

Pseudoscience - in Theory and Practice: A Reply to Shanta and Muni's 'Why Biology is Beyond Physical Sciences?'

Saurja Das Gupta

Department of Chemistry, The University of Chicago, Chicago, USA

Abstract The recent intrusion of pseudoscience into mainstream scientific literature is a cause for concern. Not only does it disseminate incorrect science, but also undermines the integrity of the scientific enterprise. B. N. Shanta and B. V. Muni's recent opinion piece is one such example that claims that the scientific method is too narrow in scope to completely understand subjective aspects of life, and proposes the necessity for a supernatural entity in accordance to ancient scriptures of Hindu Theology. To convince readers of the necessity for such an alternative, the authors reject accepted scientific theories such as Evolution by Natural Selection. In this reply, I demonstrate how their views are pseudoscientific and do not deserve a place in scientific literature.

Keywords Pseudoscience, Origin of Life, Intelligent Design, Evolution, Creationism, Scientific Method

1. Introduction

Science is the empirical study of natural processes, using the scientific method. The scientific method is a product of centuries of concerted human effort that has successfully delivered human civilization to the modern age. It is a continuum, beginning with identifying and objectively defining the question, followed by framing hypotheses, making verifiable predictions, testing those predictions through rigorous experimentation, modifying or rejecting the hypotheses according to experimental data, constructing theories that are consistent with the data, and using these theories to explain natural phenomenon and make further predictions [1]. The hallmark of science is that its theories are testable and falsifiable, and have predictive value [2]. Philosophy studies ideas using logic and a series of rational arguments. Unlike science, it does not involve experimentation and therefore philosophical 'results' are neither verifiable nor falsifiable. Pseudoscience, on the other hand, consists of claims, often having religious connotations, that are presented as scientific, but are not consistent with the scientific method [3]. The recent Intelligent Design (ID) movement, a religiously motivated vehicle to propagate Creationism [4], is one such example of pseudoscience in practice.

"Why Biology is Beyond Physical Sciences?", an article published in this journal by B. N. Shanta and B. V. Muni [5], tries to convince us of the permanent inadequacy of the

modern scientific method (that they denigrate by using platitudes like Reductionism/Materialism), and proposes the integration of the Vedantic System of thought into current scientific knowledge. The first author's paper 'Life and consciousness – The Vedantic View', which the authors claim to have caused a paradigm shift in the understanding of life and its origin [6], has already been accused of promoting creationism [7]. The current paper reiterates those ideas. Not only does the paper make extraordinary claims about the natural world (including a veiled hint at a supernatural source of creation), but it also hurls undisguised invectives toward science and its practitioners. The paper is rife with scientific inaccuracies and intentional misdirection that utterly undermine the authors' scholarship. I will demonstrate in some detail that the paper promulgates pseudoscience, and argue that such agenda-driven articles do not deserve a place in scientific literature. It is the responsibility of the scientific community to identify and keep out pseudoscience from its precincts.

2. 'Paradigm Shifts' Require Empirical Evidence

Unlike religion, science does not bow down to authority, therefore it has progressed over the years via 'quantum leaps', when existing theories have made way for novel ideas [8]. Some of the more recent paradigm shifts [8] in science occurred in the 1900s. Einstein's theories of relativity altered the concept of space and time altogether, expanding Newton's theory of gravitation into the realms of fast moving objects. Though being revolutionary at its inception, the theory of relativity was unanimously accepted by the scientific community when it stood the test of scientific rigor.

