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**The Darwinian Theories of Instinct:
from Lamarckism to Selection**

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The Darwinian Theories of Instinct: from Lamarckism to Selection

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Abstract

Darwin's theory is generally reduced to a single book, *On the Origin of Species*, and to a single slogan: descent with modification by means of natural selection. However, such a reading is a caricature of Darwin's thought. It is possible to distinguish three main periods in the elaboration of Darwin's theory of descent. The diachronic period, preceding the reading of Malthus' *Essay on Population* in September 1838, is mainly concerned with a transformist theory based on the causes and laws of variation. The synchronic period, represented by the *Origin*, corresponds to the unification of Darwin's transformism around the principle of natural selection. The panchronic period, developed in *The Descent of Man*, conciliates the diachronic principles with synchrony, and particularly with natural selection.

Three different theories of instinct correspond to the three main periods of Darwin's thought. The diachronic theory is perfectly Lamarckian, while the synchronic theory denies any instance of Lamarckism. Both Darwin's manuscripts and published works show that the conversion to synchronism does not forbid an ever-present panchronic tendency. I propose to discuss the different theories of instinct, concentrating on both the synchronic conversion and the persistency of panchrony. This approach could be considered as part of a renewal of the Darwinian studies, emphasising problematics treated by the English naturalist but eclipsed by the caricatural interpretation of his thought that the orientation of modern science confirms.

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Introduction

Darwin's thought can be divided in three main periods. Between June 1837 and September 1838, which corresponds to Darwin's reading of Malthus' *Essay on Population*, the English naturalist develops a diachronic transformism mainly characterised by investigations on the causes and laws of variation. From September 1838 until the publication of *On the Origin of Species* in 1859, Darwin elaborates a synchronic transformism based on natural selection. Finally, in *The Descent of Man* and *The Expression of the Emotions in Man and Animals*, respectively published in 1871 and 1872, the Darwinian theory is unified by a panchronic approach of evolution. The synchronism of the *Origin* is generally accepted as representing Darwin's theory. Most of the Darwinian studies are concerned with the interpretation of what is considered as being Darwin's main book. The Darwinian theory is reduced to a slogan, i.e. descent with modification by means of natural selection. Such a caricatural interpretation of Darwin's thought allows scientists to claim that their theories are compatible with the Darwinian theory without being embarrassed by mechanisms, such as the heredity of habits, that have been disavowed by modern science but are still extensively used by the English naturalist in his early and late works.

Darwin's investigations on instinct illustrate the three different sides of his theory. Before 1856 and the discovery of the principle of divergence, the English naturalist develops a diachronic and a proto-synchronic theory of instinct that can be qualified as instances of Lamarckism announcing the panchronic approach of his later works. In the *Origin*, an entire chapter is devoted to Darwin's synchronic theory of instinct, undermining any application of Lamarckism. In the *Descent of Man*, Darwin rehabilitates the heredity of habits as a possible source of instinct and renders it compatible with natural selection, which corresponds to his panchronic perspective. Finally, *The Expression of the Emotions* is entirely based on the heredity of habits.

Studying Darwin's theories of instinct is a difficult task for three main reasons. Firstly, behaviour is not a part of mainstream Darwinian studies. Secondly, Darwin's diachronic and proto-synchronic theories are to be found scattered in his manuscripts. Thirdly, the English naturalist never clearly defines terms such as 'instinct' or 'habit'. However the analysis of Darwin's theories of instinct constitute an essential approach to a renewal of the Darwinian studies. Therefore, I propose to explore Darwin's theories of instinct through an interpretation of both his manuscripts and his published works focusing on the conversion from Lamarckism to selection.

The diachronic theory of instinct

Diachrony represents Darwin's first considerations with respect to the formation of species. Preceding his Malthusian approach, diachronic transformism focuses on the causes and laws of variation. The relations between species are practically not considered and the modification of species is the result of organic responses to inorganic changes. Such responses convoke behaviour. Indeed, despite Darwin's insistence on the role of generation to explain perfect adaptation in changing conditions, reproduction being not only a means of transmitting characteristics of the previous generations, but also to allow malleable structures to adapt to a changing environment, behaviour plays a central role in the adaptation of structure. Reproduction cannot explain modifications in mature individuals. It is precisely with

respect to such variations that behaviour constitutes a fruitful explanation. The main difficulty consists in defining behaviour. Instinct represents a minimal acceptance of behaviour. Darwin being still concerned by the question of the origins, because of his diachronic perspective, he has to explain the birth of instincts. Quoting Frédéric Cuvier, the English naturalist accepts the fact that habits can be turned into instincts. Such an explanation of the origins of instincts leads Darwin to adhere to Lamarckism.

