

General theory of giraffes. An intriguing title. Associations are immediately palpable: Lamarck, Darwin, theory of evolution. So the title is begging further inquiry. The publisher is Heliks, a Serbian publishing house specializing in popular science. Author is Milan Ćirković.

I wonder whether Ćirković is aware of the provocative nature of the title in light of new winds in biology, which few decades ago existed only as winds in making, but today threaten to transform into a storm which could change the entire landscape?

American professor Michael K. Skinner, would certainly wonder what's behind the title. I will reveal reasons for his potential interest later. On his website Skinner has two "scientific mottos". One reads "Neither hope nor despair". The second one is more relevant to the subject of being provocative in a healthy sense. "If you are not doing something controversial, you are not doing something important". I am secretly hoping that Milan Ćirković will be bold enough to act as an innovator, provocateur (in a healthy sense) and populariser at the same time, by exposing "sails" of his "ship" to the new "winds".

Otherwise, the title may remain a stereotype in conformity with Neo-Darwinism, also known as Modern Synthesis (MS). This is a famous research programme initiated by three Englishmen (Ronald Fisher, Julian Huxley and John Haldane) and one American (Sewall Wright) in the first half of the 20th century. The programme had solid backing and it attracted empirical biologists, theoretical biologists, mathematicians and philosophers. W. D. Hamilton strengthened the basis of the programme with an elegant mathematical model.

The programme had a smooth ride for decades. However, with time problems emerged. Some scientists noticed that empirical results could no longer fit the mathematical model. In the simplistic language, the neo-Darwinian basic tenet that the gene is the fundamental unit of natural selection, so famously popularized by Richard Dawkins in "The Selfish Gene", started losing ground. New trends, including group selection started to take-off. The result was the birth of a new concept known as the multi-level selection theory (MLS) popularized by David Sloan Wilson. The mathematical grounding for MLS was provided by George Price and later acknowledged by W. D. Hamilton.

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However, E. O. Wilson (not related to David Sloan Wilson), veteran biologist and formerly supporter of MS, made the most radical and surprising move. In collaboration with the Harvard mathematician, Martin Nowak, he published a paper in the prestigious journal *Nature* in which the basis of MS was refuted mathematically (Nowak et al. 2010). This provoked a strong reaction from the MS camp on the pages of *Nature*. The most vitriolic attack came from Dawkins in his review of a book by E. O. Wilson. To add further excitement to this science drama, E. O. Wilson decided to strike back in an equally vitriolic way. In an interview to the BBC widely watched programme, the *Newsnight*, E. O. Wilson downgraded Dawkins to the rank of a journalist and refused to consider him a scientist worthy of having disagreement with.

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So Milan Ćirković is unwillingly in the middle of a battlefield thanks to a provocative title. One side of the frontline is reserved for neo-Darwinists. Their opponents on the other side include new forces (see later), MLS proponents, E. O. Wilson and freelancers such as Michael Skinner, capable of introducing new empirical arguments. As in any battle surprises are inevitable. The most notable surprise is the transformation of the great heretic, Jean-Baptiste Lamarck, from the figure of ridicule to the figure of at least some respect. Of course, the classical Lamarckian inheritance of acquired characters is wrong. However, a somewhat softer form, which Skinner calls neo-Lamarckism, may not be.

It is interesting to note that one of the most vocal opponents of MS was late Lynn Margulis, a famous constructive rebel of modern science. If she is alive today, Margulis would almost certainly participate in the battle. Readers may want to watch a historic programme at the Voices from Oxford (<http://www.voicesfromoxford.org/>) recorded in Bailliol College in 2009. Margulis was a visiting professor at Oxford University couple of years before her untimely death. It is interesting to watch exchanges between her and Dawkins, which looked civilized, unlike some of their encounters couple of decades earlier.

II

Let us consider the book. *General theory of giraffes* is a collection of essays which Ćirković published on various Serbian websites, and two unpublished essays. The book is divided into three parts: Strategy of science, Strategy of arts and Ages of

catastrophes. The style of writing is accessible. The text is highly informative and useful for anyone interested in history and philosophy of science. Most importantly from the perspective of a popular science book it is easy to read. Ćirković is probably the best popular science writer in Serbia. I am not aware of any other author who shows the breadth of erudition, the capacity to discover old texts and transform them, almost magically, into living wonders.