* Corresponding author:

saurja@uchicago.edu (Saurja Das Gupta)

Published online at <http://journal.sapub.org/als>

Copyright © 2016 Scientific & Academic Publishing. All Rights Reserved

One such example was the accurate determination of the rate of precession of Mercury's perihelion by Einstein's General Theory of Relativity [9]. Recent detection of gravitational waves attests to the predictive power of the General Theory of Relativity [10]. Quantum Theory, a field that arose from attempts to explain Black Body Radiation [11], was successful in explaining Photo-electric effect [12] and eventually resulted in Quantum Mechanics (QM), which provided an elegant model for the atom (This wave mechanical model was preceded by several unsuccessful to partially-successful 'classical' models) [13]. The message is clear: novel ideas are not only welcome in science but essential as long as they are backed by convincing evidence; hypotheses that merely point out inadequacies in current models do not warrant any serious consideration.

3. 'Unsolved' is not the Same as 'Unsolvable'

The authors begin by highlighting the uniqueness of life. The appeal to human emotions, morality and ethics is typical of religious apologists and will not be discussed here. The authors criticize modern biology as being 'materialistic' and its approach 'reductionist', which is the assumption that living things are governed by the same natural laws that govern the non-living world. Their thesis, if extracted from the tedious and sometimes deceptive discourse, is this: the uniqueness of living things can only be rationalized by the presence of a divine/supernatural life-force that they refer to as *Atman* (or soul). Neither do they cite scientific literature, nor do they present any original research in support of their hypothesis. Instead they quote extensively from ancient religious texts of *Sanatana Dharma* (commonly known as Hinduism) that are thousands of years old and were orally passed on for generations, before being written down. The veracity of these documents is therefore doubtful. Some of the tactics used in this paper are typical of pseudoscience: focusing on the so-called 'mystery of life', an appeal to ancient wisdom obtained from dubious sources, assuming knowledge beforehand instead of arriving at it through careful experimentation, using long-outdated concepts to support their ideas (the authors use the philosophy of ancient Greeks such as Aristotle) and a complete irreverence to valid scientific research. The authors muddle up science and philosophy, more specifically metaphysics (they even try to explain teleology of a pot!), and cite questionable [14, 15] and widely criticized [16, 17] sources and opinion pieces throughout the article. Unsurprisingly, the authors do not cite a single paper from primary or secondary literature in the fields they challenge. For example, the authors completely ignore the vast literature in the field of Origin of Life [18-20]. Like many other fields of inquiry, there are gaps in our understanding in this field. However instead of falling into the infamous 'God of the Gaps' trap or any variation of it (as the authors clearly do), science thrives on unsolved problems. A particular criticism of modern science, according to the authors, is in its 'bottom-up', 'reductionist' approach.

Scientists break down a complex system into simpler parts to enable easier investigation and aim to integrate information gained from studying the 'parts' to construct a model for the 'whole'. The paper claims, without evidence, that this approach will never be able to provide complete information on the whole system. Once again the alternative is the 'Soul Hypothesis', which is unverifiable, unfalsifiable and is based on ancient scripture. Another reason, why the Vedantic approach and the Soul hypothesis fail as a true scientific alternative is because it provides no mechanism for its action (we shall see this again when I discuss evolution). It is ultimately a matter of faith. Pseudoscience never progresses. Ancient wisdom that the authors glorify, has been present for thousands of years, but its understanding of the world has remained static.

The scientific method, on the other hand has delivered. The authors claim that knowledge at the molecular level is inadequate for holistic understanding of life. This very paradigm that the authors criticize, forms the bedrock of Biochemistry and Pharmacology, which has resulted in hundreds of life-saving drugs and has been instrumental in doubling our life-span in a mere span of 150 years [21]. Molecular and structural insights about nucleic acids and proteins have ushered the era of molecular biology thereby revolutionizing medicine. Cancer was previously thought to be caused by the spread of degenerated lymph fluid [22]. Though an intuitive hypothesis at the time of its inception, taking into account the 'organic whole', only when cancer was understood at the molecular level as misfiring of a plethora of biochemical signals, did we start to make real progress in cancer therapy. A comprehensive discernment of the basic molecular/biochemical pathways proved indispensable in understanding the 'organic whole'. To give an analogy for the bottom-up approach: trying to decipher a busy conversation in a room full of people is a futile exercise; it gives you noise. A scientist listens to each person and then makes a logical reconstruction of the entire conversation. The authors make no mention of clinical research where basic science compounded with statistical methodologies, is used to study the organism as a whole. The authors conveniently avoid real life applications that have resulted from the 'reductionist study of parts'.

