What Darwin Got Wrong

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April 7-8, 2012

When I first heard about the principle of Natural Selection I was struck and impressed that simple and beautiful ideas were not only to be found in mathematics and physics, but also in biology. I should have been leery, biology is messy, and whatever can happen tends to happen, and beauty can never be assumed as a reliable guiding principle. Further reflection on the principle led to the disturbing thought that it was tautological. Tautological if fitness was defined in terms of survival, or more to the point, reproductive advantage. Darwinism in its radical aspect is simply a beautiful philosophical principle which explains how order can spontaneously arise out of chaos without the interference by a designing intelligence. To make Darwinism scientific you need to anchor it firmly in a specific context, namely of the organic world. As a philosophical principle it has wide applications going beyond its explanation of natural evolution. In fact one needs to make a distinction between evolution as such as an historical fact and an explanation for it. Evolution was recognized before Darwin was born, but no one is more identified with it than Darwin, and did more than him to popularize it. This is because distinct as the theory may be from the facts, without the theory it is hard both to interpret the facts and look for them.

The major impact of the theory is its philosophical. It is a materialistic theory *par excellence* of the development of organic life, it does away with the notion of a divinity. Darwin himself may have outwardly preserved the usual conventional religious homilies of the day, but deep down he must have recognized, if not necessarily welcoming, the implications of standard religion.

Now in order to appreciate and thus being able to criticize the content of Darwinism one needs to compare it with other explanatory theories of a naturalistic bent, not just the story presented by the Bible. The naturalistic theories are all based on some principle of inheritance. The progeny is very similar to the parents. This makes evolution a gradual diverging process and one can speak about a tree of life with a proliferation of branches. In particular one does expect that species will over time blend into each other[1]. Lamarckism is the standard alternative example. In this theory the environment plays a very active role by singling out acquired traits and seeing to it that they are inherited; while in the Darwinian theory of natural selection its role is passive. Different traits are randomly generated and the environment simply allows some to prevail. It is reminiscent about the distinction between reasoning by induction and by deduction formulated by the historian Collingwood: Deduction compels while induction permits. Similarly Popper talks about Lamarckism as learning by instruction, and Darwinism as learning by putting questions. In the former case learning is passive, while in the latter learning is active. The challenge

[1] There is no notion of the species-relation which is transitive as well as reflexive and symmetric, hence there is no possibility to partition all organisms in mutually disjoint equivalence classes

of explaining how the Lamarckian process really works is far more of a challenge than how to explain Darwinistic processes. Thus Darwinism is simpler (and hence more beautiful?). None of the evolutionists before the 20th century had any idea how inheritance worked only that the conservative principle of inheritance was basic, without the notion of modified descent there will be no evolution, conservation being the rule, change the exception. It was only with Mendel the modern synthesis of Darwinism during the 20's was made possible.

Still the fundamental principles of evolution (regardless of the exact explanatory principle) were clear to 19th century naturalists. Basically it amounts to a search procedure. If you are to guess a number and are allowed stepwise information at each digit whether it is correct or not, the length of the search grows linearly with the length of the digital representation of the number, not exponentially. Without this added information the production of organisms would indeed be a case of pure chance, with the added information one can at least metaphorically talk about an algorithm, although as with all metaphors this should not be taken too literally, then it becomes merely silly[2]. It is highly indicative that Darwin mentions Malthus as the source of his idea. If organisms were allowed to multiply unchecked, their progeny would sooner or later overflow, which is clearly something absurd. What happens? Most organisms die before they have a chance to procreate, there is a struggle to survive, which acts as a filter[3].

The fundamental outcome of the subsequent synthesis was a distinction between the genotype and the phenotype. Only changes in the genotype can be transmitted to subsequent generation, never changes in the phenotype. This makes the distinction between Lamarckism and Darwinism very clear, and anyone who does not appreciate that distinction is considered beyond the pale and relegated to the dustbin of history. One may argue that only with the modern synthesis did Darwinism become scientific, before it was to be considered as a merely metaphysical theory. The adjective 'merely' is a misnomer, metaphysics is important, as Popper reminds us; it provides a powerful stimulus to the imagination, and as we will see Darwinism still keeps important metaphysical elements.

