

THE ENVIRONMENT IN EVOLUTION : DARWINISM AND LAMARCKISM REVISITED

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Abstract

Evolutionary biology has begun to re-evaluate the role of organisms in the construction of their own environment or niche. Rather than the passive victims of natural selection, organisms are increasingly seen as active agents by means of the impact they exert on their environments. The resurgence of **environmentalism** and the role of the 'subject' in its construction make sense in view of the enormous impact of living beings on their immediate surroundings. The physiological needs of organisms created by their interactions with the environment drive Lamarckian evolution. Lamarck emphasized that organisms must first be faced with a different mode of environment that would trigger some sort of pressure for an altered gene, to be inherited in the next generation. Darwin's theory was one of natural selection and survival of the fittest. As the environment underwent changes, the species affected by these changes underwent changes in response to changes in the environment. The environment then plays very different roles in the thinking of the two legendary biologists. For Lamarck, the environment steers adaptive change by Inheritance of Acquired Characters, while in Darwin's thought, it performs the cruel but immensely important task of selecting the fittest organisms.

Keywords : Environment, evolution, Darwin, Lamarck, 'Survival of the fittest', 'Inheritance of Acquired Characters'

"Man is the only animal for whom his existence is a problem which he has to solve."

Erich Fromm, Man for Himself, 1947.

Darwin described 'Evolution' as the growth of a tree, the "Tree of Life." The tree began with a single organism at the root, with myriad species branching off from the trunk. The late 20th century version of the Modern Synthesis assumed the main pattern of evolutionary divergence to be at all times and for all taxa in the semblance of a tree. Microbes constantly swap DNA. Hybrid plants and animals cross species lines, blurring the demarcation. The theory of evolution continues to evolve....

The year 2009 was the 200th anniversary of the publication of Jean-Baptiste Lamarck's *Philosophie Zoologique* and the 150th anniversary of Charles Darwin's *On the Origin of Species*. Evolutionary biology has begun to re-evaluate the role of organisms in the construction of their own environment or niche. Rather than the passive victims of natural

selection, organisms are increasingly seen as active agents by means of the impact they exert on their environments. The role of nature or the environmental forces that combine to produce “the struggle for existence” of Darwin is certainly not ignored. Rather, the emphasis is now on reciprocity, or the ‘dialectical’ relationship between organism and environment, part and whole, subject and object. The resurgence of environmentalism and the role of the ‘subject’ in its construction make sense in view of the enormous impact of living beings on their immediate surroundings.

Lamarck, Darwin’s predecessor in evolutionary theory, held that (a) species underwent changes in response to changes in their environment. One notable example quoted by him was the case as it might exist with respect to Giraffes. Lamarck contended that as trees began to grow taller, giraffes responded to the change by growing longer necks so that they could continue to feed. His second contention was that (b) that this change was permanent for as long as the new environmental conditions continued to apply. In other words, *nature* chose the best possible solution and organisms (species) responded accordingly.[1]

The idea that Lamarck introduced into the whole evolutionary principle was that it was the environment that modified living things. “Time and favourable conditions are the two principle means which Nature has employed in giving existence to all her productions. We know that for her time has no limit, and that consequently she always has it at her disposal.” What Lamarck actually believed was far more complex – organisms are not passively altered by their environment. The environment created needs to which organisms responded by using some features more and others less, that this resulted in those features being accentuated or attenuated, and that the difference was then inherited by the offspring.

Various evolutionary phenomena that came to fore in the last few years, seem to fit a more broadly interpreted (quasi)Lamarckian paradigm. Horizontal gene transfer (HGT), a dominant evolutionary process, at least, in prokaryotes, appears to be a form of (quasi)Lamarckian inheritance. The rate of HGT and the nature of acquired genes depend on the environment of the recipient organism and, in some cases, the transferred genes confer a selective advantage for growth in that environment, meeting the Lamarckian criteria. Various forms of stress-induced mutagenesis are tightly regulated and comprise a universal adaptive response to environmental stress in cellular life forms. Stress-induced mutagenesis can be construed as a quasi-Lamarckian phenomenon because the induced genomic changes, although random, are triggered by environmental factors and are beneficial to the organism.[2]

Lamarck’s *idea* that organisms responded to changes in their environment was *transcendental* and was [probably] instrumental in the formulation of Darwin’s theory of evolution.[1] The physiological needs of organisms created by their interactions with the environment drive Lamarckian evolution. Lamarck emphasized that organisms must first be faced with a different mode of environment that would trigger some sort of pressure for an altered gene, to be inherited in the next generation. Lamarck felt there was a pattern in nature that was imposed from outside; that animals were constantly striving to be better. He believed in the idea of continuous progress: that somehow nature had arranged things so that every day in every way we improve.[3]

Darwin did not deny any of this. He regarded it as a support for Natural Selection as an evolutionary mechanism. Darwin's theory was more complex than Lamarck's. Darwin had rooted his theory on the concept of adaptation, just as Lamarck had previously done. Adaptation is the idea of organisms responding to a changing environment, by evolving either a form or function of the body that would better suit it in that particular environment [4]. Lamarck stated that the method of transfer of information was directly to the organism; the animal would perceive the change and simply respond in the necessary way so that their offspring can be better adapted.

