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Introduction

- 1 Bergson offers an epistemological critique of Darwin's theory that focuses on variation. In Darwin's view, variation is not directed: it is natural selection that shapes adaptation by favouring organisms that carry advantageous variation. While Bergson emphasizes the improbability that random variations will accumulate in such a way as to produce an organ as sophisticated as the eye, this is not the cornerstone of his criticism. Bergson refutes above all Darwin's gradualism: for Darwin the variation is "minute," and Bergson glosses "insensible", which he understands as neutral. The latter goes so far as to speak of "the Darwinian theory of insensible variations" (Bergson 1911, 67). His argument is based on the idea that if these variations are insensible, they cannot confer any advantage to the organism and therefore be selected. Bergson refers to a section of the *Origin of Species*, where the formation of the eye is explained by the selection of "extremely slight and gradual" variations (Darwin 1876, 145). Yet, for Darwin, the retained variations are by no means insensible: they must represent an "[improvement ...] natural selection will pick out" (Darwin 1876, 146). Where does such a shift come from in this scrupulous reader that Bergson usually is? It cannot be a mere clumsiness, since and it is the main argument for his rejection of Darwinism: "if the accidental variations [...] are [...] insensible, some good genius [...] must be appealed to [...] in order to preserve and accumulate these variations, for selection will not look after this" (Bergson 1911, 72).
- 2 This interpretation actually echoes a popular criticism against Darwin's gradualism. The aim of this study is to trace the history of this false paradox that transforms the slight variations upon which natural selection acts into insensible ones that, by

definition, cannot be selected. Since Bergson gives no reference for his interpretation of Darwin, this paper will rely on the works of the authors cited by Bergson in *Creative Evolution*. This will lead us to St. George Mivart who proposes an indictment against the Darwinian theory based on the impossibility of selecting an insensible variation. After studying this critique of Darwinism, we will analyse the counterexample of the *Pecten maximus* to show that, despite Bergson's misunderstanding, he points to actual limits of Darwin's theory.

The Bergsonian Critique of Darwinism: The Insensibility of Variation

The Case of the *Pecten* against Mechanism

- 3 Bergson's purpose in the first chapter of *Creative Evolution* is to reveal the inadequacy of mechanistic explanations of evolution. According to these explanations, "evolution must [...] have occurred through a series of accidents added to one another, each new accident being preserved by selection if it is advantageous to that sum of former advantageous accidents which the present form of the living being represents" (Bergson 1911, 57). But in this hypothesis, it is highly unlikely that "two entirely different series of accidents being added together [...] will arrive at similar results" (Bergson 1911, 57). It is by demonstrating the existence of this improbable fact that Bergson intends to discredit mechanistic explanations, which for him include Darwinism. Bergson refers to the eye of the *Pecten maximus*, which would present an "analogy of structure" with the human eye: it would have exactly the same structure as that of our eye, up to the retinal inversion. But "molluscs and vertebrates separated from their common parent-stem long before the appearance of an eye so complex as that of the *Pecten*. Whence, then, the structural analogy?" (Bergson 1911, 66). Darwin explained the homologies of structure (in two species, the same structure inherited from a common ancestor) and analogies of function (organs with the same functions in divergent lineages, due to natural selection). But according to Bergson, none of the evolutionary theories under debate can explain the analogies of structure.

Bergson versus Darwin

- 4 Bergson starts by analysing the Darwinian theory: that of the indirect influence of the environment which selects individuals according to their very slight accidental variations. Indeed, Darwin assumes that variations are accidental (non-oriented). Bergson objects: "If the variations are accidental, how can they ever agree to arise in every part of the organ at the same time, in such way that the organ will continue to perform its function?" (Bergson 1911, 67-68). This is why Darwin would assume the variation to be "insensible" i.e., neutral with regard to its effect for the organism. Thus, variation "will not hinder the functioning of the organ; and hence this first accidental variation can, in a sense, wait for complementary variations to accumulate and raise vision to a higher degree of perfection" (Bergson 1911, 68) There would be here an epistemological inconsistency: "while the insensible variation does not hinder the functioning of the eye, neither does it help it, so long as the variations that are complementary do not occur. How, in that case, can the variation be retained by

natural selection?" (Bergson 1911, 68). The insensibility of the variation makes it possible to understand why it is not eliminated while 'waiting' for the other variations which will allow the construction of the organ; but it does not justify the fact that it is preserved by selection: "Unwittingly one will reason as if the slight variation were a tooting stone set up by the organism and reserved for a later construction" (Bergson 1911, 68).

