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“Great is Darwin and Bergson his poet”: Julian Huxley’s Other Evolutionary Synthesis.

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"Great is Darwin and Bergson his poet": Julian Huxley's Other Evolutionary Synthesis.

In 1912, Julian Huxley published his first book The Individual in the Animal Kingdom which he dedicated to the then world-famous French philosopher Henri Bergson. Historians have generally adopted one of two attitudes towards Huxley's early encounter with Bergson. They either dismiss it entirely as unimportant or minimise it, deeming it a youthful indiscretion preceding Huxley's full conversion to Fisherian Darwinism. Close biographical study and new archive materials demonstrate, however, that neither position is tenable. The study of the Bergsonian elements in play in Julian Huxley's early works fed into Huxley's first ideas about progress in evolution and even his celebrated theories of bird courtship. Furthermore, the view that Huxley rejected Bergson in his later years needs to be revised. Although Huxley ended up claiming that Bergson's theory of evolution had no explanatory power, he never repudiated the descriptive power of Bergson's controversial notion of the élan vital. Even into the Modern Synthesis period, Huxley represented his own synthesis as drawing decisively on Bergson's philosophy.

Key Words: Julian Huxley – Henri Bergson – Modern Synthesis – Progressive Evolution – Animal Behaviour

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1. Introduction

In 1970, at the end of a career of almost six decades covering areas as diverse as experimental and field zoology, eugenics, the theoretical foundations of the Modern Synthesis (a phrase which he coined), politics as well as the popularisation and philosophy of science, Julian Huxley published his Memories in two volumes. When recounting the years of his youth, Huxley looked back fondly upon the 1909 semi-centenary celebrations of Charles Darwin's Origin of Species at the University of Cambridge, identifying this moment as decisive in his own personal intellectual history, for it was then that he vowed to forever be a Darwinian.[1] Huxley did not however mention that, a few years later, when he published his first book The Individual in the Animal Kingdom (1912), a work that he qualified as 'philosophical biology'[2], in which he developed his first reflections on evolutionary progress, he had eagerly admitted that his main influence had been, not Charles Darwin but the French philosopher Henri Bergson[3], author of the international best seller Creative Evolution (1907). During the first decade of his career, the young zoologist frequently drew upon Bergson's metaphysical biology in his publications, lectures and personal notes but these early Bergsonian inclinations were also left out of his 1970 memoir. In fact, in his Memories, Huxley only mentioned Bergson once, to dismiss one of the philosopher's key notions, the élan vital, as 'unscientific and pseudo-mystical, failing both in immediate and in evolutionary relevance, and in biological accuracy'.[4]

This shift gave rise to two main historiographical attitudes towards Huxley's Bergsonism. The first ignores, or minimises, the impact of Bergson's influence in Huxley's work: Robert Gascoigne[5], John Greene[6] and Peter Bowler[7] study Huxley's notion of progress, and although the latter two do mention Huxley's early Bergsonism, they do not treat it as an important feature of his subsequent worldview. Mary Bartley successfully shows that there is a link between Huxley's vision of progress and his studies in field zoology.[8] However, she limits her study to Huxley's socio-political preoccupations ignoring his metaphysical interests and therefore misses an important aspect of Huxley's fascination with animal minds: his Bergsonian approach to mental evolution. The second trend is supported by historians such as William

Provine[9], Richard Delisle[10], Jean Gayon[11] and Michael Ruse[12], who argue that Huxley's intellectual trajectory progressed from his Bergsonian youth to his Darwinian coming of age. Huxley is seen as having shifted from defending purposeful evolution, a form of Bergsonian vitalism to a less metaphysical and less teleological view. Given Huxley's family history[13], it is no surprise these historians favoured the idea that there was a conflict in Huxley's mind between his obligatory Darwinian heritage and his early Bergsonism, and that in the long run his Darwinism won.

However, in what follows, I argue that new archive materials, in particular Huxley's personal notes and preparatory lecture notes, show that both options must be rejected. Firstly, Huxley's early investment in Bergson's philosophy cannot be ignored or minimised, for Bergson's influence on the young Huxley extended to areas of his research which, at first glance seemed to be part of an exclusively Darwinian conversation. Indeed, in addition to his 1912 book on individuality in which he explicitly declared allegiance to Bergson, Huxley's better remembered 1914 article on the courting habits of the Great Crested Grebe drew heavily on his Bergsonian reflections. Secondly, the idea that Huxley ultimately rejected Bergson needs to be revised. Not only did Huxley's encounter with Bergson during his formative years condition some of his subsequent main theoretical concerns, like evolutionary progress or the importance of mental evolution, but Huxley also maintained the Bergsonian components of his progressive evolution that he had developed in his 1912 book, long after his supposed shift away from Bergson. Rather than rejecting Bergson in favour of Darwin, Huxley operated a synthesis of both theories. This was made possible by the fact that, from the outset, Huxley envisioned both theories as performing different and complementary theoretical tasks, Bergson provided a description of what was in need of an explanation, while a certain version of Darwinism did the explaining. Before developing both of these claims further it is necessary to take a slight detour via Huxley's formative years. It was during his student days, before he even secured his first academic job, that Julian Huxley first encountered Bergson's philosophy.

2. Huxley's training in Darwinian-Oxonian biology and the transformative encounter with Bergson (1906-1911)

In his Memories (1970), Huxley acknowledged the good fortune of being born into the Huxley family, presided over by his grandfather, T. H. Huxley: 'I was born with great advantages, genetic and cultural'.[14] The cultural benefits took, among other things, the form of a perfect school career, from Eton to Oxford. Entering Balliol College, Oxford in 1906, the young man

joined one of the few intellectual environments that did not appear to be affected by what he would later come to call 'the eclipse of Darwinism'.[15]As historian Jack Morrell puts it 'In the 1910s and 1920s, when Darwinian natural selection was under attack as the sole or chief mechanism of evolution it was staunchly defended' in Oxford.[16] As a student, Huxley was in contact with some of the key actors in this Oxonian school of Darwinian biologists: he followed lectures by E. S. Goodrich and J. W. Jenkinson, 'the first major British experimentalist in embryology'[17], and he handed in weekly essays to his 'brilliant zoological tutor'[18] Geoffrey Watkins Smith. In June 1909, after graduating from Oxford with first-class honours, Huxley attended the semi-centenary celebration of the publication of the Origin of Species at Cambridge. The event was attended by delegates from over a dozen countries and, as Huxley recalled many years later, the 'the stream of addresses stressing the importance of Darwin's many-sided work' made a great impression on him. He had been invited 'as a Huxley and a budding biologist'.[19] Over 60 years later Huxley claimed that this was a decisive moment in his intellectual life:

> I resolved that all my scientific studies would be undertaken in a Darwinian spirit and that my major work would be concerned with evolution, in nature and in man. This was not so much a turning point in my career as a crystallization of my ideas, a clear vision and inspiration which I can truly say remained with me all through my life.[20]

Therefore, however romanticised this retrospective account may appear, this indicates that when Huxley eventually encountered Bergson, he was already working within a Darwinian framework.

