Historians of science will be interested in *Critique's* overarching claim that science emerged from the western materialistic tradition that runs from Democritus and Epicurus through Hobbes, Marx, and Freud. It is interesting to contrast *Critique's* view of the long-standing materialist tradition of modern science with other claims, particularly the equally extreme one that asserts (see, e.g., J.T.O. Kirk, *Science and Certainty*, CSIRO Publishing Collingwood, Australia, 2007, p. 219) that "The brand of monotheism that universally prevailed in Europe, that proclaimed that the universe had been created by a single just and rational being, may have been crucial" to the dramatic development of modern science, which started in earnest only in the nineteenth century, yet has dramatically exploded our knowledge of the natural world.

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This extensive book may be the most complete synthesis of various criticisms of neo-Darwinian ideas stemming from distinct research traditions that, although steeped in the past, have received new attention in the last decade. The criticisms are used to build an alternative to neo-Darwinism by contesting its core claim; that is, natural selection is the cause of evolution. The originality of the book consists in arguing that new findings in evolutionary biology converge to support a theory of emergent evolution as "natural experiments," a name reminiscent of C.L. Morgan's *Emergent Evolution* (1923). The argument is systematic and thorough, with impressive and considerable results. The book draws on a wide-variety of works including Evo-Devo, physiology, symbiotic biology, and molecular epigenetics. Many of the major contributors to those fields are cited including West Eberhardt (2003) on developmental plasticity, Gerhardt and Kirschner's *Plasticity of Life* (2005), Newman and Muller on mechanisms of developmental novelties, Margulis on endosymbiosis, etc. Yet, Reid offers a more radical approach, since most would not argue that natural selection is essentially a "barrier to evolution" (p.410).

The book has two main dimensions. First, there is the anti-Darwinian critique: "the causal theory of the Modern Synthesis must be replaced, since its crucial agent, natural selection, reinforces stasis and obstructs evolution" (p.62). Reid argues that selection assumed evolutionary novelty begins a positive feedback process. In other words, Mayr's famous distinction must be inverted: "the proximate causes exhaust the searches for evolutionary causation, and the ultimate cause of natural selection belongs to non evolutionary causes" (59). Second, Reid offers a positive account of evolution by a theory of emergence, resting on an analysis of evolution on several levels including associations (esp. the origin of cellularity), physiology, development, epigenetic mechanisms (regulation of the genome), and directional evolution or orthogenesis. All these levels display a version of emergence that closely resembles the notion in the general literature from physics or computer science.

This novel theory mixes several traditional worries about neo-Darwinism not usually coming from the same sources. The traditional view considers only genes and forgets organisms, whereas the latter are genuine agents of evolutionary change. It contains a theory of variation that is insufficient, caused only by point mutation and recombination, whereas mechanisms of variation have become far richer. These new
involves epigenetic events and developmental constraints (i.e., "novelty in structural genes is not only caused by point mutation, but also by new cis-tron combinations, intragenic duplication, exon shuffling and the conversion of introns to exons" (p. 259)).

Neo-Darwinian evolution by natural selection is gradual whereas discontinuities occur that are crucial in understanding the history of life. Clearly, those three critiques are not logically related but Reid’s emergence theory still combines them.

Useful and general views of these controversies have been provided by some philosophers. For example, Godfrey-Smith in Complexity and Its Function in Mind and Nature (1996) contrasts external explanations of systems (environmental factors) with internal explanations emphasizing intrinsic processes. Obviously neo-Darwinian notions fall into the first class while many challenges to neo-Darwinism are internalist, such as Goodwin’s structuralism. However, Reid’s alternative is far richer than Goodwin’s and includes criticisms that mostly bear on the question of variation. In his The Changing Role of the Embryo in Evolutionary Theory, Amundson also distinguishes between two prominent positions, selectionist (neo-Darwinian) and developmentalist, that differ in terms of their explanatory framework. The selectionist explains differences (e.g., the frequencies of white and black moths on trees) whereas the developmentalist explains commonalities (e.g. the tetrapod limb). Reid’s position embraces the opponents of selectionism in both senses and, therefore, raises questions about his project. The first distinction is in terms of the explanation and the second is in terms of explanation, but one cannot conflate these two kinds of “selectionism vs. X” dichotomies. In other words, it may not be possible to build a structured unique alternative to neo-Darwinism; to be sure, Biological Emergences does not achieve such project.