- 5 If this idea seems far-fetched, the one claiming that innumerable variations must have been selected despite their uselessness in order to build the future organ is even more implausible. Assuming that the first useless variation is selected, the fact remains that any variation is the result of chance. How then can they accumulate in a rectilinear way until complex organs develop? Because Bergson assumes selected variations to be insensible, their accumulation in the same direction seems quite inconsistent.
- 6 Finally, Bergson questions how these random variations can be preserved, despite their respective uselessness, and be repeated in exactly the same order not only on one but on two lineages, as the analogies of structure seem to reveal. "How could the same small variations, incalculable in number, have ever occurred in the same order on two independent lines of evolution, if they were purely accidental? And how could they have been preserved by selection and accumulated in both cases, the same in the same order, when each of them, taken separately, was of no use?" (Bergson 1911, 68).

Darwin versus Bergson

- 7 Bergson uses the word "insensible" which could mean 'imperceptible to the human eye' in the sense of neutral: neither useful nor harmful, and therefore imperceptible to the eye of the selection itself. This is a far cry from Darwin! Although Darwin speaks of variations so slight they are invisible, they are by no means useless and therefore indifferent for natural selection: "Only those variations which are in some way profitable will be preserved or naturally selected" (Darwin 1876, 90).¹ Darwin thinks of selected variations as slight, but of real benefit. To appreciate this, one must capture the intensity of the struggle for existence, which explains that the smallest variation, apparently insensible, can be significantly advantageous for the survival and reproduction of its bearer: "The slightest difference of structure or constitution may well turn the nicely balanced scale in the struggle for life, and so be preserved. [...] It may metaphorically be said that natural selection is daily and hourly scrutinising, throughout the world, the slightest variations; [...] silently and insensibly working, whenever and wherever opportunity offers, at the improvement of each organic being in relation to its organic and inorganic conditions of life. We see nothing of these slow changes in progress, until the hand of time has marked the long lapse of ages" (Darwin 1876, 65-66). Here, two observations should be made. First, the benefit of a variation is defined in relation to the struggle for existence: an advantageous variation is one that enables the organism to survive and reproduce better than others. Second, Darwin does use the word 'insensible' in a few places, and the French translation uses it a bit more ('graduated' is often translated by 'insensible' in Darwin 1882). However, even when Darwin uses this word, it is never to speak of the effect of variation for its bearer, but only to qualify the invisibility of the work of the natural selection to the human eye, i.e., the minuteness of the differences in degree between individuals, varieties and species. On the few occasions when Darwin speaks of insensible gradations, he makes it

clear that each of the selected variations is actually advantageous to its carrier. Even in the French edition, it is impossible to understand “insensible” as “not useful.”²

- 8 Concerning the improbability of accumulation of random variations in the same direction, it does address a difficulty of Darwinism. How does natural selection allow the rectilinear development of organs? If natural selection certainly eliminates the most unfit, it also actively preserves individuals with beneficial variations. This is why, in Darwin, the action of selection is often described as directional: “all spontaneous variations in the right direction will thus be preserved” (Darwin 1876, 188, see also 64; 80). If there is no orientation of variation, which occurs randomly, there is orientation by natural selection: variations are accumulated towards what’s best for organisms according to the conditions they live in. In addition, the principle of divergence, which Bergson does not discuss, accounts for the development of an individual variation into a specific feature. This principle is observed in differentiated breeding. If we select on one hand the swifter horses, and on the other, the stronger ones, the principle of divergence will be “causing differences, at first barely appreciable, steadily to increase, and the breeds to diverge in character, both from each other and from their common parent” (Darwin 1876, 87). This principle also applies in nature “from the simple circumstance that the more diversified the descendants from any one species become [...] by so much will they be better enabled to seize on many and widely diversified places in the polity of nature, and so be enabled to increase in numbers” (Darwin 1876, 87). The combination of the struggle for existence and the divergence of character ensures for natural selection not to be at random: the environment and the coexistence of individuals regulate the living in the sense of adaptation and thereby diversification and improvement of characters.
- 9 Concerning the last Bergsonian argument, it may seem to fall on its own as the premises of the argumentation are flawed. First, the variation in Darwin is not insensible. Second, with regard to the accumulation of random variation being implausible, it must be underlined that, in Darwin it is made probable by the principle of divergence. However, while two different species may evolve in the same direction, insofar as they may be facing the same environmental problems, it’s indeed quite unlikely that the same variations in the same order would build the exact same organ on two different lineages. From this perspective, this is the only Bergsonian objection that seems to remain valid.
- 10 We will come back to this argument. But before that, we will study the source of Bergson’s interpretation. Why, even though Darwin keeps repeating that variation must be of benefit to the organism in order to be selected, does Bergson speak of insensible variations?