After graduating, Huxley obtained a 'Naples Scholarship' which allowed young biologists to conduct research in the Naples Marine Biological Station founded in 1872 by Darwinian zoologist Anton Dohrn (with help from people like Julian's grandfather, T. H. Huxley). Upon arriving in Naples, the privileged young man encountered poverty for the first time. He sardonically recounted:

> The saying "See Naples and die" can be taken in two senses – either that you will never again see such beautiful scenery, or that you may catch some fatal disease like typhus in the city slums or malignant malaria in the adjacent marshlands.[21]

The station's well-equipped facilities attracted many reputable scientists over the years including August Weismann, Hans Driesch and Thomas Hunt Morgan. All Huxley needed was an interesting research project that would allow him to break new ground. It was one of the permanent members of the Stazio*ne Zoologica's* staff, the German zoologist and disciple of Haeckel, Paul Mayer (1848-1923), who suggested that Huxley explore some of the phenomena of regeneration and dedifferentiation already studied by Henry Van Peters Wilson (1863-1939). Wilson had published two papers in 1907 describing the results of his experiments on silicious sponges.[22] He demonstrated that, as a result of artificially induced degeneration, some of the surviving cells aggregated (or coalesced) and formed undifferentiated tissue which had the power to regenerate, differentiate and form a new functioning sponge. In addition, he suggested that a thus obtained differentiated cell would, under the right conditions revert to an undifferentiated state which, in turn, could regenerate. During his time in Naples, Huxley attempted to repeat Wilson's experiments on a different, less-specialised form, Sycon raphanus. He carefully applied himself to the replication of Wilson's method of chopping up the sponge and straining it through a fine gauze in order to segregate the cells, receiving technical advice from Mayer. He was able to show that Wilson's results on silicious sponges also extended to Sycon raphanus. Huxley's descriptions were lengthier and more detailed that Wilson's. He described the spontaneous reunion of the artificially separated cells; this phenomenon did not occur in natural conditions. It was followed by regeneration, or as Huxley called it 'reorganisation', the phase during which the cells specialised and arranged themselves according to this division of labour, and the last phase was 'redevelopment'. Huxley extensively described each phase and compared the latter two to what occurred during 'normal' development. He observed the 'behaviour'[23] of the collar cells of Sycon raphanus when completely isolated from the rest of the organism: in these special conditions, these cells would arrange themselves in the reverse of their normal position, as a reaction to the sea-water environment. Back in Oxford in 1910 Huxley was appointed lecturer and he published the results of his experiments on Sycon in the Philosophical Transactions of the Royal Society in 1911[24], 'a real honour for a biologist only twenty-three years old'.[25] Huxley's Sycon experiments had provided food for the young zoologist's more philosophical thoughts. In 1907, Wilson, had noted that for such organisms 'the ordinary idea of the individual is not applicable'.[26] Prompted by Wilson's reflections, Huxley began formulating his own thoughts on the matter. Huxley also drew inspiration from the fashionable philosophy of the man of the hour, Henri Bergson, who reflected on biological individuality as well as evolution in general in his international best seller, *L'Evolution créatrice*.

The same year Huxley published his Sycon article, Bergson momentarily abandoned his responsibilities as Professeur at the Collège de France and travelled to England to deliver some much-anticipated public lectures.[27] Bergson's nephew, Floris Delattre claimed that in the period 1910-1914, Great Britain had been hit by a veritable 'Bergson Boom'. [28] Everybody was talking about his new philosophy of time. First, he went to the University of Oxford and delivered two lectures in French before crowds of about 300 people[29] titled 'La Perception du Changement'. Two days later, he was at the University of Birmingham giving the 7th Thomas Huxley lecture, in English this time, titled 'Life and Consciousness'. In October, Bergson gave four lectures at University College London on 'The Nature of the Soul' to a large audience, his third lecture filling the theatre 'to its utmost capacity' and he was greeted to the sound of 'loud cheers'.[30] These talks were concise and clear presentations of some of the central ideas of his philosophy. In 'La Perception du Changement' he spoke about his philosophical definitions of intuition and time. With 'Life and Consciousness' he presented his metaphysical take on biological evolution, developed in his 1907 book *L'Evolution Créatrice* which had just been published in English. In London, he discussed the relation between spiritual and physical realities, between memories and the brain as well as the temporal and creative nature of consciousness.

Huxley had already become acquainted with Bergson's ideas thanks to a philosophy fellow and tutor at Balliol, Alexander Dunlop ('Sandy') Lindsay (1879-1952) who would later become Vice-Chancellor of the University of Oxford and who published in 1911 his Jowett lectures on 'The Philosophy of Bergson'[31]. Huxley later recalled that he often engaged in philosophical discussions with Lindsay.[32] When Bergson came to deliver his first ever lecture on British soil at Oxford, in 1911, Huxley had just taken up his first job as lecturer and demonstrator in the department of zoology and comparative anatomy, at that very university. It is therefore hard to imagine that the young philosophically-minded zoologist would have missed the opportunity to listen to one of the most famous intellectual figures of the time, right on his doorstep. Three days later, Bergson was honouring Julian Huxley's beloved grandfather, Thomas Henry Huxley, in Birmingham, all the more reason for Julian to be excited about Bergson's visit. If Huxley did indeed attend these lectures, he was surely captivated by Bergson's renowned oratory skills and galvanised by the enthusiasm of the audience.

The starting point of Bergson's philosophy and the central idea behind all of his main theses was apparently simple: time is not space. He believed that science had always provided a distorted picture of time and motion. He objected to time conceived as a juxtaposition of instants (mathematical time), proposing instead that time is an indivisible creative force which

he called duration (durée). Bergson's main works addressed several problems all based on this central notion of real time: the intimate nature of consciousness[33], the relation between mind and matter[34], the meaning of laughter[35] and biological evolution.[36] In his Oxford lectures, Bergson outlined his philosophical project. Since Plato, he said, philosophy has been suspicious of the unreliable human senses and has, as a result, taken refuge in conceptual thought. A more intuitive, non-systematic philosophy was possible. This philosophy would echo the way in which artists, like Turner embraced and transcended the senses by making visible certain aspects of reality which would otherwise have been left unnoticed. In his second lecture, Bergson described in detail his key notion of duration. The pre-Socratic philosopher Zeno of Elea (490-430 BC), with his famous paradoxes, exemplified and inaugurated the most pervasive misunderstanding in Western philosophy: the confusion between the juxtaposition of mathematical points and 'real movement'. Time and movement, said Bergson, are not a succession of simultaneities and duration is indivisible. Therefore, said Bergson: "There are changes, but there is no thing that changes: change doesn't need anything to stand upon. There are movements, but there aren't necessarily invariable objects that move; mobility does not presuppose something that moves"[37].