This is how Ćirković characterizes the essence of the book:

The guiding idea behind all experiments in this book suggests that the intuitive and so called common-sensical outlook on the world is not a good guide towards truth and success neither in science, nor in art, nor in questions which go beyond borders of science and become key societal questions of the 21st century (such as climate change and other risks from global catastrophes), so it seems appropriate to start from that "impossible" giraffe.

This summary reminds me of a much older text written by a well-known British scientist and writer Lewis Wolpert. In his book *The Unnatural Nature of Science* Wolpert said exactly the same almost a generation earlier. Here is Wolpert's summary of his own book (Wolpert 1993: Introduction, page xii):

The central theme presented in this book is that many of the misunderstandings about the nature of science might be corrected once it is realized just how 'unnatural' science is. I will argue that science involves a special mode of thought and is unnatural for two main reasons... Firstly, the world just is not constructed on a common-sensical basis. This means that 'natural' thinking - ordinary, day-to-day common sense - will never give an understanding about the nature of science. Scientific ideas are, with rare exceptions, counter-intuitive: they cannot be acquired by simple inspection of phenomena and are often outside everyday experience. Secondly, doing science requires a conscious awareness of the pitfalls of 'natural' thinking. For common sense is prone to error when applied to problems requiring rigorous and quantitative thinking; lay theories are highly unreliable.

So Ćirković is not saying anything new in *General theory of giraffes*. However, I can understand his motivation given that the text is in Serbian, and as such it targets the local attitudes which are probably tougher than those targeted by Wolpert, given Serbia's recent turbulent past which resulted

in resurrection of quasi-values rooted in the dark ages. As far as I am concerned, Ćirković should be lauded for his valiant efforts to explain the “unnatural nature of science” to his Serbian audience.

However, problems for Ćirković originate from a different source. In my opinion the way Ćirković constructs the metaphor is problematic. As far as I can understand it, the giraffe from the title represents a metaphor. The giraffe-metaphor hides a question. How to explain the origin of giraffe’s exceedingly long neck? The “impossible” giraffe probably reflects inability of the intuitive common-sense to explain the origin of the giraffe’s long neck. Ćirković gives the unenviable role of the intuitive common-sense to one of the most prominent heretics of science, Jean Baptiste Lamarck. Lamarck infamously thought that acquired characters are heritable. In the case of giraffes it is enough that mums and dads stretch their necks in the search for leaves on high trees and their offspring will all have longer necks than parents, so reasoned intuitively and common-sensically this infamous Frenchman. On the other hand, the role of a successful discoverer of truth in the metaphor, is given to Darwin or Darwinism – the patient and counter-intuitive (in Wolpert’s vocabulary “unnatural”) manner of natural selection, which after many generations discovers the only “possible” counter-intuitive giraffe with long neck.

At the first sight the metaphor is brilliant and amusing; the perfect symbol for a popular science book fighting “scientific illiteracy” by playing the heretic Lamarck against his opposite Darwin. However, the fierce battle raging in modern biology threatens to shatter the brilliance of the metaphor. Actually, the metaphor becomes an innocent collateral victim. Ćirković unwittingly took the side in the battle. In the further text I will expose the metaphor to the vision of the opposite side. One of the surprises on the battlefield is not in line with Ćirković’s vision – the birth of Lamarck’s legitimacy. After 200 years Lamarck gains some respect. It is not the full respect, but respect it is. (Actually Darwin himself thought that Lamarck was right).

III

While working at St Andrews University towards the end of 1990s I was trying to measure the length of telomeres, physical ends of chromosomes. Telomeres represent a biological chronometer, which reflects cellular replication history. Some researchers think that telomere length can also serve as a

proxy for the human biological age. Three American scientists received Nobel prize for Medicine in 2009 for discovery of telomeres and the enzyme telomerase. To measure telomere length I used a novel technique called Q-FISH (quantitative fluorescence *in situ* hybridization), which was the most sophisticated technique at the time. I was developing the technique together with Peter Lansdorp a medical professor from the University of British Columbia at Vancouver. Our analysis was pioneering in some respects. Measurements showed a remarkable regularity in the distribution of individual telomere lengths. It turned out that our measurements were in line with the theory of “chromosome field”, developed by Antonio Lima-de-Faria, Professor of genetics from Lund University. Lima-de-Faria is a well-known name in genetics. His book from 1984, *The molecular evolution and organization of the chromosome*, is a classic even by the modern standards. I contacted the respected Professor and we entered into a discussion, which lasted for several months. I also published a paper in which my measurements of telomeres were interpreted in light of the theory of “chromosome field”. More importantly for the present context, I learned from Professor Lima-de-Faria details from the history of genetics, which shed some light on the dichotomy Lamarckism-Darwinism.