Tracing the History of This False Paradox

The Argument against Darwinism

- 11 This Bergsonian interpretation echoes a criticism of Darwinism that is widespread at the turn of the 20th century. What is called into question is not the existence of natural selection, which is recognised by Darwin’s detractors, including Bergson, even if its

importance is relativised (Ansell-Pearson 1999, 46; Bergson 1911, 179), but rather the gradualism of the Darwinian theory, that can be summarised as follows:

1. Individuals always differ from each other by small variations.
 2. Given the intensity of the struggle for existence, even a small variation can be highly advantageous (or highly detrimental) in a given context.
 3. A slight variation is selected, preserved, as long as it is advantageous.
 4. It is through the accumulation of these slight variations that specific differences arise and that complex organs are built.
- 12 The problematic point is the idea that a minimal variation can be useful (2). In the case of the wing, the first minimal rudiment (the small proto wing) certainly did not allow for flight, so how could it be advantageous? And if it was not, how could it have been preserved (3), and how could the variations have been accumulated in the same direction (4)?
- 13 It should be pointed out that there is a synthesis of two objections here:
- (A) If the variation is slight, its usefulness must be slight too. It is not sufficient to give the organism an advantage in the struggle for existence: the variation cannot be selected for. For instance, if a giraffe's neck is only a few millimetres longer than that of its congeners, it is likely that the few extra berries it attains are not enough to give it a reproductive advantage.
- 14 (B) In the case of a complex organ, if the first rudimentary variation is minimal, it cannot achieve its function. The function only arises once the organ is complete. The first variation is therefore useless. This is the case of the wing: if the first variation is a simple beginning of a growth, it does not allow the organism to fly, and therefore cannot be selected.

Bergson's Likely Sources

- 15 This criticism, in either its A or B formulation, is found in several authors cited by Bergson in *Creative Evolution*, although their names do not appear in the discussion of the Darwinian argument. A is found in particular in an article by Cuénot from 1901, which Bergson must have read. When Bergson argues, against the heredity of acquired characters, that "it is perhaps because its eyes were becoming atrophied that [the mole] condemned itself to a life underground" (Bergson 1911, 84), he refers to an 1894 paper by Cuénot. Yet, in this paper, even though Cuénot refutes the heredity of the acquired and takes the example of the mole, nowhere do we find the idea of an internal tendency to blindness (the atrophy of the mole's eyes is explained by panmixia). It is in a later article in which Cuénot departs from Neo-Darwinism that the idea taken up by Bergson is found almost word for word: "It is not because the mole lives underground that its eye has degenerated, but it is because its eye has degenerated that it has been forced to adopt a cavernicolous [*obscuricole*] life" (Cuénot 1901, 269, my translation). It is highly probable that Bergson read this 1901 article. In this text, Cuénot questions the usefulness of minimal variation: "minimal variations, even when they are useful in all degrees, are of too little use to create an advantage giving rise to selection", and takes the example of the giraffe: in times of scarcity, the weakest (oldest or youngest) are the ones that die, "and there is no chance that a neck that is a few centimetres longer will ensure the survival of its possessor" (Cuénot 1901, 266, my translation). Cuénot distinguishes usefulness and benefit in the context of the struggle for existence, even

though in Darwin, usefulness is defined in direct relation to the struggle for existence. Cuénot refers to Mivart, Nägeli and Delage among others.

