adaptation, it will be in the sense in which one may say of the solution of problem of geometry [...] that it is adapted to the conditions. [It] explains why different evolutionary processes result in similar forms: the same problem, of course, calls for the same solution. But it is necessary then to introduce, as for the solution of a problem of geometry, an intelligent activity, or at least a cause which behaves in the same way [Bergson 1907/1911, 58].

The deterministic mechanism, supposedly metaphysically neutral, supposes in reality a finality «more than ever charged with anthropomorphic elements» [*ibid.*]: the metaphor of the machine only hides the divine reference.

That explanation is not only finalist, it is also heuristically circular. That's what philosopher Jerry Fodor points out in his controversial book *What Darwin got wrong.* In Darwin's artificial selection, organisms are selected for an interest defined by the breeder. But in the case of nature, the selection happens without a defined interest; what an organism is selected for is adaptation to the environment. But how to define the environment of a living being? One usually finds in the environment what is relevant to a living being, calls it a niche, and then says that the living being has adapted to that niche. «But that there are spiders, who would have guessed how to spin webs to catch flies is an ecological problem?» [Fodor *et al*. 2011, 140]. The evolution of biological forms cannot be understood as answers to the successive problems posed by their environment, since the environment and the problems it poses are defined on the basis of phenotypical traits that are assumed to be adaptations. Wondering whether the dodo has lost its ecological niche or whether the opposite has happened, Fodor answers: «The extinction of the dodo was the very same event as the extinction of the dodo's way of making a living so neither can serve to explain the other» [*ibid*., 147].

Finally, while natural selection seems to adequately describe the apparition of a form adapted to an environment, it cannot explain the absence of a certain form. As Fodor points out, if, instead of asking why organisms have similar traits in similar environments, we ask why certain traits do not exist, the selectionist explanation becomes absurd. «Nobody, not even the most ravening of adaptationists, would seek to explain the absence of winged pigs by claiming that, though there used to be some, the wings proved to be a liability, so nature selected against them. Nobody expects to find fossils of a species of winged pig that has now gone extinct. Rather, pigs lack wings because there's no place on pigs to put them» [Fodor 2007, 21].

Thus, an explanation of evolution that would stick to natural selection alone is implicitly finalist, and, purged of this finalism, it risks falling into tautology. Moreover, it would be insufficient, since it would not take into account the internal constraints of organisms. Let us now examine these constraints, starting with those that have been crucial in the Modern Synthesis: genetics.

What genetics brings to the mechanism of natural selection is the unit of selection: the gene. But again, the explanation does not escape finalism, since nature is interpreted as having a purpose: the survival of the gene. For Dawkins, in *The Selfish gene*, to define evolution by natural selection as the process by which genes increase their reproductive capacity is to say that biodiversity in its entirety can be understood by referring to the interest of the gene. Accordingly we read that what is important in evolution is «the good of the individual (or the gene)» [Dawkins 1976/2006, 2], an argument from which it can be said that «the predominant quality to be expected in a successful gene is ruthless selfishness» [*ibid.*] and that the «fundamental law» of evolution is «gene selfishness» [Dawkins 1976/2006, 6]. Every phenotypic trait is explained by the interest of the gene. In consequence, if organisms can behave altruistically, it is precisely *for* the survival of genes. According to Dawkins, genes behave in this way because of «blind natural selection» [*ibid.*, 196]. To truly understand evolution by natural selection, we must therefore consider that it acts with an apparent goal: the survival of genetic information, the destiny of evolution resulting this time from the "goals" of each gene, and no longer from the intelligence of an omniscient engineer. If genes do not have conscious purposes, they do have an unconscious one: survival, which explains the finalized appearance of evolution in general.