Lima-de-Faria told me about his collaboration with Conrad Waddington. In 1969 Lima-de-Faria was a visiting Professor at the Edinburgh Institute directed by Waddington. Waddington was a geneticist, embryologist and philosopher; one of the most brilliant minds of British science in the after-war period until his death in 1975. In 1940s Waddington coined the term “epigenetics” which is today one of the most recognisable terms in the professional parlance. On the basis of his own research on the fruit fly Waddington thought that Lamarck was unfairly treated as a figure of ridicule. Waddington’s results were in line with the inheritance of acquired characters (see below) or epigenetic inheritance, which gives a far greater role to the environment in shaping the organismal phenotype than the neo-Darwinism would recognise. Here is an excerpt from a paper published by Waddington (1960):

Evolutionary theories had, of course, been put forward some time before Darwin wrote *Origin of Species*. The most famous of these earlier discussions is that associated with the name of Lamarck. It has suffered a most surprising fate. Lamarck is the only major figure in the history of biology whose

name has become, to all intents and purposes, a term of abuse. Most scientists' contributions are fated to be outgrown, but very few authors have written works, which two centuries later, are still rejected with an indignation so intense that the sceptic may suspect something akin to an uneasy conscience. In point of fact, Lamarck has, I think, been somewhat unfairly judged.

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At least two new lines of research in modern biology agree with Waddington. The first one is the new evolutionary synthesis known as EES (Extended Evolutionary Synthesis), a research programme which emerged as a result of MS's or neo-Darwinism's inability to explain many biological phenomena. EES is a collaborative effort by scientists from the following Universities/Institutes: St Andrews, Lund, Clark, Indiana, Stanford, Cambridge, Southampton and Santa Fe. An additional team of 22 unaffiliated scientists participate in the EES programme. According to EES "acquired characters can play evolutionary role and participate in heritability". EES has a dedicated website (<http://extendedevolutionarysynthesis.com/>). For those interested in the real science behind EES a good introductory text is a short paper published in Nature (Laland et al. 2014) in which basic EES principles were set against the conventional neo-Darwinian view. A philosopher Massimo Pigliucci, an EES member, cited Max Plank's words in an EES blog post alluding to the battle lines between EES and MS outlined in part I:

A new scientific truth does not triumph by convincing its opponents and making them see the light, but rather because its opponents eventually die, and a new generation grows up that is familiar with it.

Independently of EES, Michael K. Skinner developed a new theory based on his work on "trans-generational inheritance" using mouse as a model, which absolved Lamarck from his unenviable status of a lowly heretic and promoted him into a much more respectable figure through what Skinner calls Neo-Lamarckian inheritance. For those interested in science behind it I recommend Skinner's paper published in the prestigious journal Science (Anway et al. 2005). Here is an excerpt from Skinner's popular essay on the topic:

The question is this: if natural selection isn't acting on genetic mutations alone, then what molecular forces create the full suite of variation in traits required for natural selection to finish the job? One clue came almost a century after Darwin

proposed his theory, in 1953, just as James Watson and Francis Crick were unravelling the mysteries of DNA and the double helix. In that year, the developmental biologist Conrad Waddington of the University of Edinburgh reported that fruit flies exposed to outside chemical stimulus or changes in temperature during embryonic development could be pushed to develop varying wing structures. The changes the scientists induced in that single generation would, thereafter, be inherited by progeny down the lineage. Waddington coined a modern term – 'epigenetics' – to describe this phenomenon of rapid change. Notably, before Watson and Crick had even revealed their DNA structure, Waddington recognised the potential impact his discovery could have on the theory of evolution: the single-generation change in the fruit-fly wings were supportive of the original ideas of the heretic Lamarck. It appeared that the environment could directly impact traits.