Instead of tackling deeper issues like the difference between living and non-living (one of the most fascinating questions in biology; viruses are said to be a link between living and non-living) [23], they naively ask questions like: "*What is the minimum number of parts that are essential for a living organism to survive and by what mechanism do these parts get assembled together?*", without offering any definition of 'parts'. It may be of interest to this discussion that scientists have whittled down the bacterial genome to 473 genes, the lowest till date [24]. From an argument from incredulity (we shall encounter this in the next section), the authors argue that the divinely created soul is the entity that solves all the outstanding problems of the origin and nature of life. We have learnt from history that such simplistic, intuitive but untested, easy-way-out hypotheses used to deal

with unsolved problems have met their eventual demise. The Caloric theory [25], Phlogiston Theory [26], Luminiferous Ether model [27], the Vital force theory [28], all tried to introduce a specific entity without any evidence, to explain away experimental observations. Science cannot afford to repeat its mistakes by falling into the lures of pseudoscientific thinking.

4. Evolution, a Triumph of the Scientific Method, is the Cornerstone of Biology

The Creation movement has long plagued the public sector, be it in education or politics. The Intelligent Design (ID) movement has tried to present the openly religious Creation movement as an alternative scientific endeavor. Not surprisingly, whereas the number of peer-reviewed papers on neo-Darwinian evolution, since the 1970s have exceeded 100,000, ID has had a sole paper on original research, which has since been refuted [29]. Though the authors do not use the term ‘Intelligent Design’, but advocate Vedantic Philosophy, their arguments and tactics are typical of ID as argued elsewhere [7]. The authors argue from ignorance and incredulity (typical of pseudoscience and in particular, ID) that the intricacies of living systems are of irreducible complexity and could not be products of Darwinian evolution. Their primary criticisms are absence of direct experimental observation for the process of macroevolution and the apparent impossibility of the appearance of vast biodiversity, both of which have been extensively refuted by evolutionary biologists [4], [29-33]. Without countering every point, I will highlight a few of the many misconceptions that the authors demonstrate and try to propagate throughout their discursive narrative.

The authors argue that one cannot demonstrate the origin or extinction of species. While the former is true (and the latter is not: more than a hundred species went extinct in the last ten years [34]), as with any pseudoscience rhetoric, they simply choose to ignore the immense geological time scale required for evolution to operate. Again using the argument from incredulity they claim:

“However, a speculation on these accidental, adaptation or survival based geographic explanations of the proliferation of life (microevolution) in the past, explains nothing about how one living form transformed into another (macroevolution).”

“How random mutations can produce those different novel genetic networks and how those novelties in an individual were transformed to the population, are the important unanswered questions addressing multiplication of species.”

They go as far as to incriminate evolutionary biologists for using ‘chance’ to fit their “*ever changing historical narratives*” and assert that “*invoking chance in any explanation is unscientific*”.

Clearly the authors grossly misunderstand the theory of Evolution by Natural Selection. As noted evolutionary biologist Richard Dawkins precisely articulates, “Darwinism

is not a theory of random chance. It is a theory of random mutation plus non-random cumulative natural selection” [31]. A similar misconception about how natural selection operates is illustrated, when the authors argue that “*the least adapted individuals in every generation are eliminated first, while those that are better adapted have a greater chance to survive and reproduce...in contrast to the elimination process, only truly best individuals will survive in a selection process*”.