Bergson's philosophy of change left almost no one indifferent. It is therefore not surprising that traces of these talks, delivered in the very university where Huxley was working, can be found in one of Huxley's first publications in 1912, a contribution to a collection of Oxford Mountaineering Essays.[38] The chapter contained poetical and philosophical thoughts inspired by a holiday Huxley had spent in the Swiss Alps. These thoughts were all variations on a Bergsonian theme: at first sight, mountains are the very symbol of stability. We like to see them as immutable beings supporting all the changes occurring around them. However, just as Bergson had remarked in his Oxford lectures, Huxley stated that "Our intelligence, indeed, although it transcends the senses' immediate judgements, has to go back to them and ask their aid if it is to attain to fullest knowledge" and it is thus, "a very imperfect instrument"[39]. Even though we cannot perceive it, mountains, like everything else in the world, are subject to unceasing, irrevocable change (or duration). Human intelligence allows us to go beyond our senses to obtain knowledge about things we cannot perceive, such as the mutability of the seemingly immutable mountains; however, intelligence is ill-equipped when it comes to "feel[ing] fully and unquestioningly the rightness of"[40] the rationally obtained knowledge. This unquestionable feeling was akin to Bergson's notion of intuition, which Huxley acknowledged at the end of the essay: "feeling as well as reasoning, reasoning as well as feeling, is necessary

to true knowledge; a conclusion which would appeal to followers of M. Bergson but hardly falls within the scope of this book'"[41]. Like Bergson, Huxley believed that the mobile nature of reality required thinking in terms of tendency rather than static categories and he applied this principle in 1912 in his first book The Individual in the Animal Kingdom, a philosophical take on the question of biological individuality. The same year, Huxley took a position as research associate in biology at the newly founded Rice Institute in Houston. He had been head hunted by the President of the Institute himself who was travelling Europe to recruit promising young scientists.[42] Therefore, as Huxley was launching his scientific career, he had gained the experience and the intellectual maturity to take a step back from his experiments and begin thinking about some of the wider implications of his research.

3. The Individual in the Animal Kingdom: Huxley's first formulation of his theory of evolutionary progress.

Huxley had first tackled philosophical questions in biology, specifically the problem of biological individuality in 1911 through reflections about 'the meaning of death'.[43] Huxley stated that certain biological phenomena force us to question things we would otherwise take for granted such as the idea that life is necessarily accompanied by death. For instance, unicellular organisms divide but do they really die if they leave no corpse? By asking 'what dies?' Huxley was questioning the very nature of individuality and the link between the parts of an organism and the organism as a whole.

Huxley built upon these reflections in The Individual in the Animal Kingdom. His previous research on Sycon raphanus had made him eager to try to make sense of phenomena which appeared to complicate the notion of biological individuality such as reproduction, regeneration, human societies, parasitism and evolution. Huxley admitted that when he first chose animal individuality as a subject he 'had no idea of its real importance, its vastness and many ramifications'[44] but he then came to realise that the essay's subject-matter was such that it necessarily integrated psychological and philosophical considerations on top of the biological because biological individuality was intertwined with the evolution of consciousness. Huxley therefore identified his essay as a work of 'philosophical biology'[45] and was explicit about his Bergsonian heritage:

> My indebtednesses are great. It will easily be seen how much I owe to M. Bergson, who, whether one agrees or no with his views, has given a stimulus (most valuable gift of all) to Biology and Philosophy alike.[46]

Huxley quoted Bergson in the introduction outlining the main thesis of his book:

> the major portion of this book is devoted to showing that living matter always tends to group itself into these "closed, independent systems with harmonious parts". Though the closure is never complete, the independence never absolute, the harmony never perfect, yet systems and tendency alike have real existence.[47]

One of the main tendencies of life was to strive towards individuality or 'wholeness', a certain form of internal harmony by which the different parts of the system worked together towards the conservation of the whole and of the kind. The more complex the parts and their interactions, the stronger the internal harmony needed to be. Therefore, higher individuality was realised through higher complexity, via the differentiation of the parts, a sort of division of labour.

Bergson responded to the book with warm and enthusiastic words of encouragement:

> Not only do you manage to synthesise a great number of facts in simple, clear and elegant fashion; you also outline a sort of philosophy of nature by showing the progress of life in the direction of individuality. Your vision of progress gives us insight into the essence of individuality in a much more convincing way than simple formulations such as my own that you nevertheless do me the honour of quoting. [48]

In this book, Huxley formulated the first version of a vision of progressive evolution that he would maintain throughout his whole career. Progress, said Huxley, could be measured through the individual's independence from its environment: the more options an organism was able to consider and choose from in any given situation, the more independent it was. This was especially achieved through the complexification of the nervous system, allowing for more and more elaborate forms of consciousness. These themes had been developed by Bergson in *L'Evolution créatrice* and summarized in his 1911 Birmingham lecture. Like Bergson, Huxley claimed there existed almost an infinity of degrees of consciousness from primitive organisms, whose nervous systems were so simple that perception and action were mashed together in immediate reflexes, to more complex organisms whose complex nervous systems, with a division of labour between nerves and brain, allowed recollection of past perceptions and anticipation of future situations through choices based on these recollections. The more differentiated the nervous system, the higher the degree of consciousness, the more choices the organism was able to make and the more independent it was. Huxley employed Bergson's

description of the human nervous system as 'a veritable reservoir of indetermination' and added that this nervous system, 'by supplying the individual with memory and reason gives him the largest scope to adjust his actions, and so himself to the variations of circumstance'.[49] Bergson and Huxley viewed humans as the highest expression of progressive evolution, the most individuated of all individuals (and thus the most independent from their environment) because of how differentiated the human nervous system was.

Huxley continued to develop his Bergsonian vision of evolutionary progress in the years that followed. In the preparatory notes for the first of a series of public lectures he gave in Houston in 1916, he argued that with the arrival of mankind on the biological scene new forms of control had appeared. Huxley would later carefully lay out the principles of his eugenicist position, but he originally situated the very possibility of human controlled evolutionary progress, within a Bergsonian framework in which evolution was seen as continuously creative and constantly bringing about new means of creativity. According to Huxley, humans were in an extraordinary, unprecedented position, both products of creative evolution and within reach of taking creative control over evolution:

> "Creation is not a thing of the past, but here and now: and that he, Man, is the being to whom has been delegated some of the power of creation; for his own destinies are in his own hands, and it is within the power of his control to shape the future of his race".[50]

These early expressions of Huxley's theory of progressive evolution were therefore embedded within a Bergsonian framework in which evolution was a movement of progressive liberation of life from inert matter which culminated in humans, the species with the strongest creative potential. This constitutes, in itself, reason enough to take Huxley's Bergsonism seriously. In addition, a closer look at the fieldwork Huxley was conducting during the same period shows that Huxley's Bergsonism went beyond his explicit references to the French philosopher. Indeed, around the time Huxley published The Individual in the Animal Kingdom, he was also carrying out research in field-zoology, concentrating on the courtship habits of British birds. At first glance, there is no link between Huxley's philosophical concerns and his zoological fieldwork. However, when taking into account his vision of progress, it becomes apparent that Huxley's zoological practice and his fascination with the emotional lives of animals was a direct consequence of his Bergsonian philosophy, equating progress with the ability to acquire more and more complex mental and emotional states.

