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ORIGIN OF LIFE

Darwinism and the Origin of Life

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Abstract Historically, ideas on the origins of life have been mingled with evolutionary explanations. Darwin avoided discussing the origin of the very first species in public although he acknowledged the possibility that life originated by natural causes. Some of his followers adopted this materialistic position and advocated some sort of spontaneous generation in the distant past. Nevertheless, Pasteur's experiments were a major obstacle for scientific acceptance of the sudden emergence of life. The scientific study of the origin of life, established in the 1920s, required abandoning the idea of a unique chance event and considering a view of life emerging as the result of a long evolutionary process. At the turn of the twentieth century, some authors adopted non-Darwinian views on the origin of life, exemplified in this paper by the neovitalism of some Catholic scientists. We propose that Darwinism represents a genuine example of an adaptive scientific framework. By recognizing the shift in the features characterizing Darwinism, we can understand its relationship with theories on the origin of life in a non-dogmatic line.

Keywords Neovitalism · Spontaneous generation · Erich Wasmann

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What is Darwinism?

The search for a theory on the origin of life is a major issue in contemporary evolutionary biology, presenting both a philosophical (Griesemer 2008) and educational challenge (Lazcano and Peretó 2010). Historically, ideas on the origins of life have been mingled with the emergence of a generalized evolutionary account. Before Charles Darwin, some evolutionary systems had already incorporated a postulate of restricted spontaneous generation that could potentially explain the mystery of the origin of life without direct divine causation. In the German cultural world–very given to recognizing such spontaneous generation (Farley 1977, pp. 31–39)–we find the proposal by Carl Friedrich Kielmeyer (1765–1844), who posed a parallel between the developmental aspects of Earth's history, the series of organic forms and individual development, united under a common causal force. In 1804, in a letter to a friend, he explained that certain geological changes would produce some organic bodies (Richards 2002, pp. 246–247). Even though this idea is not exactly a hypothesis about the origin of life, it is an obvious option when considering the distant roots of life. In France, Jean-Baptiste Lamarck (1744–1829) suggested that the starting point of the continuous transformative process of living beings was just a phenomenon of spontaneous generation (Lamarck 1986). This spontaneous generation must be seen as the beginning of each series of organisms, which are generated by the inner directive forces of transformation. But it could also represent the "primordial start" of the history of life on Earth. Certainly, Lamarck hesitated about the problem of the origin of life. His ideas on chemistry hindered an open acceptance of the transformation of mineral substances into living ones (Tirard 2006). In any case, he took a discreet but real interest in the matter, despite all his doubts.

Opposed to these trends, British naturalists and philosophers were generally hard opponents of spontaneous

generation. Farley (1977, pp. 43–45) finds idiosyncratic theological reasons for this position. In any case, the mid-nineteenth century was characterized by a waning popularity of the theory, and this was the context experienced by Charles Darwin. We know that Darwin's interest in the origin of life was never a central concern within his theoretical framework. In fact, he explicitly eluded public discussion about the origin of life because he considered that science was unable to answer this question correctly at that time (Mayr 1982, p. 582; Peretó et al. 2009). Obviously, the influence of Darwinian ideas on several scientific proposals about the origin of life during the late nineteenth century and afterwards is quite another matter. At this point, it is not irrelevant to rethink the meaning and scope of what we term *Darwinism*.

It is possible to consider Darwinism merely as Darwin's theory. This apparently easy solution is not uncontroversial. According to Mayr (1985, p. 757, 1988, p. 198), there is no *single* Darwinian theory of evolution. In fact, we may distinguish five theories that Darwin combined: evolution as such, common descent, gradualism, multiplication of species, and natural selection. In this sense, the conceptual core of those five theories intertwined would constitute Darwinism. But Darwinism is not only a theoretical conglomerate, it is also a worldview and a scientific stance with deep social, ideological, and political implications. It is probably true that no supporters of Darwinism were to be found during the decades immediately following the publication of *On the Origin of Species* if we define a Darwinian as a complete adherent to all Darwin's theories. This is the idea underlying Peter Bowler's influential and provocative book *The Non-Darwinian Revolution* (Bowler 1988). But such a statement could also be impregnated with an anachronistic and essentialist attitude. For a historian of religious or political thinking, it is of course very important to measure the degree of deviation from the original predication of a creed or from the first manifesto of a governmental system. But surely, the historical analysis of the experienced faith or the real implementation of a regime is of greater importance. Similarly, we can find a great many nominal followers of Darwin that only partially adopt the theoretical kernel of his theory; but they see themselves, and are seen by others, as Darwinists—or, alternatively, supporters of Darwinism.