Darwin's opinion on Lamarck's theory reflects the misunderstandings typical of his contemporaries, and of many present-day scholars, with respect to the French naturalist. In his *Philosophie zoologique*, Lamarck develops his theory of the heredity of characters acquired by habits, which can be summarised by two laws of nature. The first one states that the use or the development of a function provokes the improvement of a pre-existing structure or the creation of a new structure, while the disuse of an existing structure leads to its atrophy and its destruction. The second one concerns heredity of such acquired structures and states that two parents equally modified transmit their structure to their offspring. Although Darwin precisely uses this principle of the heredity of habits since his 'Transmutation notebooks' and relies on it as a law of variation even during the synchronic climax represented by the *Origin*, he criticises Lamarck's theory and affirms the divergences of his own theory several times. Darwin's criticisms do not bear on the two laws of nature as means of adaptation to changing circumstances but on the supposed cause of use or disuse, which leads the English naturalist to express several times that 'Lamarck's willing is absurd' (Darwin in Barrett *et al.*, 2009, pp. 224-225, 259). Indeed, Darwin thinks that Lamarck convokes the will of animals to explain use or disuse. However, such an interpretation of Lamarck's theory is completely erroneous. The French naturalist recognises, for the higher classes of animals only, a willing power, which is materially determined due to Lamarck's fluidic theory. By developing his diachronic theory of instinct, which is also a diachronic transformist theory based on perfect adaptation in the context of a changing environment, partly in reaction to the pseudo-Lamarckian theory previously evoked, Darwin constructs a perfectly Lamarckian theory based on the direct influence of circumstances.

The complexity in interpreting Darwin's diachronic theory of instinct is due to the lack of definition of the term 'habit'. Considering Darwin's evaluation of the pseudo-Lamarckian theory helps refining the acceptance of 'habit' in such a context. Opposed to the introduction of 'willing' in the process of adaptation through the heredity of habits, Darwin recognises the existence of purely physical, corporeal, or even vegetative habits provoked and modified by external conditions and common to both plants and animals. Such habits do not need any intervention of reason. However, it would be erroneous to limit the complexity of the outcome of these habits:

'In North and South America many birds slowly travel northward and southward, urged on by the food they find, as the seasons change; let them continue to do this, till, as in the case of the sheep in Spain, it has become an urgent instinctive desire, and they will gradually accelerate their journey. They would cross narrow rivers, and if these were converted by subsidence into narrow estuaries, and gradually during centuries to arms of the sea, still we may suppose their restless desire of travelling onwards would impel them to cross such an arm, even if it had become of great width beyond their span of vision. How they are able to preserve a course in any direction, I have said, is a faculty unknown to us. To give another illustration of the means by which I conceive it

possible that the direction of migrations have been determined. Elk and reindeer in N. America annually cross, as if they could marvellously smell or see at the distance of a hundred miles, a wild tract of absolute desert, to arrive at certain islands where there is a scanty supply of food; the changes of temperature, which geology proclaims, render it probable that this desert tract formerly supported some vegetation, and thus these quadrupeds might have been annually led on, till they reached the more fertile spots, and so acquired, like the sheep of Spain, their migratory powers.’ (Darwin in Stauffer, 1999, p. 125)

The habit of nutrition, which does not necessitate reason, can explain the complex instinct of migration, although the faculty of keeping the correct direction remains a mystery. Such an explanation of the emergence of the instinct of migration, which will be part of Darwin’s theory of instinct until the redaction of the *Origin*, is not only based on heredity of habits but on a perfectly diachronic acceptance of this principle. However, from the ‘Transmutation notebooks’ on, Darwin recognises that animals possess reason, which is defined as a mere association of ideas acquired through the senses. Reason emerges early in the scale of species. Intelligent action is not incompatible with the diachronic theory of instinct. Darwin’s adoption of materialism, which culminates in his notebooks *M* and *N*, reinforces the compatibility between reason and diachronic heredity of habits. The brain being the organ of intelligence, it is influenced by the same inorganic conditions that determine purely physical, corporeal, vegetative habits. Despite the accordance between reason and the diachronic theory of instinct, intelligent behaviour is the key to the panchronic approach, which is undeniably developed in the two essays of 1842 and 1844 and in *Natural Selection*, but will lie dormant until *The Descent of Man* because of the extreme synchronism of the *Origin* that denies both the heredity of habits and its intelligent determination as sources of instinct.