4. Birdwatching and mental evolution: Bergsonian biology in practice

In 1910, when Huxley was appointed lecturer at Oxford, he took up birdwatching again, an activity he had started pursuing at a very young age:

> at the age of thirteen, the sight of a green woodpecker at Stocks, with his green and yellow plumage, red head and black moustache, gave me my first full awareness of the wonderful creatures in our countryside and set me to serious birdwatching.[51]

According to Richard W. Burkhardt, Huxley's return to animal behaviour was due to chance since there were no apparent theoretical or institutional reasons for him to do so:

> When Huxley returned from Naples to Oxford in 1910 (…), neither his research in Naples nor his responsibilities at Oxford gave him any particular reason to take up the study of animal behaviour. Experimental embryology and genetics were the hot fields in biology. The study of animal behaviour, in contrast, was scarcely on the horizon.[52]

However, rather than this return to his old hobby being completely due to chance, it seems that Huxley's regained and maintained interest in birdwatching was a consequence of his fascination with the mental lives of animals, which he believed could be studied through their behaviour.

By 1912, Huxley had published three papers on bird behaviour. The first[53] was a note about a 'disharmony' in the behaviour of wild ducks in which Huxley described in quite gruesome detail the aggressive behaviour male ducks would sometimes inflict on females, going against their own individual interest and that of the species. Then came a detailed description of the courtship of the Redshank[54], observed by Huxley in April 1911 during a trip to Wales. The third bird-watching article Huxley published that year dealt with a strange phenomenon observed in the Great Crested Grebe[55]: both males and females possessed 'an erectile ruff at the sides of the neck and a pair of erectile tufts on the head'[56] and they both used them identically during courtship. These characters (by characters Huxley meant both structures and behaviours) had arisen through sexual selection rather than natural selection, and would be defined as secondary sexual characters were they not identical in both sexes. Huxley therefore proposed to name these characters 'epigamic characters'[57] instead.

At first glance, there is nothing very Bergsonian about any of these articles and they all seem to be part of an exclusively Darwinian conversation. If we are to look more closely though however, we find that here too, Huxley was operating a synthesis between Bergsonian and Darwinian biology. Burkhardt notes that as early as 1907 in a talk delivered before the Decalogue club at Balliol, Huxley provided 'an explanation of birdsong as an expression of emotion ('a kind of mental safety valve'[58]) and that like Darwin, he 'credited birds with 'mental states' and granted them at least a glimmering of reasoning power'.[59] In 1912, while he was developing his Bergsonian theory of progressive evolution, Huxley had become convinced that there was an element of choice in the birds' behaviour, more precisely in the female's attitude towards a potential mate. Huxley pushed the anthropomorphism as far as comparing the female Redshank's rejection of the male with the attitude of female humans:

> though the hen does not actively select her mate from among a bevy of competing cocks, yet, like the modern European woman, she has the power of saying yes or no to each individual male who may choose (here literally, there metaphorically) to run after her.[60]

This passage might seem to indicate that Huxley wanted to distance himself from any accusation of anthropomorphism by showing that he did not truly believe that any real choice was involved on the bird's part, but rather something that looked like choice to the human observer. However, a letter Huxley wrote to his then fiancé while observing the birds suggests that he believed that there was a difference in the degree of consciousness in bird and human behind the act of choosing, but that there was a choice in both cases nonetheless:

> the hen has the power of choice, – if she doesn't like the cock, away she just goes, & he always has to give up the chase eventually. Not only has she got it, but she exercises it a great deal – all the suitors so far have been rejected! It must be a queer kind of choice, I daresay, scarcely conscious at all, but very decided in its workings.[61]

John Durant qualifies Huxley's position as 'psychologistic'[62], meaning that he postulated the existence of the mental lives of animals and speculated about them. Huxley was putting into practice Bergson's idea of different degrees of animal consciousness correlated with the degree of choice and independence possessed by the animal, which he had already developed in The Individual in the Animal Kingdom.

Huxley expanded on this idea in his famous 1914 article 'The Courtship habits of the Great Crested Grebe (Podiceps cristatus); with an addition to the Theory of Sexual Selection'.[63] This article is still celebrated today[64] and is seen as a pioneering work in ethology.[65] Huxley later regretted the use of the word 'courtship' which designated behaviour carried out by an animal in order to court a member of the opposite sex, whereas the behaviours Huxley had observed among the Grebes were 'self-exhausting' expressions of emotion which served no such purpose. They were instead ways of strengthening the relationships between the bird couples and Huxley, in retrospect, admitted that the term 'Love-habits'[66] would have been more adequate. These behaviours, executed by both sexes, were accompanied by veritable emotions: 'during courtship there must be in the mind of the bird an excitement, a definite feeling of emotion'.[67] The structures and behaviours displayed by the birds had arisen, according to Huxley, through a process half way in between Natural and Sexual Selection, which he named 'Mutual Selection' and which ultimately rested upon the birds' reactions and 'choices' based on their emotional stimuli. The last pages of the article left no doubt whatsoever about Huxley's ideas on the importance of mental states in the birds, similar yet less complex than those of humans:

> In animals such as Birds, where there is a regular pairing-up season, and where, too, the mental processes are already of considerable complexity, it is impossible to doubt but that mating may be, and in some species is, guided by impulse, unanalysable fancies, individual predilection. There, in a rudimentary state, we find that form of 'choice' – intuitive, unreasoned, but none the less imperious, and none the less in its results a true choice – which reaches its highest stage of development in the intensely-felt affinities of man and woman – in that condition known as 'falling in love', where the whole of the subconscious mental activities become grafted on to the inherited sexual passions, the whole past of the mental organism is summed up in the present, in the intensely real act of choice which chooses one from among thousands and says, whether in words or no, 'that one being, and no other, is the being that I desire for my mate'. That a choice of this type can exist in birds is shown by the subject of this memoir.[68]

The Bergsonian style of this passage is manifest, in particular the reference to the present summing up the past in an act of choice which Bergson would have simply called 'durée'. Huxley was once again summoning Bergson's conclusions from 'Life and Consciousness'.