Coordinated this way, genetics and natural selection present a doubly finalized mechanism. Genes seem to be both the programs and programmers of the biosphere: they appear as small engineers designing the machines (organisms) for the sole purpose of their own survival. Natural selection, on the other hand, appears to be a finalized mechanism directed towards the increasingly optimal adaptation of species to their environment for genetic survival. Although Darwin was more cautious than his interpreters, there was already a temptation of this kind in his early works:

> Let us now suppose a Being with penetration sufficient to perceive differences in the outer and innermost organization quite imperceptible to man, and with forethought extending over future centuries to watch with unerring care and select for any object the offspring of an organism produced under the foregoing circumstances; I can see no conceivable reason why he could not form a new race (or several were he to separate the stock of the original organism and work on several islands) adapted to new ends [Darwin 1909, 85].

There would thus be a "demon of natural selection", similar to Laplace's "demon". Laplace's hypothesis was that an omniscient observer who knew the laws of physics and the initial conditions of the motion of each body in the universe at a time t1 would be able to predict its final state at t2. In this case again, Bergson's philosophy offers a valid critique of this hypothesis of a superhuman intelligence capable of embracing the entire universe precisely because it implies the universe thought of as a whole: a closed system analogous to that which the machine is to the engineer who designs it [Bergson 1907/1911, 37-39]. Therefore, the universe is reduced to an object, which can only exist if we implicitly accept the existence of a metaphysical entity capable of embracing it: the eye of the demon.

To think of evolution as a system strictly determined by a single mechanism towards an optimal situation is in fact to think of nature as a closed system, where nature appears as doubly indefinite, both diachronically (it is a process) and synchronously because of the multitude of its interactions sometimes conflicting, and the different levels of causality involved.

3. Biological evolution: A Metaphysical Object

Evolution, in fact, cannot be a deterministic system of the Laplacian type, because it is *not* closed, it is not an object that an observer could walk around. There is a *meta*-physical dimension to life as well as to the world in Kant's philosophy: it goes beyond the experience that we can have of it, not because of our ignorance, but because of this double openness, synchronic and diachronic, which characterizes evolution in general as well as each living being. «A living being [is] distinguished from all that our perception or our science isolates or closes artificially» [Bergson 1907/1911, 15]. Because of this indeterminacy of life and the complexity of interactions that characterizes it, it seems impossible to order by any kind of algorithm, without falling into a peremptory anthropomorphism. Yet, it is what Daniel Dennett claims to do in *Darwin's dangerous idea*. He posits that natural selection is a machine for sorting out blind variations, a technological tool, i.e. a set of constraints added to the physical conditions to allow the emergence of a function. Dennett presupposes a Mendel Library, which would correspond to all possible genomes; and a Design Space, which would contain all possible phenotypes that may result from a combination of genes. The algorithm updates the phenotypes by searching for them in the Possibilities

Space and constructing them on the basis of the available genetic "recipes". This implies, on the one hand, that the organisms are artifacts constructed unilaterally by an ingenious genetic mechanism (whose engineer cannot be found), on the other hand, that all biological possibilities are already given. Bergson already criticized this fixed vision of the organism, and this excessive pretension of logical intelligence in the face of the unpredictability of living things:

> We [...] feel that not one of the categories of our thought [...] applies exactly to the things of life: who can say where individuality begins and ends, whether the living being is one or many [...]? In vain we force the living into this or that of our molds. All the molds crack [...]. And most often, when experience has finally shown us how life goes to work to obtain a certain result, we find its way of working is just that of which we should never have thought [Bergson 1907/1911, X].