Darwin (and Wallace's) theory was one of natural selection and survival of the fittest. As the environment underwent changes, the species affected by these changes underwent changes in response to changes in the environment. On the face of it there is not much dissimilarity between the theory proposed by Lamarck and that of Darwin. What does make a difference is that Darwin proposed a *mechanism* whereby such changes were effected. Changes in species was due to procreation or breeding. Those species that spawned changes that adapted to the new conditions, survived while those that didn't, fell by the way side. [1]

Darwin's answer to 'what the mechanism is' was much different. He had taken into account that the species did indeed create offspring better suited for the environment, just as Lamarck had said. Darwin proposed that instead of direct transfer of environmental change, those that vary by possession of a beneficial trait are better suited for the environment and leave more surviving offspring. A species would have this 'beneficial trait' through random variation. This characteristic would then help the organism survive, while the others perished. This ensured that the beneficial trait would get passed on. This explanation is similar to Lamarckism, with obvious adjustments. Darwin simply showed that Natural Selection is, above all, a theory about the 'struggle for survival' and 'survival of the fittest.'

Darwin considered Inheritance of Acquired Characters (IAC) a 'secondary mechanism.' Yet Darwin was not reticent to invoke Lamarckian processes and he suggested that IAC supports the evolutionary changes affected by his primary mechanism, Natural Selection. **The environment then plays very different roles in the thinking of the two legendary biologists. For Lamarck, the environment steers adaptive change by IAC, while in Darwin's thought, it performs the cruel but immensely important task of selecting the fittest organisms.**[5]

Lamarck envisioned, with no experimental observation to back his hypothesis, changes taking place singly and automatically in response to changes in the environment, corresponding to a mechanical working of nature; the environment underwent a change and nature underwent a change. By contrast, Darwin saw infinite changes taking place in nature evoking infinite responses in organisms (species) only the fittest of which survived.[1]

A **key difference** between Lamarck's and Darwin's ideas occurs when a variation appears. Lamarck thought that acquired characteristics arise **after the environment changes** *i.e.* a change in the environment caused a change in the organism. But Darwin believed that variations are present in a population **before the environment changes**. Lamarck saw evolution in terms of **individuals**, but Darwin realized that **populations** are just as important.

Unlike Darwin, Lamarck held that evolution was a constant process of striving toward greater complexity and perfection. Even though this belief eventually gave way to Darwin's theory of natural selection acting on random variation, Lamarck is credited with helping put evolution on the map and with acknowledging that the environment plays a role in shaping the species that live in it. [6]

Both Darwinian and Lamarckian modalities of evolution appear to be important, and reflect different aspects of the interaction between populations and the environment. A kind of meta-Lamarckism combines the best of both Darwin and Lamarck.[3]

The vast majority of environmental factors cannot directly alter DNA sequence. Epigenetic mechanisms directly regulate genetic processes and can be dramatically altered by environmental factors. Therefore, environmental epigenetics provides a molecular mechanism to directly alter phenotypic variation generationally. Lamarck proposed in 1802 the concept that environment can directly alter phenotype in a heritable manner. Environmental epigenetics and epigenetic transgenerational inheritance provide molecular mechanisms for this process. Therefore, environment can on a molecular level influence the phenotypic variation directly. The ability of environmental epigenetics to alter phenotypic and genotypic variation directly can significantly impact natural selection. Neo-Lamarckian concept can facilitate neo-Darwinian evolution.[7]

Both Darwinism and Lamarckism have left their mark on the development of human social and cultural environment. Human culture can be looked upon as an ecological niche-like phenomenon, where the effects of cultural niche construction are transmissible from one generation to the next and thus the formulation of the 'Meme Theory.' Richard Dawkins defines Meme as a "unit of cultural inheritance, hypothesized as analogous to the particulate gene, and is naturally selected by virtue of its 'phenotypic' consequences on its own survival and replication in the cultural environment." One interpretation of the Meme theory is that memes are both Darwinian and Lamarckian in nature. In addition to being subject to selection pressures based on their ability to differentially influence human minds, memes can be modified and the effects of that modification passed on. Another reason for the longevity of Lamarckian concepts is the fact that human culture is passed down through generations in a Lamarckian manner; acquired changes in language, religion and other cultural practices can be transmitted to succeeding generations. This phenomenon led Richard Dawkins to his notion of 'memes' in 'The Selfish Gene' and 'The Extended Phenotype.' It is indeed ironic that the term meme has been coined to stress the similarity between the inheritance of cultural practices and biological heredity while the transmission of memes and genes depend on entirely different mechanisms. [8,9]

Unlike genetic evolution, memetic evolution can show both Darwinian and Lamarckian traits. Cultural memes will have the characteristic of Lamarckian inheritance when a host aspires to replicate the given meme through inference rather than by exactly copying it. Meme-theorists contend that memes evolve by Natural Selection (in a manner similar to biological evolution) through the processes of variation, mutation, competition and inheritance. The difference between the two modes of inheritance in the evolution of memes is characterized by the Darwinian mode in '**copying the instructions**' and the Lamarckian mode by '**copying the product.**'

And so evolution proceeds at all levels and in all spheres....Centuries later amidst raging battles and controversies in the academic world, Darwinism and Lamarckism continue to thrive and flourish unabated urging scientists to seek beyond the known to the ultimate truth of evolution.

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