Humans possessed the most complex nervous system and were thus the most independent and individuated. Their mental states were the most complex and their range of emotional responses was the widest. Human expressions of emotion were 'more fluid'[69] and less determined by heredity than the Grebes' but the fact remained that human and Grebe alike possessed (in different degrees) a 'complex emotional life'.[70] Physiology could only go so far in understanding the emotional responses of birds. Translating the mental states of the Grebes using physiological terms like 'nerve-currents'[71], 'merely indicates the possible material mechanism; of the actual, we know next to nothing'.[72]

Huxley believed that Bergson's account of different degrees of consciousness leading up to man meant that drawing from our own human experience, inferences could be made about the inner states of the birds using a form of analogical reasoning. The naturalist could therefore conduct a form of animal psychology:

> by comparing the actions of the birds with our own in circumstances as similar as possible, we can deduce the bird's emotions with much more probability of accuracy than we can possibly have about their nervous processes: that is to say, we can interpret the facts psychologically better than we can physiologically. I shall therefore (without begging any questions whatever) interpret processes of cause and effect in terms of mind whenever it suits my purpose so to do – which, as I just said, will be more often than not.[73]

Huxley added that the level of complexity of the Grebe's mental states, as illustrated by their displays of emotion, proved 'how difficult, and almost inevitably futile, it is to try and deal with the emotional essence of things by the methods of 'ordinary biology'.[74] 'Ordinary biology' did not take into account a whole range of phenomena essential for understanding the evolution of life as a whole[75]. In Huxley's mind, 'ordinary biology' did not allow for philosophical ideas, such as those he developed in the Individual in the Animal Kingdom (one of his works in 'philosophical biology'), to inform scientific practice, such as his field-zoological study of bird behaviour.

It is therefore clear that Darwin and Bergson were major influences for Huxley from the very beginning of his intellectual life and remained so throughout his career. His first account of progressive evolution in The Individual in the Animal Kingdom rested upon Darwinian

selective pressures. The general characteristics of evolutionary progress on the other hand (increased complexity of mind and increased independence of mind from matter), were profoundly Bergsonian. Similarly, in his birdwatching papers, Huxley inserted himself in a Darwinian debate on Natural and Sexual Selection. However, it was Bergson's metaphysical take on evolution that inspired Huxley to take a closer look at animal emotions. In other words, before he coined the expression "Modern synthesis", Huxley was operating another, perhaps more personal synthesis between his Bergsonian philosophical vision and Darwinian science.

5. "Great is Darwin and Bergson his poet"

In one of his personal notebooks from around 1916, Huxley emphasised the complementary nature of Bergson's élan vital and natural selection in a simple phrase: "Great is Darwin, and Bergson his poet".[76] This single line which Huxley seems to have almost absentmindedly scribbled, among other notes to himself, in fact embodies the true nature of his attachment to Bergson's philosophy. Huxley did not favour Darwin over Bergson. In his lecture notes from the same period, Huxley's endorsement of Bergson was clear: "Bergson is right when he speaks of creative evolution" but he viewed Bergsonism as providing the picture or framework for evolutionary explanations which were from the outset Darwinian: "Through the labors and the insight of Darwin and his successors, it is being revealed to us how creation proceeds, and by what methods that which is higher and better may be produced from that which is inferior".[77] Huxley was, from the very outset, operating a synthesis between Darwin and Bergson, between scientific explanation and philosophical vision. Instead of starting out Bergsonian and gradually becoming Darwinian, Huxley saw his Bergsonian and Darwinian views as complementary from the outset. This is not, however, how historians account for Huxley relationship to Bergson's philosophy.

The received historiographical view, defended by Provine, Delisle and others, holds that Huxley shifted from a Bergsonian vision of purposeful evolution, envisioning mankind as the inevitable result of evolutionary progress, to a less vitalistic and more Darwinian view. While it is true that Huxley disavowed Bergson's notion of the élan vital as early as 1923, no doubt, as noted by Michael Ruse partly in a tactical move to distance himself from the vitalistic connotations of the élan vital[78], it remains to be seen exactly what form this shift took. First of all, it is important to note that neither Bergson in 1907 nor Huxley in 1912 argued in favour of

purposeful or teleological evolution. For both thinkers, to say that progressive evolution followed certain tendencies did not entail that evolution pursued a predetermined goal. They did, however, involve general evolutionary trends. One of these trends was the increasing control of organisms over their environment which had become tied to the development of higher forms of consciousness via more and more complex nervous systems and, for contingent reasons, the highest point of this trend was mankind. The élan vital, or vital impetus, was a metaphor Bergson had devised to describe the creative nature of life and the unpredictability of its evolution. Bergson explicitly said that evolution could have turned out differently[79] and this was because the main trends pursued by the élan vital were limited by material constraints. Huxley shared a similar position, recycling one of Bergson's comparisons between the creativity of life and the creativity of poets:

> Life has had to contend with the limitations of her own physical basis, and the result achieved is a compromise; not what she planned, but what her imperfect materials allowed her to carry out – the old difference between the poem flashed on the poet's brain and the same poem of paper, striving to gleam through the words that build it.[80]

Secondly, if there was indeed a shift, it was not away from Bergson and towards Darwin. As I have shown, Huxley had been Darwinian-minded since the beginning of his intellectual career. In fact, as early as 1912, in The Individual in the Animal Kingdom, although he kept an open mind about the causes and mechanisms of evolution, Huxley already envisioned evolutionary progress as part of a Darwinian framework[81]. Furthermore, the vision of progress Huxley defended throughout his career remained very close to the Bergsonian vision he developed in 1912. In 1942, in his famous book Evolution, the Modern Synthesis, Huxley represented the new Darwinism to which he subscribed and named "the Modern Synthesis", as still resolutely drawing upon Bergson's philosophy:

> It is with this reborn Darwinism, this mutated phoenix risen from the ashes of the pyre kindled by men so unlike as Bateson and Bergson, that I propose to deal in succeeding chapters.[82]

In this book, Huxley's vision of progress in evolution was still a non-universal phenomenon which was expressed through complexification, 'the possibility of bringing past experience to bear on present problems'[83] and the 'increase in the control exerted by organisms over their

environment, and in their independence with regard to it'[84] and was still intimately tied to mental evolution, culminating in human intelligence and the human nervous system.[85] In other words, Huxley maintained all that the élan represented: unitary evolution, creation of new forms, directionality understood as the pursuit of certain tendencies without telos.