- 16 Delage's *L'hérédité et les grands problèmes de la biologie générale* is also cited several times by Bergson. In this work, Delage formulates several arguments against Darwinian theory. We find A: "slow variations, even when useful at every stage, are too little to create an advantage for selection" (Delage 1903, 404)³; and the example of the giraffe. Just before this argument, he also develops B: "there are many useful characters which selection has not been able to form because their usefulness only becomes apparent when they are perfectly developed" (Delage 1903, 402). He then refers to the examples given by Mivart among which the baleen plates and the cases of mimicry (resemblances between certain organisms and their environment or other living beings, which enable them to camouflage themselves or, on the contrary, to attract prey). As Delage writes, "a protective imitation only becomes useful when it is perfect" (Delage 1903, 403). Thus, the early stages of variation are "of no [adaptive] interest and cannot be the basis of selection" (Delage 1903, 403). As a footnote to this passage, we find a lengthy discussion of the possible causes of mimicry, in which Delage quotes Eimer's explanations.
- 17 In a work by Eimer, also cited by Bergson, we find in detail B: variations, as long as they are still minimal, cannot be useful (Eimer and Fickert 1897, 52). Eimer, referring to Mivart, also studies mimicry, pointing out that, since variations go in all directions, the first variations would not be sufficiently similar to another object for natural selection to capture and retain it (Eimer and Fickert 1897, 279-290). How can initially useless variations that go in all directions (they are accidental and undirected) be preserved and accumulated until mimicry is perfect?
- 18 Many of Bergson's sources set out the problem of the uselessness of minimal variations, whether variations are seen as insufficiently useful to give rise to selection, or simply utterly useless until the final trait is fully developed. It may be pointed out that A is also found, albeit very briefly, in Cope (1887, 28), again referring to Mivart's work. Therefore, Bergson must have been familiar with this critique of Darwinism. Yet, he does not make a classical exposition of it, since he synthesises A and B by evading Darwin's (2): he identifies the minuteness of variation with its neutrality in terms of usefulness, without seeing that, in Darwin, the one does not entail the other, because of the intensity of the struggle for existence. He summarises the Darwinian argument as follows:
- I. Variation is insensible (minimal and neutral).
 - II. Natural selection operates on these insensible variations.
 - III. Through the accumulation of these neutral variations, a useful organ would appear.
- 19 Bergson denounces the absurdity of (II), which leads him to say that natural selection should have a prescience of the final organ in order to preserve the first variations. This is a caricature of the Darwinian argument, but also a misleading simplification of the criticism of gradualism, which confuses A with B through the word 'insensible'. Where does this odd interpretation come from?
- 20 It is difficult to know where he got the phrase, but we can assume that he borrowed it from an article by Dastre in 1903 in *La Revue des deux mondes*. This article is not explicitly cited by Bergson, but it can reasonably be assumed that he read it. Dastre was a fairly well-known figure, and Bergson refers to him in *Creative Evolution*. *La Revue des deux mondes* was also widely read by intellectuals at the time. More importantly, Dastre

proposes an argumentation quite close to the Bergsonian one. Like other critics, Dastre considers that the benefit of a slight variation “would be too insignificant to give rise to selection” (Dastre 1903, 211, my translation). He refers to the case of the giraffe and exposes it as a mix of A and B: “With Mivart, Naegeli, Delage, [...], Cuénot, etc., we can affirm that in case of a scarcity this advantage [a neck a few centimetres taller] would be null and void [...]. The variation has to be considerable from the very outset in order to constitute a real advantage and for the selection process to apply to it” (Dastre 1903, 211, my translation). He adds that (4) is also impossible: it seems absurd that unnecessary variations accumulate while waiting to become useful (Dastre 1903, 210, my translation). This accumulation of variations in the same direction would be unlikely, not just because the variation appears randomly but because each small variation would be useless in itself. This argumentation blurs the meaning of ‘insensible’: and it is hard to know if it is supposed to mean ‘minute’, or ‘neutral’: “the main reproach that one must address [to Darwin] is precisely that the considerable change that creates a new species is derived from a too slow accumulation of insensible changes” (Dastre 1903, 212, my translation).

- 21 All these authors refer to Mivart, who formulated first these objections A and B, although, unlike Delage who makes them two separate objections, he brings them together under the idea that natural selection cannot account for the first stages of useful structures. He also uses the word “insensible,” which adds to the confusion about the objection: are variations insufficiently useful to be advantageous in the struggle for existence, or are they merely useless?