Indeed, the living world is characterized by unpredictability that is not due to our ignorance, but to the very nature of evolution: because of its causal pluralism, each biological situation is unique. Therefore, laws in biology would imply taking into consideration a quasi-infinite number of particular parameters. It is only arbitrarily that we can turn nature into a closed system with only a few parameters, unchanged from place to place and from time to time. In order to find laws in biology as predictive as physicochemical laws, we would have to take into account interactions at extraordinarily heterogeneous levels: the molecule, the gene, the cell, their interactions, development, the interaction of tissues, the interaction of organisms... Moreover, these different levels are studied by sciences just as diverse: genetics, molecular biology, ethology, geology... Finally, these levels are distinguished only artificially: one cannot close a living system with regard to another in order to study natural selection only at its level. Symbiosis phenomena in particular defy traditional distinctions: some organisms are composed of several distinct species, inviting us to think of the evolutionary process not only as an intergenerational phenomenon, but also as "horizontal", by community assembly. For instance, mycorrhizae, born from the association between a mycorrhizal fungus and the root of a plant: the fungi promote the absorption of nutrients while providing a bulwark against pollutants for the roots also gain sugar. The complexity required by the laws of evolution is unprecedented in other sciences. As Fodor points out, where the laws of gravity need only a few parameters to account for the multitude of phenomena they explain, the laws of evolution would require placeholders for each type of living being to which they apply and for each type of environment with which these creatures interact [Fodor *et al.* 2011, 183-186]. The organism is at the intersection of extremely diverse levels of causality, and it is precisely this interpenetration of causal chains that we could describe as contingent, i.e. unpredictable.

Besides, biodiversity is not a fixed entity, but is always in the process of becoming. We do not have before us evolved species, but evolutionary *change.* When it comes to living beings, nature, which is always thought of as the realm of ahistorical necessity, comes curiously close to our history. As with human history, it is impossible to make predictions about biological evolution, because the temporality of the phenomenon implies the bringing together of beings and environments that had never been brought together before. This is what Bergson already understood very well: there is a historicity of biological phenomena, which means that, if the birth of a species can be linked to precise causes, «this can only mean that if, after the fact, we could know these causes in detail, we could explain by them the form that has been produced; foreseeing the form is out of the question» [Bergson 1907/1911, 27]. Despite being fiercely Darwinian, biologist Ronald Fisher nevertheless underlines the radical unpredictability of evolution by referring to Bergson: it is «thinkable in an indeterministic world, in which the causative system might indeed have been different. It is quite unthinkable in a strictly deterministic world. Looking back at the cause we can recognize it as creative; it has brought about something which could not have been predicted – something which cannot be referred back to antecedent events» [Fisher 1952, 350]. This unpredictability stems from the fact that the phenotype of an organism is not simply the product of its genotype and the environment in which it evolves, but also of its phenotypic *history.* Darwin said something similar about *Malaxis paludosa.* The ovary of the orchid is twisted 180 degrees in a normal situation (so that the labellum serves as a landing strip in *Ophris*). In *Malaxis*, the labellum, which is used to protect the pollen bags, is twisted 360 degrees. Without torsion, there would be exactly the same result. But because of the orchid's antecedent torsion, the adaptation was made in the sense of an accentuation of the torsion [Darwin 1862/2016, 200]. This irreversibility is linked to heredity, which transmits both the traits born of adaptation through natural selection (even if they are no longer adaptive at present; as long as they are not harmful either) and the consequent non-adaptive traits of other structural traits. These traits, which Gould and Lewontin call "structural expansions", become structural constraints but form an exaptative reserve: they can be co-opted later according to their usefulness in relation to the environment. Thus, some traits not directly shaped by natural selection that constitute structural constraints may prove adaptive later on [Gould *et al.* 1979]. The inadequacy of cause and effect, in such a way that the cause does not make it possible to predict the effect, is part of the contingency of the evolutive process. In an article Ruyer devotes to one of Bergson's examples, one reads that the evolutionary history of Paralytic Hymenoptera resembles a «"history" in the strong sense of the word, a complex and capricious political or linguistic evolution. [… It is] a mixture of organization and chance, of fortuitous displacements of meaning, of improvisations according to circumstances, and of catching-up by makeshift means» [Ruyer 1959, 176, my translation]. Evolution is not a harmonious story: it is made up of maladjustments and antagonisms. It does not function at all like a well-oiled machine in which each part is perfectly adapted to all the others; on the contrary, it manifests conflicts, inappropriateness, regressions; there is contingency everywhere. Ruyer's description of the dynamic "history" of evolution seem to reveal all his debts to the Bergsonian idea that the organized world is not all harmonious: «Nature […] everywhere presents disorder alongside of order, retrogression alongside of progress» [Bergson 1907/1911, 40].