The proto-synchronic theory of instinct: the emergence of panchrony

Darwin’s synchronic or rather proto-synchronic theory commences after the reading of Malthus’ *Essay on Population*. On 28th September 1838, using Malthus’ mathematical presentation of the geometrical growth of population compared to the arithmetical growth of resources, Darwin expresses for the first time what will become his theory of natural selection:

‘One may say there is a force like a hundred thousand wedges trying force <into> every kind of adapted structure into the gaps <of> in the œconomy of Nature, or rather forming gaps by thrusting out the weaker ones.’ (Darwin in Barrett *et all.*, 2009, p. 375)

Darwin’s synchronic theory emerges by the consideration of the economy of nature, i.e. by the relations between species. However, as Ospovat (1994) has shown, until the discovery of the principle of divergence in 1856, natural selection acts intermittently because of its dependence on inorganic conditions. Indeed, natural selection can only operate when physical conditions change, causing variations. Because of the intermittence of natural selection, the emphasis on inorganic conditions and the belief in perfect adaptation, Darwin’s theory preceding the discovery of the principle of divergence can be qualified as proto-synchronic.

The reading of Malthus modifies Darwin's theory of instinct. Although the principle of use and disuse is still recognised as a law of variation, which forbids the exclusion of behaviour as a source of modification and adaptation, the mental powers and instincts are studied with respect to their compatibility with natural selection:

'I beg to repeat that I wish here to consider not the *probability* but the *possibility* of complicated instincts having been acquired by the slow and long-continued selection of very slight (either congenital or produced by habit) modification being as useful and necessary, to the species practising it, as the most complicated kind.' (Darwin in Stauffer, 1999, p.121)

The proto-synchronic shift is rendered evident by the structure of the two essays of 1842 and 1844 and of *Natural Selection*, which separates the causes and laws of variation from the question of instinct. In the *Origin*, the synchronic climax of the Darwinian theory is attained and while the structure is similar to the one of the unpublished essays and *Natural Selection*, any instance of Lamarckism is ruled out in the chapter dedicated to instinct, contrarily to the previous theories of instinct developed by the English naturalist. Indeed, both chance variations and habits are taken into account in the two essays of 1842 and 1844 and even in the chapter on mental powers and instincts of *Natural Selection*. Although a strong emphasis is given to the selection of chance variations, the heredity of habits is at least recognised for domesticated species. Arguing from domesticated species to species in the state of nature, Darwin does not forbid the occurrence of the heredity of habits for natural species but limits its importance. However, the observation of animals seems at odds with Darwin's theoretical conclusion. While reading the passages concerned with animal intelligence in Darwin's notebooks, one is startled by the generosity of the English naturalist with respect to the mental powers of animals. Such an attitude prefigures the argumentation of *The Descent of Man* in which Darwin confesses that 'the more the habits of a particular animal are studied by a naturalist, the more he attributes to reason and the less to unlearned instincts' (Darwin, 2004, p. 96). The two essays of 1842 and 1844, although the compatibility between instinct and reason is affirmed, do not insist on animal intelligence. In the contrary, in the chapter on mental powers and instinct of *Natural Selection*, Darwin not only reaffirms the compatibility of instinct and reason, despite a strong limitation of such occurrences, but introduces examples proving intelligent reactions to the external conditions, including the behaviour of others species, leading to the acquisition of a new instinct through what can only be defined as the heredity of habits:

I have already discussed the hereditary tameness of our domesticated animals: from what follows I have no doubt that the fear of man has always first to be acquired in a state of nature, & that under domestication it only is lost again. In all the few archipelagoes & islands uninhabited by man, of which I have been able to find an early account, the animals were entirely void of fear of man (...) But I have in my Journal given details on this subject; & I will here only remark that the tameness is not general, but is special towards man (...) The tameness of the birds at the Falklands is particularly interesting, because most of the very same species, more especially the larger birds, are excessively wild in Tierra del Fuego, where for generations they have been persecuted by the savages. (Darwin in Stauffer, 1999, pp. 495-496)