The Origin of Bergson's Argument: Saint George Mivart

- 22 In 1871, Mivart publishes *On the Genesis of Species*, that brings together his ideas on evolution. His most popular idea is that “natural selection utterly fails to account for the conservation and development of the minute and rudimentary beginnings [...], however useful those structures may afterwards become” (Mivart 2009, 23). Mivart eventually admits that small variations can be selected, “provided always that these minute beginnings are of such a kind as [...] to have a certain efficiency, however small, in favour of the conservation of the individual possessing them” (Mivart 2009, 24), but Darwin himself expresses this reservation!
- 23 He gives examples that seem to correspond to objection A, others to objection B, without making the difference explicit. He mentions, among others, the case of baleen, which cannot yet act as a sieve to retain the whales’ tiny prey until fully developed (B). He also underlines how difficult it would be to account for preservation of the first rudiments of limbs in higher animals, “such rudiments being, on the hypothesis in question, infinitesimal and functionless” (Mivart 2009, 38) (B). On the giraffe’s neck, he explains that even if the first variations may seem useful, they would entail inconveniences, such as an increase of the giraffe’s weight, that would ultimately make the variation disadvantageous to the survival of its bearer (A).
- 24 Mivart also criticizes the idea of variations accumulating in the same direction. He relies on the cases of mimicry amongst lepidoptera. Here is Mivart’s objection: “The deviation must [...], in each case be in some definite direction. [...] But as, according to Mr. Darwin’s theory, [...] the minute incipient variations will be in all directions, they must tend to neutralize each other [...] It is difficult, if not impossible, to see how such

indefinite oscillations of infinitesimal beginnings can ever build up a sufficiently appreciable resemblance to a leaf, bamboo, or other object, for 'Natural Selection' to seize upon and perpetuate" (Mivart 2009, 33-34). Mivart draws on another example, much more Bergsonian: the formation of the eye. Like Bergson after him, he thinks that "these complex and simultaneous co-ordinations could never have been produced by infinitesimal beginnings, since, until so far developed as to effect the requisite junctions, they are useless" (Mivart 2009, 52). He quotes a passage by Joseph John Murphy in which the latter underlines the difficulties raised by "the concordant result of visual development springing from different starting-points and continued on by independent roads" (Mivart 2009, 52). That's the Bergsonian analogy of structure. This example, as with Bergson, serves to show that if it is improbable that small variations accumulate in the same direction on a single evolutionary line, it is all the more incredible, if one admits natural selection as the mechanism of evolution, that the same variations accumulate in the same way on two different lineages.

- 25 It is difficult to know whether Bergson had first-hand access to Mivart's work, or whether he simply synthesised what he had read elsewhere. Although it does not constitute historiographical evidence, the similarity in the structure of the argument is nevertheless remarkable. We have, however, left out a crucial source for Bergson: Darwin's own work, where we can find the most comprehensive account of Mivart's argument. If Bergson did not read Mivart directly, he may have had a detailed summary in *The Origin of Species*.

Darwin's Response

- 26 Darwin addresses Mivart's objections in the 7th chapter of the 6th edition. He first points out that some answers can be found in chapter 6, where he studies the "gradation of characters, often accompanied by a change of function" (Darwin 1876, 177). Thus, he resolves B by putting forward the argument of functional changes: "an organ originally constructed for one purpose, namely [...] may be converted into one for a widely different purpose" (Darwin 1876, 148). In Chapter 7, he explains the formation of whale baleen as a gradual change in function from horn points for grasping and tearing food to baleen for filtering water (Darwin 1876, 182-186). He also discusses the more difficult case of mimicry (Darwin 1876, 181-182). The problem is solved, according to him, when it is understood that insects which, through natural selection, end up resembling an object in their environment almost exactly, must already have presented "some rude and accidental resemblance" to this object. Implicitly, there is a change of function: the structure of the insect did not originally have the function of mimicry (it resulted from organs that had other functions). The first accidental resemblance, however, may have proved useful and natural selection was then able to preserve all the variations that accentuated this initial resemblance.
- 27 He also addresses A by discussing the counterexamples proposed by Mivart. Among them, the giraffe for which Darwin indicates that even small differences in size "are not of the slightest use or importance" (Darwin 1876, 177-180). Therefore, the selected variation is by no means indifferent; it is very useful, although very slight. Despite the fact that a giraffe with a slightly longer neck will need extra food, the length of its neck has advantages that will more than compensate for this defect: the giraffe will be able to reach more food, and "that increased bulk would act as a protection against almost

all beasts of prey.” What Darwin demonstrates is precisely that the selected variation is not insensible. For each case advanced by Mivart, Darwin’s response is the same: even the slightest variation, if selected, must have been of real benefit in the struggle for existence.