The modern synthesis, as presented to the public, is greatly simplified, as is the case with most if not all popular presentations of science. This is of course inevitable, but while in most other cases this has no effect on the scientific pursuit per se, this is not the case with natural selection which has spawned all kinds of pseudo-scientific endeavors. The reason being the seductive appeal and the simplicity and accessibility of the ideas involved. There has developed a widely dispersed orthodoxy which can be summarized as follows. There are distinct entities called genes, and the genes code for traits. The genetic information thus encodes all the properties of the phenotype. Thus in principle every trait is ultimately genetically based, and the fact that a trait is present is that it

[2] This proto-algorithmic nature of evolution is a powerful incentive to simulate evolution on the computer, as well as setting up various mathematical models. They may be illustrative, but only as with metaphors, one should never draw too literal and exact conclusions from them. The course of evolution is unpredictable, as we will have occasion to return to,

[3] It is striking that evolutionary theory shows so many similarities with economic theory of the 18th and 19th century, and in fact still do. Darwin mentions only Malthus explicitly but it stands to reason that he must also have been influenced, consciously or subconsciously, by the concept of the invisible hand, as explained by Adam Smith.

had at one stage had had a reproductive advantage most likely also a survival advantage. This simplified picture appears somewhat of a travesty, yet it has been taken seriously by all kinds of people engaged in evolutionary psychology presenting all kinds of evolutionary scenarios in the tradition of Kipling, doing earnestly in scientific journals what Kipling did tongue in cheek in stories for children.

The obvious arguments against evolution through modified descent (which incidentally also includes Lamarckism) is that there is no compelling evidence that evolution has indeed been so gradual without any saltations[4]. When it comes to Darwinism (but the argument also, if not so clearly, works against Lamarckism as well) we have the existence of highly intricate organs, which only seem to work when present in its full development and for which any partial and preliminary stage does not seem to confer any advantage whatsoever, on the contrary sometimes even seem to be a liability. And finally that certain traits such as altruism work against the individual carrying the genes, and thus should not on selectional principles be transmitted and thus ought to be quickly weeded out.

The first objection is easily disposed of, as was already done by Darwin. The fossil record is very incomplete, only a tiny fraction of everything that has ever lived has left any record. In a sense this is an irrefutable argument against a refutation of a refutation, but of course subsequent discoveries have vindicated Darwin, indeed many so called missing links have been unearthed (as well as missing links between missing links), the most exciting to the public being the gradual revelation of our hominid forefathers. To address the other objections we need to go beyond the simplified picture presented above.

What is a trait? What is a gene? The latter question had to wait for the 50's to be more technically explained in terms of DNA and the genetic code, although the basic philosophical issue was clear to Mendel. Genes are discrete entities. But traits are not! Thus the very idea of a 1-1 correspondence between genes and traits is preposterous. One may in principle compile a catalogue of all the human genes[5] but one can hardly make a list of all human traits? What is a trait? A combination of traits is clearly a trait by itself, but is it possible to speak about basic traits, so to speak atomic traits, and only with those may we have a 1-1 correspondence with genes? Anyway the idea that a trait such as altruism (which clearly is not a well-defined physical trait but a vague evasive mental one) should be coupled to a specific gene is completely unfounded. But even if it would be genetically determined, what is there not to say that it would be the effect of the presence of a combination of two different independent genes? It would be advantageous to a population that there are altruistic individuals, even if not all individuals are altruistic? Thus it would be advantageous for the population to have those two types of genes floating around in their common gene-pool because of the possibility that altruistic

[4] There is a somewhat redundant modifying theory of punctuated euilibria, proposed by Gould and Elridge, which suggests that species are stable for long eriods and suddenly go through steep modifications. Redundant as it is fully within the flexible explanatory powers of Darwinism.

[5] The human genome has recently been mapped. What does that mean? Hardly that we have a catalogue of all the different human genes that have ever existed or even exist at the time. Does it mean that we have catalogued all common human genes? And/or that we have mapped the structure of human chromosomes and gotten the place-holders so to speak? Such things are never explained in any necessary detail in the media.

individuals would occasionally emerge among their midst. That the combination of those genes are not inherited because of the early self-sacrificing demise of their bearers is of no importance[6]. In fact genes are directly inherited, combinations thereof, unless linked on the same chromosome, are not. Thus the idea that many traits are not heritable is a rather trivial observation on first principles in need of no empirical verification. In particular there are many traits, in fact most, who are in a sense accidental and whose appearance is not the result of an adaptive success story[7]. Not only can we speak about independent traits, some traits are also linked to each other, as already Darwin noted. Hence there are traits which get a free ride for a variety of reasons, and are not the result of adaptation. Every invention has unpredictable consequences, and this is what ultimately drives evolution, examples of which abound in the evolutionary record, and which Darwin took as the most compelling evidence of evolution and its blind principle of lack of foresight[8]. Evolution forces organisms into narrow furrows greatly restricting what kind of modifications are possible[9] . Pigs cannot start to grow wings, unless of course they are evolved beyond recognition, just as deer cannot start to grow fins, unless they have been submerged in water for a very long time[10]. And the environment imposes all kinds of constraints, those by elementary physics obviously not to be forgotten. Genetic creativity cannot trump the law of physics. There are e.g. *a priori* bounds on the size of terrestrial animals[11]