Why then, do the historians of science who have studied Huxley's theory of progressive evolution, claim that such a shift ever took place? I have already mentioned Huxley's dismissal of the élan vital in his 1970 Memories. Another, much less recent article of Huxley's is often quoted to illustrate his repudiation of Bergson. In a now somewhat famous passage, in his 1923 article, "Progress, Biological and Other", Huxley described Bergson as 'a good poet but bad scientist' and argued that the élan vital was as bad an explanation for evolution as the 'élan locomotif'[86] would be for explaining the complex engineering of a train. The apparent contrast between the Bergsonian tones of Huxley's 1912 book and his dismissal of the élan vital in 1923 is what has misled historians; but however damning Huxley's critique may appear, several elements should draw our attention to the fact that the 1923 article did not represent a repudiation of Bergsonism. In in the same passage, after calling Bergson a "bad scientist" and just before deriding the explanatory power of the élan vital, Huxley had lauded Bergson's philosophical insight:

> [Bergson's] intellectual vision of evolution as a fact, as something happening, something whole, to be apprehended in a unitary way – that is unsurpassed. He seems to see it as vividly as you or I might see a hundred yards race, holding its different incidents and movements all in his mind together to form one picture.[87]

Huxley's comment about Bergson being a "good poet" should not be understood as a sarcastic attempt to discredit Bergson's philosophy. It was, on the contrary, to be taken quite literally. Huxley himself had been writing poetry since his teenage years and his 1923 essay even opened with one of his poems entitled "Evolution: at the Mind's Cinema" in which he mused about his own "intellectual vision" of cosmic as well as biological evolution:

EVOLUTION: AT THE MIND'S CINEMA

I turn the handle and the story starts:
Reel after reel is all astronomy,
Till life, enkindled in a niche of sky,

Leaps on the stage to play a million parts.

Life leaves the slime and through all ocean darts;
She conquers earth, and raises wings to fly;
Then spirit blooms, and learns how not to die, –
Nesting beyong the grave in others' hearts

– I turn the handle: other men like me
Have made the film: and now I sit and look
In quiet, privileged like Divinity
To read the roaring world as in a book.
If this thy past, where shall thy future climb,
O Spirit, built of Elements and Time!'

This poem can be seen as Huxley's attempt to capture his own "intellectual vision of evolution". The young biologist sincerely admired (perhaps even envied) Bergson's poetic insights into the evolution of life (these insights did, after all, earn the philosopher the Nobel Prize for literature in 1927). Bergson's philosophical writing style was based on the notion that that fluid metaphorical language would do a better job at representing the mobility of reality than would restrictive conceptual language. When Huxley called Bergson a poet, he was referring to the multiple metaphors the philosopher used in his books in an attempt to put the reader on the track of an intuitive vision of the mobile nature of reality. Therefore, even though Huxley did not grant the élan vital explanatory value, he did attach importance to its descriptive power. In his personal notes from around 1916, Huxley referred to the élan vital as a useful descriptive term whose evocative powers bore witness to Bergson's talent, his "poet's eye". The metaphor of the élan was however, said Huxley, too vague to convey matters "of cold fact"[88] and the explanation for progressive evolution could be found in a form of Darwinian pressure.

This brings us back to Huxley's simple and elegant note to himself: "Great is Darwin and Bergson his poet". The élan described what was in need of an explanation: the progressive movement of evolution. The metaphor of the élan stretched beyond biology and provided insights into evolution understood as a universal movement as well as into the purpose and meaning of human life. Darwinism, on the other hand provided much needed scientific tools to explain the general trends of progressive evolution made visible through the philosopher's eye.

Therefore, science could inform the poetical insights of philosophers while Bergson's intuitive methods could inform science by giving a direction to scientific research. Before coming up with the phrase "Modern Synthesis", Huxley was already a synthesist at heart who saw philosophical reflections as having their place within scientific enquiry and who sought to insert scientific research within his philosophical worldview.

6. Conclusion

Huxley's dismissal of Bergson in his autobiographical work in 1970 has misled historians by misrepresenting or, at least, omitting the true nature of his intellectual relationship with Bergson. From the 1910s to, at least, the 1940s, Huxley's Bergsonism was neither a minor interest of his to be disregarded nor a youthful indiscretion to be dismissed as the prehistory of his career as a Darwinian biologist. Huxley's admiration towards Bergson was deeply rooted in his appreciation of different types of knowledge and their possible interactions, in his rejection of the separation of science and philosophy. In other words, in his desire to synthesise.

Why then the change of heart later in his life? Huxley's harsh rebuttal of the élan vital in 1970 is made all the more confusing by the fact that, in his later years, progressive and mental evolution remained major concerns of Huxley's. He went on to develop a worldview incorporating panpsychism into a monistic universe[89] and praised French Jesuit palaeontologist Pierre Teilhard de Chardin, also a Bergsonian at heart. It is not entirely clear at this stage what it is that changed in Huxley's mind. For now, one might speculate that by the 1970s, Bergson's name had become most unfashionable among biologists (with the exception of one or two French biologists at the end of their careers[90]). Nobel Prize laureate Jacques Monod provided a definitive albeit respectful dismissal of Bergson's philosophy in his best-selling book Le Hasard et la nécéssité. Study of the evolution of Huxley's philosophical interests and his attitude towards philosophy in the last decades of his career might shed light on these questions.

Beyond Huxley, in the light of the reconstruction above, three further historiographical threads appear worth pursuing. Firstly, the thread of Bergson's indirect legacy, through Huxley, in a certain anti-reductionist tradition in ethology. This tradition, exemplified by people like William H. Thorpe, continued to put the emphasis on the evolutionary importance of the mental lives of animals and animal activity, against a more mechanistic biological tradition.[91]

Secondly, the recent illuminating study by Jimena Canales on Bergson's encounter with Einstein[92] proved the importance of taking Bergson's influence in the scientific world seriously and embedding this influence within its political, social and cultural contexts. Bergson's debate with Einstein was ultimately devastating for the philosopher, who went from international fame to near oblivion. In contrast, Bergson's legacy within biology was longer lived and of greater importance than the historiography currently suggests. In the minds of Bergsonian biologists like Julian Huxley, Bergson had raised the status of biology, not by integrating it within physics, but by giving it philosophical significance. They viewed Bergson as having promoted biology to the position of most fundamental science by placing it at the intersection between questions about matter and questions about mind.

Finally, this study is an attempt to build upon the works of historians like Jon Hodge[93], Jean Gayon[94] and Richard Delilse[95] who have successfully drawn attention to the philosophical diversity within the Modern Synthesis. In addition to Huxley, other founders of the Synthesis, including Theodosius Dobzhansky, Ronald Fisher and Sewall Wright[96], were sympathetic to certain of Bergson's ideas. This is not to say that the Modern Synthesis was secretly carrying out a vitalistic agenda. Such a claim has as little historical grounding as the idea that the Modern Synthesis was a purely mechanistic and materialist enterprise. In fact, different neo-Darwinians drew on Bergson in different ways and at different times in their career. Historians should not shy from complicating the larger picture by paying attention to the many subtleties of scientists' philosophical concerns, rather than assigning them rigid intellectual categories. Julian Huxley is just one instance where close biographical study brings into light the complex interplay between philosophy and science.