The current understanding of evolution is rather different. If random mutations give rise to additional adaptive advantages in particular species (for example better access to food, mate or survival in general), those species will reproduce at a higher rate, thus propagating their ‘fitter’ genes. The next generation will contain more ‘fitter’ species and as the adaptive advantage accumulates over generations, the less adapted species will eventually die out due to their inability to compete for resources in their ecological niches and not the other way round as the authors suggest. Evolution does not produce perfection or ‘truly best’ species; as long as a species is above the threshold for survival in their niche, they would be selected. Thus, a particular organism may have an aberration that in no way affects its reproductive or general survival abilities and still be ‘selected’. In fact, an aberration that may not be of particular advantage in one generation, if passed on might be beneficial in later generations. Therefore, statements like “*the documented fossil record only shows that the occurrences of new species were perfectly adapted and there is no evidence for a frequent production of maladapted species*” are unfounded. In fact, there are numerous examples of ‘unintelligent design’ [35] that underscore the lack of teleology in evolution by natural selection and refute one of the paper’s theses: ‘*genetic variation is a response to adaptive needs of an organism*’ (authors simply reference philosophy to support teleology in nature).

The authors accept the scientific results that support microevolution but reject macroevolution that is based on the same governing principles as it goes against their preconceived notion and preset agenda – another indication of pseudoscientific practice. Working with a nebulous concept of species (Species is currently defined as a group of living organisms consisting of similar individuals capable of exchanging genes or interbreeding, see Speciation by Dr. Jerry Coyne for detailed discussion [36]), the authors use another ID paper that has been rejected by the scientific community [17] to claim that new species cannot appear from natural selection. Quoting Kuhn [15], they declare that “*Even with thousands of billions of generations, experience shows that new complex biological features that require multiple mutations to confer a benefit do not arise by natural selection and random mutation. New genes are difficult to evolve*”. This assertion is without empirical evidence and is ignorant of real scientific literature that can undermine their thesis. Bacteria have been shown to evolve new metabolic pathways on their own, through random mutations in their genome in about 30000 generations within two decades [37].

Claiming impossibility before exhaustive research is a hallmark of pseudoscience and is often exposed as a fallacy when science eventually proves the contrary with verifiable evidence. In the glaring paucity of evidence to support their slander of evolutionary science, they resort to statements that are simply untrue, such as:

"However, the superficial methodology of comparison in Darwinism places the human species as a member of the ape family...created ever widening disagreements between the conclusions of different fields like paleontology, molecular dating, genealogical data, and so on"

"Yet another speculative methodology of comparison of molecular biology (for example, sequence of base pairs in the genome) is now used to restructure the existing speculative morphological character based phylogeny."

Human descent from apes is a fact established beyond any reasonable doubt, by the very fields of study the authors mention, and is in no way 'superficial'. Fossil record and geological data coupled with dating methods have shown remarkable agreement with genomic analysis [33]. Transition fossils have been found between quadrupedal and bipedal apes (*Australopithecus afarensis*), early hominids and late hominids (*Homo habilis*), and *Homo habilis* and *Homo sapiens*/Neanderthals (*Homo erectus*), to mention a few. Furthermore, missing links between other vertebrates like fish and amphibians, amphibians and reptiles, reptiles and birds are well documented [33]. By choosing to ignore the massive body of evidence that goes against the primary thesis of supernatural creation, the paper loses scientific credibility.

5. Pseudoscience Misappropriates Scientific Concepts and Terminology

A distinguishing feature of pseudoscience is that it poses as science by using technical terms already used in one or more scientific disciplines, without defining their context. In fact, the purpose here is creating an aura of obfuscation and mystery rather than clarity. Pseudoscience has been using eastern mysticism in conjunction with the sometimes counter-intuitive field of Quantum Mechanics (QM) to support its scientifically untenable theses [38, 39]. The so-called 'spooky physics' stems primarily from the dual nature of matter and energy (wave and particle) (as suggested by de Broglie and verified separately by Young, Thompson and others) and Heisenberg's Uncertainty principle, which states that it is impossible to accurately determine the position and momentum of a particle simultaneously (this uncertainty arises directly from the act of observation) [40]. This presents an attractive metaphysical lens to look at nature and pseudoscience has been ready to incorporate QM in their arguments, without explicitly stating that these observations are only valid in the *microscopic* world (in the macroscopic world we are used to interacting with, these apparently strange quantum phenomena are imperceptible; these effects are applicable only to quantum