Instinctive fear has to be acquired. The external conditions determine the development of such an instinct. However, it is neither caused by chance variation nor by a purely physical, corporeal or vegetative habit motivated by inorganic conditions. The acquisition of instinctive fear is the result of an intelligent reaction to the organic conditions, to the economy of nature. Instinctive fear is issued from the heredity of what could be called an intelligent or mental habit. Although ‘in no case do individual acts of reasoning, or movements, or other phenomena connected with consciousness, appear to be transmitted’ (Darwin in Stauffer, 1999, p. 116), intelligent action can modify the brain and become a transmissible unconscious memory. What I have called mental habits is not to be confounded with the modification of instinct by reason or with the flexibility of instinctive behaviour through intelligent action. Mental habits are the transmission of experience, an instinctive cultural phylogeny:

‘In old inhabited countries, where the animals have acquired much general & instinctive suspicion & fear, they seem very soon to learn from each other, & perhaps, even from other species, caution directed towards any particular object. It is notorious that rats & mice cannot long be caught by the same sort of trap, however tempting the bait may be; yet as it is rare that the one which has actually been caught escapes, the others must have learnt the danger from seeing others suffer.’ (Darwin in Stauffer, 1999, p. 496)

The fact that a diachronic principle, i.e. the heredity of habits, is modified, which is evident by the introduction of the mental habits, and associated with synchrony proves that Darwin’s theory tends to panchrony. Such an orientation is still noticeable in the conclusion of the chapter on mental powers and instinct of *Natural Selection*:

‘Bearing in mind the facts given on the acquirement, through the selection of self-originating tricks or modifications of instinct, or through training & habit, aided in some slight degree by imitation, experience and intelligence, of hereditary actions & dispositions in our domesticated animals; & their parallelism (subject to being less true) to the instincts of animals in a state of nature: bearing in mind that in a state of nature instincts do certainly vary in some slight degree: bearing in mind how very generally we find in allied but distinct animals a gradation in the more complex instincts, which shows that it is at least possible that a complex instinct might have been acquired by successive steps; & which moreover generally indicates, according to our theory, the actual steps by which the instinct has been acquired, in as much as we suppose allied animals to have branched off at different stages of descent from a common ancestor, & therefore to have retained, more or less unaltered, the instincts of several lineal ancestral forms of any one species; bearing all this in mind, together with the certainty that instincts are as important to an animal as is their generally correlated structure, & that in the struggle for life under changing conditions, slight modifications of instinct could hardly fail occasionally to be profitable to individuals, I can see no overwhelming difficulty on our theory.’ (Darwin in Stauffer, 1999, p. 526)

The heredity of habits is still taken into account in the proto-synchronic theory of instinct. Habits can be the source of certain instincts but are also compatible with natural selection. Such a panchronic approach is not to be found in the *Origin*. The synchronic theory of instinct, already noticeable by the imperfect parallelism between

domesticated species (particularly subject to the heredity of habits) and species in the state of nature, is not compatible with the importance conferred to Lamarckism. In order to prove the possibility of the gradualism of instinct, Darwin uses a single principle, i.e. natural selection of chance variations, and gets almost rid of any intervention of inorganic conditions and intelligence. The diachronic and proto-synchronic theories of instinct, the latter showing the first instance of panchrony, affirm the precedence of function over structure. In the contrary, the synchronic theory of instinct is based on the precedence of structure over function.

The synchronic theory of instinct: the end of Lamarckism

One is not to find a radical change in Darwin's thought. Due to what Richards (1987) calls Darwin's conservatism, aspects of his precedent theories are always kept in the new advancements of his thought. It is not only possible to show premises of Darwin's future works in his personal writings, but also to notice previous aspects of his earlier theories in his later works. Thus, diachrony and panchrony are noticeable in the proto-synchronic and synchronic theories of instinct. The *Origin* constitutes the most pregnant expression, already evident in *Natural Selection*, of Darwin's synchronic theory. The principle of divergence, developed in 1856, allows the English naturalist to insist on the economy of nature, on the relations between species, to explain relative adaptation. The considerations on the causes and laws of variation are subordinated to those on the distribution of species. What could be called Darwin's ultra-synchronism, i.e. the assimilation of diachronic considerations by the precedence given to synchrony, is issued from the aim of the *Origin*. What is now considered as Darwin's major work is a manifesto in favour of transformism. In order to convince a sceptical scientific world, Darwin takes into account the hypothetico-deductive model of Victorian science and uses both Herschel's *vera causa* and Whewell's consilience of induction by unifying his theory of descent with modification around natural selection. The synchronic theory of instinct is issued from such a perspective.