Studies on how Darwin's ideas were received and taken up in national contexts provide an excellent testing ground for serious thought about what Darwinism really is. For example, Sander Gliboff's book on the origins of German Darwinism balances the old image of Ernst Haeckel (1834–1919) as the faithful apostle of Darwin in Germany with the harsh view of him that Bowler projects (Haeckel as a pseudo-Darwinist), describing the latter naturalist as a "Darwinian reformer." Haeckel did not use Darwin's theories for ideological purposes alone or simply because they were in fashion. He attempted a serious work on species transformation and common descent, but did not find enough arguments to be convinced about natural selection (Gliboff 2008, p. 159). The Spanish case, which has been studied by Glick (1974, 2010), Núñez (1996), and Pelayo (2008), clearly shows how Darwinism infused a lot of anticlerical and free-thinking ideas during the convulsed late nineteenth century in officially Catholic Spain. But it also reveals genuine discussion of the scientific proof for evolution and an active assumption of evolutionary postulates in everyday scientific activity in that country.

Early Darwinian Conjectures on the Origin of Life

In her excellent account of the history of ideas about the origin of life, Fry (2000) qualifies as a "dead end" the confrontation between Louis Pasteur's (1822–1895) experiments to disprove spontaneous generation and the assumption of a natural origin of life within a Darwinian context. Actually, as early as 1862, Haeckel included a footnote in his monograph on radiolarians to severely stress "the chief defect of the Darwinian theory is that it throws no light on the origin of the primitive organism—probably a simple cell—from which all the others have descended. When Darwin assumes a special creative act for this first species, he is not consistent, and, I think, not quite sincere …" (Haeckel 1862, p. 232). For Haeckel, "consistency" and "sincerity" on the origin of life within the Darwinian theory, particularly the common descent postulate, would propose the natural emergence of primitive cells on early Earth as the root of the tree of life. According to his monistic worldview and the assumption of a protoplasmic theory of life—expounded by Thomas H. Huxley (1825–1895) among others—the German naturalist called for a material, causal, and historical connection between all living beings and their remote ancestors, from the early and spontaneous transition from inorganic to organic matter (amorphous protoplasmic substances) to primitive cells (Monera). Whether all current life forms have descended from a single stem or diverse stems, or whether life started chemically once or at different times, were questions left unanswered by Haeckel during his lifetime (Fry 2000, pp. 57–59; Richards 2008, pp. 136–138). In any case, Darwin had privately been playing with such consistent notions on the chemical roots of the first species, which Haeckel had missed when reading *On the Origin of Species* (Peretó et al. 2009); moreover, today we know of his confessed repentance of the use of the "Pentateuchal term of creation," expressed in a letter to Joseph D. Hooker (1817–1911) (Darwin 1863). According to Strick (2009), Darwin's ambivalence on the question of how the ancestor of all living beings had emerged elicited some confusion among his followers. This was likely due to his fear that open acceptance of a materialistic beginning of life might have a negative effect on those of his readers affiliated with liberal Christian theology.

At any rate, for a fully consequent Darwinian, life had a non-miraculous, spontaneous beginning on this planet in the distant past, despite the difficulty or even impossibility of observing such spontaneous generation under extant laboratory conditions. This was the intellectual stance taken by Huxley in 1870 in his Presidential Address to the British Association for the Advancement of Science and followed by other materialist scientists such as Haeckel, Karl W. von Nägeli (1817–1891), John Tyndall (1820–1893), and August Weismann (1834–1914). All of them speculated on different versions of an "evolutionary abiogenesis," the generation of life from inorganic matter through a process of chemical transformations on the primitive Earth (Kamminga 1988). However, a significant minority of Darwinian scientists, the more prominent being the co-discoverer of natural selection Alfred Russel Wallace (1823–1913) and the physician Henry Charlton Bastian (1837–1915) (Strick 2000, 2009), still thought that a full-fledged evolutionary theory required the observation of present-day spontaneous generations as proof of a natural origin of life. As stated by Bastian in his very last work, "'spontaneous generation' is no myth, and that simple living units of well-known kinds can now be evolved, even within experimental vessels, as other living things must originally have been evolved on the cooling surface of the earth" (Bastian 1911, p. 29).