domains of sub-atomic particles like electrons). The authors here, follow that same trajectory, and appeal to the non-specialist's sense of wonder. On close inspection we find that their reasoning is specious and is a word-salad of technical jargon used without context.

Using findings from the uncertainty principle, so-called 'observer effect' and a fairly new and rather paradoxical field of study – Consciousness research, the authors naively conflate these into a fallacious assertion: *"Hence, physics has realized that matter does not have independent existence apart from consciousness"* that can be at best a metaphysical hypothesis, but in no way derives from quantum mechanics or any current scientific result. Sprinkling terms like 'non-algorithmic processing' and 'quantum non-locality' without establishing their direct role in explaining the problem of consciousness, introducing studies in fledgling fields like semiotics and reverting back to the armchair philosophy of ancient Greece does not in any way drive their argument forward.

6. Religious Encroachment on Science is Inimical to Scientific Progress

At the end of the long-winding tirade against modern science, the authors suggest an alternative, 'The Soul Hypothesis' that is rooted in ancient scripture. As noted earlier, considering the dubious nature of their primary source, the unverifiable/unfalsifiable nature of the central tenet of the entire hypothesis – the *Atman* or soul, and in light of their clearly religious agenda, the Vedantic view they propose does not merit any critical, scientific consideration. Their discussion is filled with religious jargon and obscurantist language, with an unwarranted belief in the veracity of 'ancient wisdom'. These are common characteristics of pseudoscientific literature. To summarize their thesis, it is implied that the soul is the unit of life and transmigration of the soul through different species provides them with different levels of consciousness. This hypothesis fails to address objectively some of the problems the authors set out to address when they reject evolution. They talk about the soul's transmigration across apparent illusory bodies of living beings, but their hypothesis does not tell us how the morphological diversity came about. No discussion is offered on the creation and properties of the soul. Presumably God, or the supreme absolute they mention in passing is the source of the soul and all creation in their present form, therefore what the authors ultimately propose is the long debunked Creationism, which they deliberately veil with pseudoscientific language throughout their article. The arguments here become even less sophisticated and even middle school text-book physics is misappropriated as the authors try to explain simple optical illusions like bending of a stick in water or mirages in deserts by invoking 'innate defects' in living beings. Considering that even middle school students are aware of the phenomenon of refraction, the authors either deny or deliberately avoid the issue to

bolster their narrative. Their religious intensions are exemplified when the authors suggest that knowledge endowed by the love of the Godhead is more important than that gained from sense perceptions. Not only do these statements underscore the pseudoscientific approach, but also make this paper anti-science. This type of material, at best, belongs to a theology document, not to serious scientific discourse.

7. Conclusions: The End is not Near

"Science knows it doesn't know everything; otherwise, it'd stop. But just because science doesn't know everything doesn't mean you can fill in the gaps with whatever fairy tale most appeals to you."

- Dara O' Brian

The scientific endeavor is a dynamic one; the gaps in knowledge are what drive science forward. Physics deals with the fundamentals of matter and energy and in principle can explain the whole of chemistry [41]. Though chemical systems are governed by physical laws, studying them just in terms of the laws of physics is extremely complicated, thus Chemistry developed its own concepts and models in an attempt to simplify the problem [41]. Biological systems are conglomerates of chemical systems and therefore are even more complex, so we need to study Biology as a separate discipline. Instead of worrying about energy states of electrons or nuclear particles in DNA, Chemistry studies its molecular structure and properties, and Biology studies the overall processes that the molecule participates in. Even if the emergent properties of DNA, or any complex biomolecule appear to be very different from its atomic constituents (this seems less mysterious if you consider hydrogen and oxygen gases combining to form water), the only way we would achieve fundamental understanding about the molecule is by understanding what it is made up of. It is still a task at hand for science to provide a more integrative model for living systems in terms of physical forces, but any success in this aspect has to involve the physical sciences. Proxies (like the soul/supernatural entity) suggested by pseudoscientific hypotheses are superfluous, violating Occam's principle of parsimony and only act to hinder scientific progress.