As in the two essays of 1842 and 1844 and in *Natural Selection*, the question of instinct is treated with respect to its compatibility with natural selection. However, the seventh chapter of the *Origin* is labelled 'Instinct' contrarily to Darwin's previous works that all mention 'mental powers'. It is with such details that the synchronic turn is to be noticeable in the *Origin*. The relations between instinct and habits are transformed in the context of the synchronic theory. Instincts are compared to habits:

'Frederick Cuvier and several of the older metaphysicians have compared instinct with habit. This comparison gives, I think, a remarkably accurate notion of the frame of mind under which an instinctive action is performed, but not of its origin.' (Darwin, 1859, p. 208)

Although instinct is never clearly defined, the phenomenal comparison with habits helps the reader to reconstruct Darwin's definition, which would have innateness, community, fixity and unconsciousness as relative characteristics. The disjunction between habits and instincts in their respective origins is the most pregnant mark of Darwin's ultra-synchronism. In *Natural Selection*, both physical and mental habits are considered as possible, though rare, sources of instinct. Moreover, instincts from habitual origins are compatible with artificial and natural selections, which corresponds to the panchronic approach developed in *The Descent of Man*. In the

Origin, habits are reduced to mental habits. Such habits are still compatible with artificial selection, which corresponds to a minimal panchronic approach and may be extrapolated from the short passage on migratory instinct and instinctive fear. However, only a reader knowing Darwin's manuscripts could reconstruct this panchronic interpretation. As an independent book, and especially as Darwin's first theoretical book, the *Origin* conveys that habits are the result of (intelligent) experience, can phenomenally be similar to instincts but cannot be assimilated or defined as true instincts, which are issued from the selection of chance variations:

'It will be universally admitted that instincts are as important as corporeal structure for the welfare of each species, under its present conditions of life. Under changed conditions of life, it is at least possible that slight modifications of instinct might be profitable to a species; and if it can be shown that instincts do vary ever so little, then I can see no difficulty in natural selection preserving and continually accumulating variations of instinct to any extent that may be profitable. It is thus, as I believe, that all the most complex and wonderful instincts have originated. As modifications of corporeal structure arise from, and are increased by, use or habit, and are diminished or lost by disuse, so I do not doubt it has been with instincts. But I believe that the effects of habit are of quite subordinate importance to the effects of the natural selection of what may be called accidental variations of instincts; -that is of variations produced by the same unknown causes which produce slight deviations of bodily structure.'

(Darwin, 1859, p. 209)

By putting an emphasis on the struggle for existence, noticeable by the use of terms such as 'welfare', 'profitable' or 'conditions of life', which are not to be confounded with inorganic conditions, and by recognising that natural selection acts on 'accidental variations', Darwin enunciates his perfectly synchronic theory of instinct. Habits can only reinforce the action of natural selection, which does not represent an instance of panchrony. Indeed, diachronic principles are assimilated by synchrony. In other words, structure, i.e. mental structure, precedes function. Habits, as function, can only reinforce a pre-existing structure subject to small accidental variations. Animal intelligence is still recognised but subordinated to the structural determination through natural selection. The examples developed by Darwin confirm the synchronic theory. The instinct of the cuckoo, the slave-making instinct of certain ants or the cell-making instinct of the hive-bee can all be explained by accidental variations being selected. One of the greatest objections to Darwin's theory of natural selection even becomes the best argument for its applicability. The English naturalist confesses that the instincts of neuter social insects, these sterile insects having different structure and instinct and being unable to transmit them, has constituted the greatest challenge to his theory. However, by arguing from artificial selection and using community selection, such differences of structure and instinct can be explained, which constitute a fatal objection to Lamarckism. In short, the synchronic theory of instinct, by its explicative power with respect to instinct, allows Darwin to overcome creationist objections about complex behaviour and to propose a gradualist explanation of such phenomena in accordance with community of descent. Nonetheless, this solution condemns Lamarckism, panchrony, and subordinates mental powers to structure.