In that case, would we be facing a vaudeville, where the story is interspersed with songs unnecessary to the plot? A plot that is itself constantly interspersed with unexpected jolts due to misunderstandings that bring together the most unlikely causal chains, to the point of ending up in funny situations like the panda's thumb (which is actually a carpus bone) [Gould, 1980]?

4. The history of biodiversity: a creative spiral of novelties

«The present moment of a living body does not find its explanation in the moment immediately before […] *all* the past of the organism must be added to that moment, its heredity – in fact, the whole of a very long history» [Bergson 1907/1911, 20]. Evolution is a *historical* phenomenon; namely, it is part of duration, or rather it *is* duration: a continuous, dynamic and multiple totality – not a simple succession. What makes biodiversity what it is today is not the immediately preceding moment, but its entire history, just as a person who falls asleep looking at a pendulum does not fall asleep because of the last perceived movement but it is «the rhythmic organization of the whole» that leads him to sleep [Bergson 1889/1910, 106]. Biological evolution has a memory that produces future biological novelties. There is a «real persistence of the past in the present» [Bergson 1889/1910, 22]. The complexity of the interactions within the living implies a particular contingency which is not pure probabilistic chance, but which is part of the historical character of the living. The same contingency implied by this durational aspect of evolution has been more recently suggested by Stephen J. Gould, inasmuch as it keeps the biologist from seeing evolution under the eye of the Darwinian demon. Through punctuated equilibrium (the idea that the variability of species has a certain *rhythm*: phases of stability then phases of rapid change) and the discreet introduction of the possibility of catastrophic factors, Gould introduces historical contingency through a thought of duration: according to him, the living weaves together and without contradictions scientific determinism and historical contingency. Nature is neither a closed system artificially objectified by science, nor an abstract metaphysical entity, but a historical process: biological history creates its own possibilities.

Does this mean that we are dealing with an inconsistent phenomenon? Can we understand the complexity of this creative process of novelty? I think so, as long as we limit our claims to an understanding rather than a prediction of the evolutive process. For this, we will refer to the work of Brooks and Wiley in *Evolution as entropy.* Their aim is to untie the apparent paradox of the law of entropy in physics and of the increase of organization in organisms as well as in biodiversity. They want to show that evolution is indeed an entropic phenomenon, but that it does not prevent the growth in complexity and the realization of innovative forms. They begin with the observation that organisms are the only systems that have instructional and not only structural information. Organisms carry their detailed blueprint with them and are able to refer to it to self-organize where the steam engine plan remains on the engineer's desk. In terms of information, living systems are closed: the environment cannot directly produce instructional information although it can indirectly cause changes in that information. As with any closed system, an increase in informational entropy will be observed through the processes (translation, transcription, duplication...). Suppose there is a phase space which corresponds to the number of possible genotypes, each micro-state being a genotype, the macro-state being the actual distribution of individuals in different possible genotypes. Entropy will be the measure of this distribution in relation to the phase space.

Evolution is an entropic phenomenon: organisms occupy more and more microstates. In that case, how can there be more organization at the same time, i.e. a greater distance from randomness? The paradox is solved if we realize that evolution is a phenomenon far from equilibrium that is characterized by an increase in phase space that is *faster* than the realized increase in entropy: namely, there is a tendency for the realized variation to *lag behind* the maximum possible diversity. The realized entropy increases, but at a slower rate than the maximum possible entropy. Organization emerges from this rhythm gap, thus from historical temporality. It is mainly history that explains the coordination of the increase in complexity (entropy) and organization. Indeed, while natural selection eliminates some phenotypes and therefore the corresponding genotypes, it is history above all that clarifies the gap between what is and what could have been: the main reason for this growing gap between the diversity of possible genotypes and the actual distribution of genotypes is that certain genotypic combinations are made impossible by speciation, which has distributed the genetic information in different lines (the Darwinian principle of divergence). Once again it is very close to what can be read in Bergson when he writes that «in evolving in the direction of the vertebrates in general, of man and intellect in particular, life has had to abandon by the way many elements incompatible with this particular mode of organization» [Bergson 1907/1911, 49].