- 28 Darwin also tackles the problem of directionality, saying it disappears as soon as one admits the natural selection of advantageous variations: “there would indeed be force in Mr. Mivart’s objection, if we were to attempt to account for the above resemblance, independently of natural selection, through mere fluctuating variability” (Darwin 1876, 182). But variability is not floating; it is guided by the very action of selection. Among the variations “in all directions”, only the useful ones are retained. Assuming a relatively stable environment at least for a certain period of time, it can be assumed that what is useful to an organism in one generation will also be useful to the next one. Therefore, there is an orientation given to variation by natural selection, which can explain the accumulation.
- 29 It is clear that Bergson was aware of Mivart’s critique, but it is hard to tell what his sources are. Even though Bergson quotes *The Origin of Species*, it is legitimate to ask whether he has read this 7th chapter. For if it was through Darwin that Bergson became aware of the Mivartian critique, his silence on Darwin’s responses seems mysterious. Perhaps it can be explained by the fact that, as the popularity of Mivart’s critique shows, these answers were deemed unconvincing. First, it was considered too extraordinary that a minute variation could be really useful. The second reason, found in Eimer and Cope, was that Darwin was seen as evading the problem of the origin of variation. In particular, Eimer criticises his answer regarding mimicry, since Darwin leaves open the question of how the first rude resemblance came about, only displacing the problem (Eimer and Fickert 1897, 288-290). The same reproach can be found in Bergson, whose conceptualisation of *élan vital* stems less from the negation of the principle of natural selection than from questioning the possibility of the appearance of viable variations (Bergson 1911, 179).

The Eye of the Pecten and the Anticipation of the Elan Vital

Bergson’s Mistake

- 30 Finally, we return to the example that Bergson supposes lethal to Darwinism: the structural analogy of the eye in Pecten and in man, which he probably takes from Louis Roule (Balan, 1996, 96). A Darwinian may reply that “identical effects may arise from different causes, that more than one road leads to the same spot” (Bergson 1911, 59). This is indeed what Darwin suggests when he discusses Mivart’s objection about the eye (Darwin 1876, 151-152): “In all cases of beings, far removed from each other [...], which are furnished with similar and peculiar organs, it will be found that [...] fundamental differences between them can always be detected.” Darwin studies the similarities between the eyes of molluscs and vertebrates (even though he speaks, contrary to Bergson, of cephalopods and not of bivalves). According to him, this resemblance is due to technical necessities: a transparent tissue and a lens are required to form an image. Yet, for Darwin, this resemblance is no identity: “Beyond this superficial resemblance, there is hardly any real similarity between the eyes of cuttle-fish and vertebrates”

(Darwin 1876, 152). He then lists all the differences between the two in the structure of the lens, retina, and muscle ratios, and concludes: “As two men have sometimes independently hit on the same invention, so [...] it appears that natural selection [...] has produced similar organs, as far as function is concerned, in distinct organic beings” (Darwin 1876, 152). Darwin’s argument is grounded in the fact that this similarity is not an identity. This is what Bergson calls into question when he studies the structure of the eye in Pecten and in man.

- 31 According to him, they are “*identical* structures [...] formed on independent lines of evolution” (Bergson 1911, 60, my emphasis). Bergson addresses the Darwinian idea that several roads lead to the same spot, which, he believes, could not apply to this structural analogy: “The place reached does not give the form of the road that leads there; while an organic structure is just the accumulation of those small differences which evolution has had to go through in order to achieve it.” (Bergson 1911, 59). Therefore, if two organs have exactly the same structure in different lineages, they must have undergone exactly the same mutations in the same order: the same effects have had the same causes. “That two walkers starting from different points and wandering at random should finally meet, is no great wonder. But that, throughout their walk, they should describe two identical curves exactly superposable on each other, is altogether unlikely” (Bergson 1911, 60).
- 32 Now, it so happens that the resemblance between the human eye and the eye of the Pecten, belongs to the first case: same meeting point (vision) but different paths taken (different organic structures). The eye of the Pecten is not identical to our eye: it has two retinas, and this explains the particular inversion of the retinal elements: the outer retina (where the elements are inverted) receives light from the inner retina, which functions as a mirror (Balan 1996). Bergson’s counterexample thus collapses. Therefore, should the Bergsonian theory of evolution be rejected outright?