Pseudoscience, as illustrated by this paper, tries to knock down the very nature of the scientific method that humanity has worked hard to establish. With the rise of information technology, the scientific community must keep its turf free from contamination by pseudoscience/anti-science artifacts to maintain its credibility. Pseudoscientific articles like this, not only misinform the non-specialist reader, but also aim to gain undeserving validity by becoming part of scientific literature. Through self-citation [5, 6] and pseudoscientists citing each other's work [5, 15], their credibility would keep on growing till it permanently tarnishes the vast corpus of scientific literature that has been sustained by careful peer review.

Instead of scientists having to spot and thwart pseudoscience at every step, their efforts are better spent in truly advancing science by using the scientific method that has sent man to the moon, eradicated epidemics like plague and smallpox and has ironically enabled worldwide dissemination of pseudoscience. The proverbial bad apple may not spoil the bunch, but it may make the bunch less appealing.

"The Visigoths are at the gates. Will we let them in?"

- John Brockman

ACKNOWLEDGEMENTS

I thank the Departments of Chemistry and Biochemistry & Molecular Biology, The University of Chicago for supporting my research and Urmimala Basu for helpful discussion and valuable comments.

REFERENCES

- [1] Wilson, E. B., 1952, An Introduction to Scientific Research. McGraw-Hill.
- [2] Popper, K. R., 1959, The Logic of Scientific Discovery. London Hutchinson.
- [3] Hansson, S. O., 2015, Science and Pseudo-Science. The Stanford Encyclopedia of Philosophy, Edward N. Zalta (ed.), URL <http://plato.stanford.edu/archives/spr2015/entries/pseudo-science/>.
- [4] Brockman, J., 2006, Intelligent Thought, Vintage Books.
- [5] Shanta B. N., Muni B. V., 2016, Why Biology is Beyond Physical sciences? *Adv. Life Sci.* 6: 13-30.
- [6] Shanta, B. N., 2015, Life and consciousness: The Vedantic view. *Communicative & Integr. Biol.* 8.
- [7] Caetano-Anolles, G., 2016, Creationism and intelligent design are incompatible with scientific progress: A response to Shanta and Vedanta. *Communicative & Integr. Biol.* 9.
- [8] Kuhn, T. S., 1996, The Structure of Scientific Revolutions. (3rd ed.) Chicago, IL: University of Chicago Press.
- [9] Einstein, A., 1916, The Foundation of the General Theory of Relativity. *Annalen der Physik* 49 (7): 769-822.
- [10] B. P. Abbott *et al.* 2016 (LIGO Scientific Collaboration and Virgo Collaboration) Observation of Gravitational Waves from a Binary Black Hole Merger. *Physical Review Letters* 116 (6).
- [11] Loudon, R., 1973, The Quantum Theory of Light. (3rd ed.) Cambridge University Press.
- [12] Sears, F. W., Zemansky, M. W., Young, H. D., 1983. University Physics (6th Ed). Addison-Wesley, 843-844.
- [13] Pullman, B., 1998, The Atom in the History of Human Thought, trans. by Axel Reisinger Oxford University Press.