Another reason (still historical) is the ontogenetic constraint that blocks the realization of certain genotypes, even though these unrealized genotypes may represent accessible microstates. What Wiley and Brooks are highlighting is the explanatory role of history in understanding biological complexity. Evolution as a process creates its own causes and its own conditions: historicity creates the obstacles as well as the possibilities of the evolutionary process. The specificity of biology is therefore not a metaphysical mystery, but a historical and thus undeterministic causality: in biology, history is not only a degradation of energy and a tendency to disorder, but the creation of new possibilities as well as new obstacles, starting from the development of the initial conditions.

That being said, how should this historical causality be understood? I propose the image of a *durational* and therefore *creative spiral*. Indeed, the evolutionary process is close to a recursive causality, as defined by Edgar Morin: a circular causality whose effects produce future causes and possibilities and therefore are necessary for the perpetuation of the loop (the product becomes a producer). But we must complete this recursive causality, because what Darwinism teaches us is that in evolution, there is no simple organization based on effects; there is what Bergson would describe as a *backward* harmony: the identity of a genetic heritage, a coherence coming from common ancestors. In fact, scientists have recently discovered that the development of organisms that are very different phylogenetically involved homologous genes or had used the same genetic circuits. This is the case of the *Hox* genes which are present in all bilaterally symmetrical animals and are responsible for the establishment of structures along the antero-posterior axis, in both vertebrates and insects (which have a homologous genetic complex: *Hom*). If the homologous gene found in mice is inserted into a mutant fly, it works and fulfills the role of the regular fly gene. Another type of parallelism observed in organisms very distant from each other is explained by the recruitment of the same genetic circuits. This is the case of *Pax-6*, which is found in several phyla: cephalopods and humans, and has homologues in drosophila and fish. Its role is to control the action of other genes that are specific to different species and whose effect is to result in eyes also specific to those species. «Harmony is rather behind us [the unity of a genetic heritage] than before [the phenotypic diversity]. [Unity comes from a *vis a tergo*: added from the French version, Bergson 1907/2007, 104, my translation] it is due to an identity of impulsion and not to a common aspiration» [Bergson 1907/1911, 51]. This implies that the unity we have spoken of is not only descriptive but *driving.* This is suggested by Gould's hypothesis that homologous regulatory genes are likely to play a key role in achieving rapid evolutionary change due to the constraint of a limited range of developmental pathways.

It is the *inadequacy* of the creative potential of the living and the constraints of its development that is the driving force behind the historical process of evolution. This means that in a certain sense evolution *shapes itself* through its antagonisms as it produces its problems as well as its solutions. Bergson writes about human history: «action on the move creates its own route, creates to a very great extent the conditions under which it is to be fulfilled, and thus baffles all calculation» [Bergson 1932/1977, 296]. Something similar happens in biological evolution: biodiversity is built up from its history. *The living is only rich in its future possibilities through its past history, as this history is both an obstacle to overcome and a reserve of novelties.* Therefore, the duration of evolution is not only a succession but also a recapitulation, which allows the story not to be repetitive but evolutionary. «The pendulum here is endowed with memory and is not the same when it swings back as on the outward swing, since it is then richer by all the intermediate experience. This is why the image of a spiral movement, which has sometimes been used, is perhaps more correct than that of the oscillations of a pendulum» [*ibid.*, 292]. *Biodiversity is the offspring of history*: the present cannot resemble the past in biology, because it is enriched by the entire movement that preceded it.