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[1] Julian Huxley, Memories I (Harmondsworth : Penguin Books, 1970), p. 68.

[2] Julian Huxley, The Individual in the Animal Kingdom (Cambridge: Cambridge University Press, 1912), p. vii.

[3] Huxley, The Individual in the Animal Kingdom, pp. vii-viii.

[4] Julian Huxley, Memories II (Harmondsworth: Penguin Books,1973), p. 92.

[5] Robert M. Gascoigne, 'Julian Huxley and Biological Progress', Journal of the History of Biology, 24, n°3 (1991), pp. 433-455.

[6] John C. Greene, 'The Interaction of Science and World View in Sir Julian Huxley's Evolutionary Biology', Journal of the History of Biology,' 23, n°1 (1990), pp. 39-55.

[7] Peter Bowler, Reconciling Science and Religion. The Debate in Early Twentieth-Century Britain. (Chicago and London: The University of Chicago Press, 2001)

[8] Mary Bartley, 'Courtship and Continued Progress: Julian Huxley's Studies on Bird Behaviour', Journal of the History of Biology, 28, n°1 (1995), pp. 91-108.

[9] William Provine, 'Progress in evolution and meaning in life', in Julian Huxley: Biologist and Statesman of Science ed by Kenneth Waters and Albert van Helden (Houston: Rice University Press, 1992), pp. 165-180.

[10] Richard Delisle, Les Philosophies du néo-darwinisme (Paris: Presses Universitaires de France, 2009), pp. 24-77.

[11] Jean Gayon, 'L'Evolution creatrice lue par les fondateurs de la theorie synthetique de l'evolution', in Annales Bergsoniennes IV ed by Frédéric Worms. (Paris: Presses Universitaires de France, 2008), pp. 59-84

[12] Michael Ruse, From Monad to Man: The Concept of Progress in Evolutionary Biology (Cambridge Massachusetts: Harvard University Press, 1996), pp. 331-338

[13] Julian Huxley greatly admired his grandfather, T. H. Huxley often referred to as "Darwin's bulldog".

[14] Julian Huxley, Memories I, p. 5.

[15] Julian Huxley, Evolution, the Modern Synthesis. The Definitive Edition (Cambridge Massachusetts: The MIT Press, 2010), pp. 22-28.

[16] Jack Morrell, Science at Oxford 1914-1939. Transforming an Arts University (Oxford: Clarendon Press, 1997), p. 269.

[17] Morrell, Science at Oxford, p. 270.

[18] Huxley, Memories I, p. 61.

[19] Huxley, Memories I, pp. 67.

[20] Huxley, Memories I, p. 68.

[21] Huxley, Memories I, p. 71.

[22] Henry Wilson, 'A new method by which sponges may be artificially reared', Science, 25, n° 649 (1907), pp. 912-915 and Henri Wilson, 'On Some Phenomena of Coalescence and Regeneration in Sponges', Journal of Experimental Zoology, 5 (1907), pp. 245-258

[23] Julian Huxley, 'Some Phenomena of Regeneration in Sycon; With a Note on the Structure of its Collar-cells', Philosophical Transactions of the Royal Society of London. Series B, 202, (1911) p. 176.

[24] Huxley, 'Some Phenomena of Regeneration in Sycon'.

[25] Huxley, Memories I, p. 75.

[26] Wilson, 'On Some Phenomena', p. 248.

[27] 'University Intelligence', The Times, 18 May 1911, p. 4.

[28] Philippe Soulez and Frédéric Worms, Bergson (Paris : Presses Universitaires de France, 2002), p. 119.

[29] 'University Intelligence', The Times, 29 May 1911, p. 5.

[30] See 'Professor Bergson on the Soul', The Times, 21 October 1911, p. 4; 'Professor Bergson on the Soul', The Times, 23 October 1911, p. 4; 'Professor Bergson on the Soul', The Times, p. 11; 'Professor Bergson on the Soul', The Times, 30 October 1911, p. 10.

[31] Alexander Dunlop Lindsay, The Philosophy of Bergson (London: J. M. Dent and Sons Ltd, 1911).

[32] Huxley, Memories I, p. 58.

[33] Henri Bergson, Essai sur les Données Immédiates de la Conscience (Paris: Félix Alcan, 1889).

[34] Henri Bergson, Matière et Mémoire (Paris: Félix Alcan, 1896).

[35] Henri Bergson, Le Rire: essai sur la signification du comique (Paris: Félix Alcan, 1900).

[36] Henri Bergson, *L'Evolution créatrice* (Paris: Félix Alcan, 1907).

[37] My translation 'Il y a des changements, mais il n'y a pas de choses qui changent : le changement n'a pas besoin d'un support. Il y a des mouvements, mais il n'y a pas nécessairement des objets invariables qui se meuvent : le mouvement n'implique pas un mobile'. Henri Bergson, La Perception du changement. Conférences faites à *l'Universit*é *d'Oxford les 26 et 27 mai 1911* (Oxford : The Clarendon Press, 1911), p. 24

[38] Julian Huxley, 'Of the Behaviour of a Chamois: and Incidentally of Some Other Matters', in Oxford Mountaineering Essays ed by Arnold Lunn (London: E. Arnold, 1912), 37-55.

[39] Huxley. 1912. On the Behaviour of a Chamois, p. 42

[40] Huxley. 1912. On the Behaviour of a Chamois, p. 42.

[41] Huxley. 1912. On the Behaviour of a Chamois, p. 55

[42] Ronald W. Clark, Sir Julian Huxley, F. R. S. (London: Phoenix House Ltd, 1960), pp. 20-21.

[43] Julian Huxley, 'The Meaning of Death', The Cornhill Magazine, 30 (1911), pp. 492-507.

[44] Huxley, The Individual in the Animal Kingdom, p. vii

[45] Huxley, The Individual in the Animal Kingdom, p. vii

[46] Huxley, The Individual in the Animal Kingdom, pp. vii-viii.

[47] Huxley, The Individual in the Animal Kingdom, p. ix.

[48] My translation : 'Vous n'avez pas seulement réussi à synthétiser un nombre considérable de faits sous une forme simple, claire et élégante ; vous esquissez en outre une espèce de philosophie de la nature, en nous montrant le progrès de la vie dans la direction de l'individualité. La vision de ce progrès nous renseigne d'ailleurs sur l'essence de l'individualité bien mieux que ne peut le faire une formule simple comme celle que j'avais donnée, – formule que vous me faites l'honneur de citer' – Houston, Rice University, Fondren Library, Julian Huxley Papers, Box 5 General correspondence, Bergson to Huxley, December 14, 1912

[49] Huxley, The Individual in the Animal Kingdom, p. 7.