- [14] Abel, D. L., 2012, Is Life Unique? *Life*, 2, 106-134.
- [15] Kuhn, J. A., 2012, Dissecting Darwinism. *Proc. Bayl. Univ. Med. Cent.* 25, 41-47.
- [16] Myers, P. Z., 2012, More Bad science in the literature. *Pharyngula*/<http://scienceblogs.com/pharyngula/2012/02/02/more-bad-science-in-the-litera/>
- [17] Coyne, J., 2012, Creationist paper in a medical journal. Why evolution is true. <https://whyevolutionistrue.wordpress.com/2012/01/19/intelligent-design-paper-in-a-medical-journal/>
- [18] Deamer, D., Szostak, J. W., 2010, *The Origins of Life*. Cold Spring Harbor Laboratory press.
- [19] Adamala, K., Szostak, J. W., 2013, Nonenzymatic Template-Directed RNA Synthesis Inside Model Protocells, *Science*, 342, 1098-1100.
- [20] Patel, B. H., Percivalle, C., Ritson, D. J., Duffy, C. D., Sutherland, J. D., 2015, Common origins of RNA, protein and lipid precursors in a cyanosulfidic protometabolism. *Nat. Chem.* 7, 301-307.
- [21] http://www.slate.com/articles/health_and_science/science_of_longevity/2013/09/life_expectancy_history_public_health_and_medical_advances_that_lead_to.html
- [22] <http://www.cancer.org/cancer/cancerbasics/thehistoryofcancer/the-history-of-cancer-cancer-causes-theories-throughout-history>
- [23] Rybicki, E. P., 1990, The classification of organisms at the edge of life, or problems with virus systematics. *S. Afr. J. Sci.* 86, 182-186.
- [24] Hutchinson III, C. A., *et al.* 2016, Design and synthesis of a minimal bacterial genome. *Science* 351 (6280).
- [25] Fox, R., 1971, *The Caloric Theory of Gases*. Clarendon Press: Oxford.
- [26] Conant, J. B., 1950, *The Overthrow of Phlogiston Theory: The Chemical Revolution of 1775-1789*. Cambridge: Harvard University Press.
- [27] Bateman, H., 1915, The Structure of the Aether, *Bulletin of the American Mathematical Society* 21 (6), 299-309.
- [28] Kinne-Saffran, E., Kinne R.K., 1999, Vitalism and synthesis of urea. From Freidrich Wohler to Hans A. Krebs. *Am. J. Nephrol.* 19 (2), 290-294.
- [29] Coyne, J. A., 2006, *Intelligent Design: The Faith that dare not speak Its name*, Intelligent Thought, Vintage Books.
- [30] Dawkins, R., 1986, *The Blind Watchmaker: Why the evidence of evolution reveals a universe without design*. W. W. Norton & Company, New York.
- [31] Dawkins, R., 1996, *Climbing Mount Improbable*. New York: W. W. Norton & Company.
- [32] Dawkins, R., 2009, *The Greatest Show on Earth: The Evidence for Evolution*. Free Press (United States).
- [33] Coyne, J. A., 2009, *Why Evolution is True*. Viking, New York (USA).
- [34] <http://www.endangeredspeciesinternational.org/overview1.html>
- [35] Atran, S., 2006, *Unintelligent Design*. Intelligent Thought. Vintage Books.
- [36] Coyne, J. A., Allen Orr, H., 2004, *Speciation*. Sinauer Associates Inc. Sunderland, Mass.
- [37] Blount, Z. D., Bortland, C. Z., Lemski, R. E., Historical contingency and the evolution of a key innovation in an experimental population of *Escherichia coli*. *Proc. Natl. Acad. Sci.* 105, 7899-7906.
- [38] Chopra, D., 1989, *Quantum Healing*. New York: Bantam Books.
- [39] Chopra, D., Mlodinow, L., 2011, *War of the Worldviews*. New York: Harmony Books.
- [40] McQuarrie, D. A., 1983, *Quantum Chemistry*, University Science Books.
- [41] Dirac, P. A. M., 1929, *Proceedings of the Royal Society of London Series A, containing papers of a Mathematical and Physical Character*, 123.