New proposals of evolutionary scenarios for the origin of life were favored by the increasing molecularization of biology at the beginning of twentieth century (Fry 2006; Lazcano 2010). The contributions of Aleksandr I. Oparin (1894–1980) have generally been acknowledged as (a) the final abandonment of spontaneous generation (Farley 1977, p. 171); (b) a philosophical breakthrough assuming a materialistic view—without gaps between inert and living matter, or "continuity thesis" after Fry (1995)—and a Darwinist context—where the emergence of life was not by chance nor a single event but the outcome of a slow evolutionary process during long periods of time (Fry 2000, pp. 77–79); and (c) an epistemological background, shaped by the sociopolitical context, for the new experimental research program of prebiotic chemistry (Lazcano 2010). In 1929, John B. S. Haldane (1892–1964) published a short paper (Haldane 1929) that independently converged with the initial ideas exposed by the Russian biochemist (Oparin 1924) and that retrospectively constitutes the most significant contribution to the field from the western world in the 1920s.

Neovitalism as a Study Case of a non-Darwinian Approach to the Origin of Life

The opposition to spontaneous generation and the radical adoption of the Pasteurian corollary that life only emerges from previous life led some prominent scientists, mainly physicists, to propose that life is as eternal as matter in the universe. In other words, the study of life's origins becomes a nonsensical pursuit as it has always been present—planetary conditions permitting. This panspermia theory also contemplated possible cross-contamination between planets, through the space travel of spores or seeds (Fry 2000, pp. 59–62). Thus, in 1871, William Thomson (Lord Kelvin, 1824–1907) suggested that life reached Earth carried on a meteorite and Hermann von Helmholtz (1821–1894) and Svante Arrhenius (1859–1927) adopted similar ideas. Some scientists felt comfortable with the materialistic, non-supernatural, panspermia argument. This notion may be compatible with evolutionary thinking—despite Thomson's opposition to Darwin—since once life reached a planet, it would evolve by natural means; however, one could hardly qualify the panspermists as Darwinian. Actually, Darwin's friends and followers joked with each other about the "notion of introducing life on meteors" (Strick 2000, p. 92). Details varied among proponents of panspermia, but all these authors were of the same opinion regarding the impossibility that such a complex structure as a cell could emerge by chance. In fact, all the panspermia versions converged on the same philosophical ground: the dualistic conception that matter and life are two different categories and it is impossible to transform one into the other (Fry 2000, pp. 59–60).

The intellectual climate at the turn of the century was of perplexity among scientists and philosophers on the relationship between matter and life. Fry (2000) saw the favorable intellectual conditions for the rise of a neovitalistic approach at the beginning of the twentieth century, taken up by authors such as Hans Driesch (1867–1941) in Germany and Henri Bergson (1859–1941) in France as a reaction to that perplexity. It could also be seen as a philosophical response to the growing army of mechanistic scientists that regarded life as the outcome of the interaction between the chemical components of the cell. This notion was well at the center of the research program led by Jacques Loeb (1859–1924), whose goal was the artificial production of life (Loeb 1906, p. 223). Although neglected by the official history of biology, some early followers of the synthetic approach to life, such as the French scientist Stéphane Leduc (1853–1939) and the Mexican Alfonso L. Herrera (1868–1943), were pursuing both a better understanding of life and the possible pathways to its origin on Earth (Keller 2002; Peretó and Català 2007; Lazcano 2010). The works by Loeb, Leduc, and Herrera, like those by Heackel, raised strong concerns among vitalist scientists with strong religious ties, especially among Roman Catholics in Europe in the early twentieth century: Jaume Pujiula (1869–1958) in Spain, Agostino Gemelli (1878–1959) in Italy, and Jean Maumus (1860–1930) in France were Catholic priests, scientists, and authors of vitriolic criticisms of the materialistic approaches to life. Common to all of them were their religious backgrounds (the antimodernism of Pius X papacy), their anti-Haeckelian (anti-monistic) position, thus affiliating them with a dualistic philosophy, and their scientific

attachment to the Pasteurian rebuttal of spontaneous generation. In fact, Maurel (1999) sees these experiments by Pasteur as a real epistemological obstacle to progress in research into the origins of life, at least in some countries like France.