[50] Houston, Rice University, Fondren Library, Julian Huxley Papers, box 57, Rice lectures 1914-1916

[51] Huxley, Memories I, p. 36

[52] Burkhardt, Patterns of Behavior: Konrad Lorenz, Niko Tinbergen, and the Founding of Ethology (Chicago: University of Chicago Press, 2005), p. 108

[53] Julian Huxley, 'A disharmony in the reproductive habits of the wild duck (Anas boschas, L)', Biologisches Zentralblatt, 32 (1912), 621

[54] Julian Huxley, 'A first account of the courtship habits of the redshank (Totanus calidris L.)', Proceedings of the Zoological Society of London (1912) pp. 647-656

[55] Julian Huxley, 'The great crested grebe and the idea of secondary sexual characteristics', Science, 36 (1912), pp. 601-602

[56] Julian Huxley, 'The great crested grebe and the idea of secondary sexual characteristics', p. 601

[57] Julian Huxley, 'The great crested grebe and the idea of secondary sexual characteristics', p. 602

[58] Burkhardt, Patterns of Behavior, p. 106

[59] Burkhardt, Patterns of Behavior, p. 107

[60] Huxley, 'A first account of the courtship habits of the redshank', p. 650

[61] Julian Huxley quoted by Richard W. Burkardt, 'Huxley and the Rise of Ethology' in Kenneth Waters and Albert van Helden (eds), Julian Huxley: Biologist and Statesman of Science, (Houston: Rice University Press, 1992), p. 135

[62] John R. Durant, 'The Tension at the Heart of Julian Huxley's Evolutionary Ethology' in Julian Huxley: Biologist and Statesman of Science ed by Kenneth Waters and Albert van Helden, (Houston: Rice University Press, 1992), pp. 150-160

[63] Julian Huxley, 'The courtship habits of the Great Crested Grebe (Podiceps cristatus) with an addition to the Theory of Sexual Selection' Proceedings of the Zoological Society of London, 84 (1912), pp. 491-562

[64] Michael Brooke, 'Michael Brooke reappraises Julian Huxley's pioneering classic of animal behaviour on its centenary' Nature, 513 (2014), p. 484

[65] Burkhardt is however suspicious of these claims. See Burkardt, 'Huxley and the Rise of Ethology', p. 135 and Burkhardt, Patterns of Behavior

[66] Huxley, 'The courtship habits of the Great Crested Grebe', p. 35

[67] Huxley, 'The courtship habits of the Great Crested Grebe', p. 509

[68] Huxley, 'The courtship habits of the Great Crested Grebe', p. 559

[69] Huxley, 'The courtship habits of the Great Crested Grebe', p. 510

[70] Huxley, 'The courtship habits of the Great Crested Grebe', p. 557

[71] Huxley, 'The courtship habits of the Great Crested Grebe', p. 509

[72] Huxley, 'The courtship habits of the Great Crested Grebe', p. 510

[73] Huxley, 'The courtship habits of the Great Crested Grebe', p. 510

[74] Huxley, 'The courtship habits of the Great Crested Grebe', p. 511

[75] This was an idea that Huxley further developed, less than ten years later, in an article with a telling title, 'Ils *n'ont que de l'âme*: An essay on bird mind' (Julian Huxley, 'Ils n'ont que de l'âme : An essay on bird mind', The Cornhill Magazine, 54 (1923), pp. 415-427). Even if there were different degrees in consciousness, a 'principle of uniformity' should apply and naturalists should expand their study of animal behaviour to include the whole range of animal emotion that organisms have acquired through evolution.

[76] Houston, Rice University, Fondren Library, Julian Huxley Papers, Box 48, Diary December 1916 – March 1917

[77] Houston, Rice University, Fondren Library, Julian Huxley Papers, box 57, Rice lectures 1914-1916

[78] Michael Ruse, From Monad to Man, p. 337

[79] Bergson, *L'Evolution cr*éatrice, pp. 268-280.

[80] Huxley, The Individual in the Animal Kingdom, p. 29

[81] Huxley, The Individual in the Animal Kingdom, pp. 114-116

[82] Huxley, Evolution, the Modern Synthesis, p. 28

[83] Julian Huxley, Progress Biological and Other, in Essays of a Biologist (New York: Alfred A. Knopf, 1923), p. 29

[84] Huxley, 'Progress Biological and Other', p. 30

[85] Huxley, Evolution, the Modern Synthesis, pp. 556-578

[86] Huxley, 'Progress Biological and Other, p. 33.

[87] Julian Huxley, 'Progress Biological and Other', p. 33.

[88] Houston, Rice University, Fondren Library, Julian Huxley Papers, box 57, Rice lectures 1914-1916

[89] See Delisle, Les Philosophies du néo-darwinisme.

[90] Emily Herring, 'Des évolutionnismes sans mécanisme : les néo-lamarckismes métaphysiques d'Albert Vandel (1894-1980) et Pierre-Paul Grassé (1895-1985)' *Revue d'histoire des sciences*, 69, 2(2016), pp. 369-398

[91] Gregory Radick, 'Biographical article on W. H. Thorpe' in The New Dictionary of Scientific Biography ed by Noretta Koertge, (Detroit, Michigan: Charles Scribner's Sons, 2008), pp. 42-45

[92] Jimena Canales, The Physicist and the Philosopher: Einstein, Bergson, and the Debate That Changed Our Understanding of Time, (Princeton: Princeton University Press, 2015)

[93] Jon Hodge, 'Biology and Philosophy (Including Ideology): A Study of Fisher and Wright' in The Founders of Evolutionary Genetics ed by Sahotra Sarkar, (Dodrecht: Kluwer Academic Publishers, 1992), pp. 231-293.

[94] Jean Gayon, 'L'Evolution créatrice lue par les fondateurs de la théorie synthétique de l'évolution'.

[95] Delisle, Les Philosophies du néo-darwinisme

[96] In addition to Huxley, these other Modern Synthesis architects were especially enthusiastic about Creative Evolution for its anti-deterministic and anti-teleological arguments. Darwin's tree of life had eliminated the possibility of evolution following a predetermined goal. For decades after the publication of the Origin of Species, however, evolutionary progress continued to be portrayed as the ascent of a ladder leading towards mankind or modern industrial civilisation as end products. It is interesting to note that, despite his critique of Darwinian natural selection, Bergson proposed a non-directional vision of progress which provided the Neo-Darwinians of the early 20th century with theoretical tools to counter the teleological ladder model and drive home Darwin's original message. Evolution by natural selection, according to these thinkers, was creative in a Bergsonian sense, meaning that it brought about absolute novelties and therefore did not follow a predetermined plan nor did it result from deterministic causation. For more on this point see Jean Gayon, 'L'Evolution créatrice lue par les fondateurs de la théorie synthétique de l'évolution'. My PhD thesis (forthcoming 2018) will examine these questions at length.