Topicality of the Elan Vital

- 33 Although the eye of the Pecten is not comparable to ours, the eye of the squid does have a structure almost identical to that of our eye. There are similar structures in divergent lineages that natural selection alone cannot explain. To appreciate this, it is necessary to question what Darwin leaves out — the root cause of variation — and this implies taking genetics into consideration. We now know that the development of organisms very different phylogenetically could involve homologous genes or similar genetic circuits. For instance, the *Hox* genes, present in all bilaterally symmetrical animals, are responsible for the structures along the antero-posterior axis, both in vertebrates and in insects (which possess a homologous genetic complex: *Hom*). If the homologous gene found in mice is inserted into a mutant fly, it fulfils the role played by the normal gene of the fly (Jacob 1997). There are similar phenomena for the eye. The development of the eye in squid, as in human, is governed by *Pax-6* which not only is present in cephalopods and humans, but also has homologs in drosophila and fish. It controls the action of other genes which are specific to different species and who result in eyes also specific. So, there are similar morphogenetic developments in different phyla which are reminiscent of the Bergsonian “analogies of structure”: it does seem that the same “mechanism of eye induction may be conserved throughout the animal kingdom” (Neumann and Nüsslein-Volhard 2000, 2138-2139).

- 34 This does not mean that the *élan vital* can be assimilated to genetics, but that this image, which attempts to question what the science of his time leaves out (duration), is not devoid of empiricity. Despite Bergson's scientific errors, the *élan vital* as an image aiming at accounting for the activity of evolution, capable of generating new forms, still appears as topical. It allows us to think together of a certain unity of impulse which continues through the lineages, and which is manifested as much by the community of a genetic heritage as by the diversity of biological forms, without being reduced to these manifestations: "Harmony is rather behind us than before. It is due to an identity of impulsion" (Bergson 1911, 54). It is this impulse, and its deployment through different but inextricably intertwined living beings, that Bergson attempts to think through his conception of an *élan vital*, which spreads in duration. "Life, in proportion to its progress, is scattered in manifestations which undoubtedly owe to their common origin the fact that they are complementary to each other in certain aspects, but which are none the less mutually incompatible" (Bergson 1911, 109). Hence the images of the "upspringing" (Bergson 1911, 49) and the "sheaf" (Bergson 1911, 104): the movement of life is centrifugal; from the initial unity springs an indefinite multiplicity of forms. Following Neumann and Nüsslein-Volhard, we should point out "the dramatic variation of eye structure, not only between vertebrates and invertebrates, but also within vertebrate lineages" (Neumann and Nüsslein-Volhard 2000, 2139). The same gene doesn't express the same way from one species to another, from one population to another. These structural variations based on similar genes or genetic circuits must be explained both by the evolutionary history of lineages and the individual history of living beings (their peculiar development). From this point of view, the concept of *élan vital* seems to illustrate the evolutionary process fairly well: it is faithful to Darwinism from the point of view of the powdery forms that biodiversity takes over the course of its history; it anticipates genetics by indicating the upstream similarity of certain characteristics of living beings. And yet the *élan vital* expresses something more, that Darwinism cannot account for: the irreducibility between the forms of the living and the mechanisms discovered in them. Seizing this irreducibility requires the consideration of real duration, which is not the unfolding of the external mechanism that would be natural selection, but the continuity of a biological activity, internal to the organisms and which shapes their relationships as well as their evolution. Bergson's *élan vital* seeks to think beyond the mechanism of natural selection. It expresses the original impulse of life but also its creative and unpredictable deployment through forms that are not the results of passive adaptations to changes in the environment but, on the contrary, are born of the development of internal structures that represent mediations organisms deploy with their environment (Ansell-Pearson 1999, 40).
- 35 If Bergson's misinterpretation of the variation as insensible, and his unfortunate choice of a counterexample based on a fact that would later turn out to be erroneous led to Bergson's discredit, we believe this concept of *élan vital* to be more fertile than what the end of the 20th century might have led us to believe.