Now back to Ćirković's stance on Lamarckism. He paints it in a black and white fashion. Here is a relevant excerpt:

Of course, the history of modern biology has clearly shown that the Lamarckian conception of inheritance of acquired characters is untenable, irrespective how much is the idea about fast evolution attractive to many, often for non-scientific reasons, it is not founded in reality.

This is an oversight on Ćirković's part. It is likely that many biologists would not disagree with Ćirković. However, this is primarily for the reasons of ignorance. Unfortunately, Ćirković did not do his research properly. Of course, Ćirković is partially right – the original 19th century Lamarckism is wrong. However, Ćirković's metaphor lacks the subtlety of having the full set of relevant facts and the capacity to use facts in an impartial way. If one takes into account the Skinner's results favouring Neo-Lamarckism it would not be possible to categorically say "the Lamarckian conception of inheritance of acquired characters is untenable". In addition, concrete research results generated by the EES programme, at the minimum, show serious doubts in the categorical rejection of the possibility that the environment plays a role in shaping organismal phenotypes. Otherwise, Professor Kevin Laland from St Andrews University, one of the founders of EES, would not be able to obtain funding for his research from the most respectable British funding agencies. Similarly, dozens of other EES members receive funding from relevant institutions in a competitive manner. It

is also likely that research in Skinner's laboratory is funded by the US National Institute of Health.

The thesis that Lamarck's idea could be attractive for non-scientific reasons to professional scientists is also without any ground. Waddington simply published his research results in an honest way, in the same manner Skinner or EES proponents do the same today. They are all careful scientists and Skinner takes precaution to clearly distinguish between the 19th century Lamarckism and Neo-Lamarckian epigenetic inheritance.

The thesis that Lamarckism is not grounded in reality is only partially right because Neo-Lamarckism clearly is. It is regrettable that Ćirković did not consult the full set of relevant references. It is very easy to get open access papers from Google Scholar published by Skinner. The same is true in the case of many EES papers, or even some old papers published by Waddington. In the absence of scientific papers respectable digital magazines, which publish new ideas could have been consulted. One such magazine is AEON whose partners include academic publishers, Oxford University Press, Princeton University Press and others, but also research Institutes like the Center for the Study of Existential Risk. I specifically singled out AEON because it recently published Skinner's popular essay, "Unified Theory of Evolution". Below the title the publisher inserted a single-sentence summary of the essay, which reads: "Darwin's theory that natural selection drives evolution is incomplete without input from evolution's anti-hero: Lamarck".

A proper fact checking is not only the responsibility of an author but also an editor in a publishing house, which specializes in popular science. No one expects that an editor should be an expert. However, the job of the editor is to select qualified reviewers who may correct the author and by doing so protect the reading public from being exposed to only a partial set of facts, instead

of a full set. I do not wish to sound too harsh here, but all professional scientists know how harsh the peer review process may be. The same standards, if not higher, should be in place for popular science publishing.

In his defence Ćirković says that both Lamarckism and Darwinism are only theories. This is a good way out from the pitfall that he unwittingly created for himself. True. All theories are temporary and will eventually be replaced by more successful ones. However, the metaphor intended for the general audience must be free from all major interpretative problems, at least in the time window in which it can realistically last. Unfortunately, the metaphor is problematic for the reasons outlined above. Individual essays may be brilliant and fun to read. I certainly enjoyed reading them. However, the sharpness of the collective sword of the book, as a weapon for fighting conspiracy theories and similar nonsense, is significantly compromised by a somewhat unfortunate choice of metaphor.

Interestingly, Ćirković unwittingly makes his own diagnosis of the quality of the metaphor-turned-title:

We all know that a good title may make wonders by saving an otherwise average book (and vice versa).

References:

- Nowak, Martin et al. (2010), "The evolution of eusociality." *Nature* 466: 1057-1062.
- Wolpert, Lewis (1993), *The Unnatural Nature of Science*, Harvard: Harvard University Press.
- Waddington, Conrad (1960), "Evolutionary adaptation" in Tax, S (eds.), *Evolution after Darwin* The University of Chicago Press, 381-402.
- Laland, Kevin et al. (2014), "Does evolutionary theory need a rethink?" *Nature* 514: 161-164.
- Anway, Matthew D. et al. (2005), "Epigenetic transgenerational actions of endocrine disruptors and male fertility" *Science* 328: 1466-1469.