Conclusion

Darwin's investigations on behaviour are central to his different theories of community of descent with modification. The question of instinct makes appear the different periods of his thought. Although the linear succession from diachrony to synchrony and then panchrony is constatable in Darwin's different works, the persistence of panchrony, since Darwin's proto-synchronic period, is startling. Contrarily to the caricatural interpretation of the Darwinian theory, panchrony represents Darwin's complete and unified thought. In *Natural Selection*, useless behaviours and anti-adaptive instincts are identified. Such abnormalities are particularly important with respect to what could be called the Darwinian cultural project. It is from useless behaviours and anti-adaptive instincts that Darwin explains, in *The Descent of Man* and in *The Expression of the Emotions in Man and Animals*, the emergence of culture through a deselection of natural selection. Studying Darwin's different theories of instinct renders possible the understanding of an underestimated and parallel domain of the Darwinian studies. For example, Darwin's theory of a non-adaptive origin of language can be unified around the importance of behaviour by convoking the deselection of natural selection, sexual selection or the heredity of habits in the context of the expressions. In short, such an approach of Darwin's thought contests the centrality of both the *Origin* and natural selection.

In the context of an incessant biologisation of the social sciences, the reinterpretation of Darwin's theory could legitimise the independence of such disciplines from natural sciences. The renewal of the Darwinian studies could lead to the development of aborted theories, such as a non-adaptive explanation of the origin of language. Considering Darwin as an ethologist seems to be a way to escape the reductionism to which his theory has been subject.

References

- Barrett, P. H., Gautrey, P. J., Herbert, S., Kohn, D. & Smith, S. (ed.) (2009), *Charles Darwin's Notebooks, 1836-1844 : Geology, Transmutation of Species, Metaphysical Enquiries*, Cambridge : Cambridge University Press.
- Corsi, P. (2001), *Lamarck : Genèse et enjeux du transformisme*, Paris : CNRS Editions. [In French].
- . (Ed.) (2006), *Lamarck, philosophe de la nature*, Paris : Presses Universitaires de France. [In French].
- Darwin, C. (1859), *On the Origin of Species*, London : John Murray.
- . (2004), *The Descent of Man*, London : Penguin Classics.
- . (2009), *The Expression of the Emotions in Man and Animals*, London : Penguin Classics.
- Darwin, F. (Ed.) (2009), *The Foundation of the Origin of Species*, Cambridge : Cambridge University Press.
- Gruber, H. E. (1974), *Darwin on Man : A Psychological Study of Scientific Creativity*, Londres : Wildwood House.
- Hodge, J. & Radick, G. (ed.) (2009), *The Cambridge Companion to Darwin*, Cambridge : Cambridge University Press.
- Hodge, J. (1992), 'Darwin's Argument in the Origin'. *Philosophy of Science*, 59 (3), 461-464.
- Hoquet, T. (2009), *Darwin contre Darwin*, Paris : Vrin. [In French].
- Kohn, D. (1980), 'Theories to Work By : Rejected Theories, Reproduction, and Darwin's Path to Natural Selection'. *Studies in History of Biology*, 4, 61-170
- . (Ed.) (1985), *The Darwinian Heritage*, Princeton : Princeton University Press.

- Lamarck, J. B. (1986), *Recherches sur l'organisation des corps vivants*, Paris : Fayard. [In French].
- . (1994), *Philosophie zoologique*, Paris : GF Flammarion. [In French].
- . (1830), *Système analytique des connaissances de l'homme*, Paris : J.B. Baillièrè. [In French].
- Malthus, T.R. (2008), *An Essay on the Principle of Population*, Oxford : Oxford University Press.
- Mayr, E. (1991), *One Long Argument : Charles Darwin and the Genesis of Modern Evolutionary Thought*, Cambridge : Harvard University Press.
- Ospovat, D. (1995), *The Develpment of Darwin's Theory*, Cambridge : Cambridge University Press.
- Richards, R. J. (1987), *Darwin and the Emergence of Evolutionary Theories of Mind and Behavior*, Chicago : The University of Chicago Press.
- Ruse, M. (1999), *The Darwinian Revolution*, Chicago : The University of Chicago Press.
- Stauffer, R.C. (Ed.) (1999), *Charles Darwin's Natural Selection*, Cambridge : Cambridge University Press.
- Tort, P. (1997), *Darwin et le darwinisme*, Paris : Presses Universitaires de France. [In French].
- . (2008), *L'effet Darwin*, Paris : Seuil. [In French].
- . (2010), *Darwin n'est pas celui qu'on croit*, Paris : Le Cavalier Bleu. [In French].
- . (2011), *Darwin et la religion*, Paris : Ellipses. [In French].