Conclusion

- 36 The aim of this article was to trace the history of the misinterpretation that led Bergson to believe that, in Darwin, the variation at the origin of evolution would be

insensible. We have shown that this interpretation followed a popular critique at the turn of the 20th century, which has its roots in the work of Mivart. It is difficult to know whether Bergson read this author first-hand, but he certainly had access to the content of his criticism. Whether the filiation is direct or indirect, it has allowed us to highlight the originality of Bergson's formulation. What he mainly brings to the debate, beyond his confusion about the insensibility of variation, is the case of the structural analogy, from which he develops the idea of the *élan vital*. We wanted to show that despite the falsity of this example, the *élan vital* keeps on questioning what natural selection cannot explain: biological activity and its deployment in duration. The *élan vital* is an attempt to seize the unity of the evolution of biological forms, as well as their contradictions. Bergson's philosophy proposes an approach that accounts together for the unity shared by all living beings, the specificity of their internal duration, and the contradiction that arises from their own activities. Thereby, it also allows for an ecological approach conceiving the community of all living beings through their interdependence and conflicts (Ansell-Pearson 2018, 6-7). Bergson's *élan vital* appears as a synthetic intuition of these different biological processes, studied by separate scientific disciplines. As Huxley wrote, it offers an "intellectual vision of evolution as a fact, as something happening, something whole, to be apprehended in a unitary way — that is unsurpassed" (Huxley 1923, 33).

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NOTES

1. These references come from the 6th edition of *The Origin of Species*, as this is the one to which Bergson refers.
2. For instance, "les vastes fanons de la baleine groenlandaise pourraient provenir du développement de semblables lamelles, grâce à une série de degrés insensibles tous utiles à leur possesseur" (Darwin 1882, 248, my emphasis): "the immense plates of baleen in the Greenland whale might have been developed from such lamellæ by finely graduated steps, each of service to its possessor" (Darwin 1876, 183, my emphasis).
3. All the Delage quotes are translated by me.

ABSTRACTS

Bergson offers an epistemological critique of Darwin's theory that focuses on his gradualism: for Darwin variation is "minute", and Bergson glosses "insensible." His main argument is that if variations are insensible, they cannot confer an advantage to the organism and therefore be selected. Yet, for Darwin, the selected variation is not insensible: to be selected, it must be beneficial to its bearer in the struggle for existence. This article aims at understanding the origin of this misunderstanding by tracing the history of this critique. To do this, we will study Bergson's sources, showing that his interpretation of Darwin is in line with the critique of many biologists at the turn of the 20th century, albeit in a confused way. This will lead us back to the origin of this critique: the work of Mivart. In this study, we wish to reveal the anchor of the Bergsonian interpretation in the debates of his time, and the shifts from the traditional exposition of the argument that led Bergson to formulate this false paradox. This article will also analyze more precisely the counterexample of the "analogy of structure" to show that, despite Bergson's misunderstanding, he did point to actual limits of the Darwinian theory.

Bergson propose une critique épistémologique de la théorie darwinienne qui porte surtout sur son gradualisme. Chez Darwin la variation est « minime », et Bergson glose « insensible ». Son argumentation repose sur l'idée que si ces variations sont véritablement insensibles, elles ne peuvent conférer un avantage à l'organisme et donc être sélectionnées. Or, pour Darwin, la variation sélectionnée n'est pas insensible : si elle est sélectionnée, c'est au contraire qu'elle doit procurer un avantage à son porteur dans le cadre de la lutte pour l'existence. Cet article vise à comprendre l'origine de ce malentendu en retraçant l'histoire de cette critique adressée à Darwin. Pour ce faire, nous étudierons les sources de Bergson, en montrant que son interprétation de Darwin rejoint, quoique de manière confuse, la critique de nombreux biologistes au tournant du XXe siècle. Cela nous conduira à l'origine de cette critique : les travaux de Mivart. Par-là, nous souhaitons mettre en évidence l'ancrage de l'interprétation bergsonienne dans les débats de son époque, ainsi que les glissements par rapport à l'exposé traditionnel de l'argument, glissements qui conduisent Bergson à la formulation de ce faux paradoxe. Cet article analysera enfin le contre-exemple de l'« analogie de structure » pour montrer que, malgré l'interprétation faussée que Bergson fait de Darwin, il a bien mis le doigt sur des limites réelles de la théorie darwinienne.

INDEX

Keywords: biology, Bergson, Darwin, evolutionary theory, natural selection

Mots-clés: biologie, Bergson, Darwin, théorie de l'évolution, sélection naturelle

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