As we have said, this story is made up of maladjustments, evolutionary absurdities, and conflicts between species, but it is precisely these dissonances that make biological evolution perpetually creative: it is not so much an ordered mechanism as a perpetual *reorganization* based on a constantly *renewed disorder*; Bergson speaks of «*a reality which is making itself in a reality which is unmaking itself*» [Bergson 1907/1911, 248]. We have spoken of a spiral to describe the process of evolution, but more accurately, it would be a spiral *drawn by an unbal-*

anced spinning top: the adaptation of organisms to their environment is spectacular *because* biological harmony is threatened by imbalance, be it antagonisms between species or changes in environmental conditions. «This harmony is far from being as perfect as it has been claimed to be. It admits of much discord, because each species [...] tends to use this energy in its own interest; in *this consists adaptation*» [*ibid.*, 50]. Rather than understanding this organization as the product of the invisible engineer of natural selection and resorting to finalism, Bergson proposes to grasp it through the ontological unity of the living, which is that of its *history*: antagonisms that can be transformed into self-organizing interactions. «[Evolution] will have to make the best of these circumstances, neutralize their inconveniences and utilize their advantages – in short, respond to outer actions» [*ibid.*, 58]. It is through the obstacles that the complexity of biodiversity, of living beings and of their environment is born – a complexity whose organization creates novelty. The history of life does not consist of a continuous optimization of adaptation but rather of a series of unpredictable diversions. Evolution is *organization of disorder*, an organization perpetually contradicted, and therefore perpetually *creative*. It is *in* and *through* imbalance that the organization emerges.

Evolution is the flourishing of unpredictable possibilities whose contradictions result in an unbalanced organization. The evolutionary process is that organization of diachronic and synchronic antagonisms whose complementarity and overcoming are a creative enrichment of new evolutionary potentialities. Therefore, the living is not a deterministic and ahistorical realm, but that does not make it either a Panglossian tale where fatality reigns, or an incoherent vaudeville. It is a history in the strong sense of the word: a story in the making and to be told.

5. Conclusion

This is why, according to us, evolution is less the unfolding of a mechanism than the history of living beings. It is a reality that is made by the history of living beings that create both the obstacles and the conditions of possibility of overcoming this obstacle by the creativity of their interactions as well as their antagonisms. It is obstacles and evolutive absurdities that generate coherence. The understanding we have proposed of evolution as a creative spiral is certainly not a scientific model, but a philosophical conception that must be a call to think, just as Kant imagined an "endless finalism" in History as a heuristic horizon to guide both historians and men who make History. Beyond the tragedy of chance and the tragedy of fate is the possibility of a coherence that does not exclude surprises, because it emerges precisely from creative causation. The history of biodiversity is therefore neither the unfolding of a destiny nor a succession of absurd events; it is a *time spiral*: the organization emerges from the coordinated discordances of past history. What does that mean for us? As Stephen J. Gould said, «We are all the offspring of history, and must establish our own paths in this most diverse and interesting of conceivable universes – one indifferent to our suffering, and therefore offering us maximum freedom to thrive, or fail, in our own chosen way» [Gould 1989, 323].

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Abstract

Neo-Darwinism, through the combination of natural selection and genetics, has made possible an explanation of adaptive phenomena that claims to be devoid of metaphysical presuppositions. What Bergson already deplored and what we explore in this paper is the implicit finalism of such evolutionary explanations, which turn living beings into closed and static systems rather than understanding biological evolution as a process characterized by its interactions and temporal openness. Without denying the heuristic efficiency of the explanation resting upon natural selection, we analyze what it leaves out and what remains to be explored: the unpredictability of the evolutionary process. We will therefore study the role of contingency in evolution, as Stephen J. Gould proposed, but we will also consider the causality specific to the living world that makes it impossible to reduce it to a simple algorithm, as proposed by Daniel Dennett among others, since it is really a creative causation, or dialectical spiral.

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