Another point in common for all these neovitalistic authors was the acceptance, albeit incomplete, of the postulates on the origin of life by Erich Wasmann (1859–1931). This prestigious German entomologist and Jesuit priest was probably the most vocal opponent to Haeckel and saw in him the worst enemy of science (Lustig 2002; Richards 2008, Chap. 9). Wasmann's first studies on slave-making behavior in ants were done under the influence of his anti-Darwinian convictions. But his researches on myrmecophiles (guests of ants) during the period 1901–1903, radically modified his opinions of evolutionary explanations (Lustig 2002; Richards 2008, pp. 360–367). Wasmann then became an advocate of evolutionary theory and its compatibility with the Catholic doctrine. In 1903, he published a work that summarized his research and its evolutionary implications: *Die modern Biologie und die Entwicklungstheorie*, reedited in 1904 and 1906 and translated into English in 1910 (Wasmann 1910). The author recognized that "the theory of evolution is indispensable to an explanation of the interesting facts of myrmecophily and termitophily" (Wasmann 1910, p. 340). This work was considered by Haeckel as a "masterpiece of Jesuitical sophistry" (cited by Richards 2008, p. 360) and actually sparked his very last public lectures in Berlin. Haeckel proclaimed the irreconcilability between the theory of evolution and any religion-inspired account of a scientific fact, especially the teachings of Jesuits and particularly the most dangerous among them, "Father Erich Wasmann, not only because that writer deals with the subject more ably and comprehensively than most of his colleagues, but because he is more competent to make a scientific defense of his views on account of his long studies of the ants and his general knowledge of biology" (Haeckel 1906, p. 171). The Berlin lectures by Haeckel held over three days in 1905 in the Sing-Akademie had a spectacular public impact. In 1907, Wasmann accepted an invitation to deliver three lectures and participate in a public discussion with scientists, also in Berlin, attended by thousands and attracting much media attention (Wasmann 1912). In contrast to Haeckel's Darwinian creed, Wasmann considered the origin of life to fall outside the scope of evolutionary explanations since for him it was a philosophical, not a scientific, issue (Wasmann 1912, p. 6).

Thus, for very different reasons, Darwin and Wasmann excluded the beginning of life from the general evolutionary scenario. Darwin privately argued that the emergence of life was a chemical process—see, for example, the now famous letter to Hooker in 1871 on the "warm little pond" and other texts in Peretó et al. 2009—but also recognized that it was still outside experimental scrutiny, despite the efforts of people like Bastian. Wasmann's position was philosophical and forced by the Pasteurian tradition against spontaneous generation. Remarkably, Wasmann's "theistic theory of life," assuming divine intervention in the origin of the first organisms, admitted the possibility of a future demonstration of spontaneous generation and then a withdrawal of the assertion that "the acceptance of a personal Creator is a real postulate of science" (Wasmann 1910, p. 205). In fact, in his second Berlin lecture and during the public discussion, Wasmann recognized the conditional character of this postulate (Wasmann 1912, pp. 29 and 211–212). In summary, Wasmann accepted the evolutionary theory as an explanatory framework for his research as myrmecologist, explicitly affiliated to Driesch's neovitalism (Wasmann 1912, p. 30) and adopting a soft ideological stance on the origin of life, much in contrast to some current strongly dogmatic versions of creationism (Peretó 2011). There are some studies on the reaction of the Catholic hierarchy to the adoption of evolutionary thinking by priests and scientists (see the accurate work by Artigas et al. (2006) on the period 1877–1902) but further studies are called for. This is especially true regarding the intellectual influence of Wasmann's ideas on twentieth century Catholic scientists and on the theological and doctrinal views of the Vatican on evolution.

Conclusion

Darwinism is not a monolithic, immutable block of scientific theories; on the contrary, it represents a genuine example of an adaptive framework. During the last third of the nineteenth century, it could be a synonym of evolution for many people, while today it represents the natural selection mechanism for many others. Assuming the changing features of Darwinism, we can understand its relationships with theories about the origin of life in a non-dogmatic line. Obviously, we must not make the mistake of thinking that every kind of evolutionism is Darwinism. Thus to distinguish, strategies require a contextualized analysis. What is considered as Darwinism at any given moment should be a good guideline. Therefore, we could legitimately value the contribution of Darwinism to our understanding of the origin of life.

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