Nevertheless, among the many interesting contributions in the book there are two aspects worth mentioning. First, there is the emphasis in on physiology instead of developmental theory, normally the preferred field Darwinian dissidents choose to oppose to Darwinism. Chapter 4 deals with the creation of novelty at the physiological levels and makes a useful parallel between the fundamental property of homeostasis and the reliability of development, referred to as homeostasis. Second, the theory of emergence distinguishes between both emergence through internal facts (repetitive differentiation, among others) and through the effect of environments (such as Müller and Newman’s experiments on development). Thus, it is not a purely internalist theory of emergence sensu Godfrey-Smith. It also distinguishes “salutary” emergence (symbiosis) involving both intrinsic and extrinsic factors from “critical point” emergence (which arises internally and functions like phase transitions), those forms underlying respectively “progressive evolution” (i.e. occurrence of new complexity levels) and adaptive evolution (i.e. diversification of species). Such a complex theory makes sense of various features of evolution pointed out by anti-selectionists. Though such an account is rich, the author should have consulted the recent emergence literature (i.e., J. Kim, “Making sense of emergence,” Phil.Stud. 1999 and P. Humphreys, Phil. Sci., 1997) instead of reviewing less relevant theories. What “emergence” means is described carelessly; philosophers usually consider it in terms of irreducibility, novelty, unpredictability, and possibly downward causation. Reader would have benefited to know how “biological emergence” behaves in terms of those issues, particularly concerning the controversial downward causation, mentioned only cursorily in the book. And since Reid cites John Holland’s Emergence (1998), an account of emergence centered on computer simulations (see the work of James Crutchfield or Mark Bedau) is relevant here.

Concerning the criticisms of selectionism, Reid does not cite the philosophy of
biology controversies on this issue. Indeed, most of his arguments have been developed and discussed in detail in several papers by Karen Neander, Elliott Sober, Denis Walsh, and others; all have questioned whether natural selection explains traits of organisms or only the spreading of the traits across populations. There are arguments that natural selection also contributes to the creation of new traits, arguments that Reid should have considered especially because he devotes much attention to assert that selection is not creative. Previously, Denis Walsh (Phil. Sci. 2003) made the case that selection assumes traits have arisen in individuals, mostly through developmental mechanisms, and fail them to spread or to become extinct, but he does not say that selection has no evolutionary role. Similar to Amundson's opposition, selection and developmental causes do not explain the same things. Reid incorrectly concludes from the first point—selection does not cause adaptations, as Walsh stated—to his point selection is not a cause of evolution (p.63).

Several critiques are relevant to Reid's downplaying of selection. A. The chapter on symbiosis curiously does not cite any of the important work on the concepts of cost, benefit, optimization, etc. (Bronstein, D. Yu, Van Baalen, and Jansen), all of which greatly deepened our understanding of biological associations. In this regard, symbiosis is a clearly a phenomenon to be fruitfully approached through selectionist concepts. More generally, the book does not display any formulae or equations, whereas natural selection created the possibility to build models in ecology, population genetics, etc. This enabled predictions and experiments. Even if it were more structured, emergence theory can not compete at this level. Additionally, Reid speaks of the emergence of multicellularity and societies. Indeed, there is a research program [he cites Maynard-Smith and Szathmary, Major Evolutionary Transitions (1995)] providing sophisticated explanations of the emergence of new levels in the evolutionary hierarchy (genes, chromosomes, cells, multicellular organisms) precisely in terms of multi-level selection (Michod, Darwinian Dynamics, 1999). If Reid had considered such selection theory he would have had more difficulty to oppose selection and emergence. Finally, a major concept in the book is the distinction between adaptation and adaptability, the latter being "the ability to modify itself or its behavior in direct response to environmental or internal change" (p.143), therefore a property distinct from variability in populations. However, adaptation is defined in a way [("genetically fixed and inflexible quality... appropriate to certain conditions of the internal or external environment" (p.140)] that does not do justice to the complexity of the concept in neo-Darwinian biology. "Adaptation" is usually a trait originated or maintained by natural selection and not a property of organisms (which is better referred to as "adaptiveness"), whereas some adaptive traits are not adaptations. In this context, "adaptability" can still be understood in a neo-Darwinian research program that would require the conditions under which the plasticity of phenotypes is selectively advantageous and, hence, likely to evolve. Thus, the contrast between adaptation and adaptability is not enough to rebut orthodox evolutionary biology.

It may seem unusual that a review points to missing references in a lengthy book. However, citations to philosophical notions, discussions, and typologies mentioned in the last paragraph would have assisted the author to make the book more focused and, hence, shorter. Still, it remains an important achievement and the most up-to-date synthesis of a coherent anti-selectionist position, with the utmost interesting contributions from the viewpoint of physiology.

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