Finally the articulation of genes into traits is a complicated and round-about process, the study of which is part of developmental biology, i.e. the embryological process. The DNA guides the production of proteins who play catalytic roles in biochemical processes, eventually creating a phenotype. Incidentally that this complicated process succeeds in spite of all the environmental noise to such a high degree is remarkable. The process is rather subtle and goes beyond the genetic instructions. In the case of conjoined twins, there is a sharing of organs which is not encoded in the genome, clearly the formation is to a large extent guided by local laws. Finally a single gene can code for many different traits, and genes can be turned on and off for a variety of reasons, some having to do with the effect of other genes. Somehow there seems to be some kind of hierarchy in the genetic

[6] This ties in with the age-old question on whether selection is made on the level of the individual, the species, or maybe, as Dawkins was arguing, at the level of the gene? The point is that you cannot settle this question, the principle of natural selection is vague, or if you prefer, flexible enough to allow selection at any kind of level, including those of the eco-systems themselves, an idea that was not strange to Darwin.

[7] Clearly while some traits may have a definite impact on survival, most traits only confer advantages on the second or third order so to speak, and for very high order traits it is doubtful whether they have had any impact at all, given the finite number of generations and individuals involved.

[8] One of my favorite examples are traffic-lights, they were designed to regulate the flow of traffic, not to act as aids to navigation (take a left on the fourth traffic light). Of course this should be taken metaphorically, as evolution has no intentions or designs.

[9] I am particular reminded of the Pandas thumb being the theme of one of Gould's early essays.

[10] This is of course a reference to the story of how whales evolved from land-dwelling mammals.

[11] The chapter on Magnitude taken from the classic book by d'Arcy-Thompson made a very deep impression on me when I first encountered it. Once again a case of simple mathematical principles having far-reaching consequences also in biology.

expression. And once again what traits are really encoded? Humans have an uncanny ability to recognize faces, but this remarkable cognitive ability is seriously impaired when looking at faces upside down? Why? To say that there are adaptive pressures for the former but not for the other is a metaphysical statement not a scientific one. How should we ever start to explain through protein synthesis this discrepancy in cognitive abilities?

The actual complexity of the organic world is well-known to 'wet' biologists as opposed to the armchair variant. So what is so controversial about the message of the book? Is it not a case of 'kicking in doors' which are already wide open? What exactly do they say that Darwin got wrong, as opposed to what the vulgar interpretation of Darwinism gets wrong? To be honest I cannot really tell. They make a comparison between the nowadays rejected Skinnerian theory of learning and Darwinism claiming that they are very similar. This is a clever rhetorical device, but as most rhetorics, as Cicero pointed out they work best on a first encounter but do not usually survive the night. Cicero was somewhat of a cynic, his use was primarily concerned with the court, where the point was to persuade the jury at hand, not posterity. The reason we reject Skinner's radical behaviorism is that by introspection we know that he leaves out the most import features of learning in particular and behavior in general, namely intentions and other inner mental states. What would the corresponding objection be in the case of Darwinism? The presence of an intelligent designer? That evolution cannot be predicted is common knowledge. This is no more surprising than our inability to make long-range weather forecasts, in spite of the fact that we have full knowledge of the relevant physical laws. There are simply too many contingent factors. Evolutionary explanations are more in the nature of historical explanations than scientific ones, permissible rather than compelling, in the words of Collingwood[12]. Furthermore the authors spend a lot of time on the 'issue of spandrels', ultimately the fact that any invention has unintended consequences, but now from the perspective of 'free-riders'. How can we tell that it is actually the pumping of the blood which lies at the heart of what the heart does and not the noises it makes. In short that natural selection selects for an efficient pump not a frivolous noise-maker. We can as conscious beings able to make mental representations and thus pursue counter-factual reasoning, conclude that it must be the pumping aspect that counts in the struggle for survival, not the noises. But how can natural selection do that? I fail to see the point, above the obvious one that natural selection merely selects, it never selects for. Logically it is meaningless to ask which one of several linked traits has reproductive value, unless a straightforward experiment is undertaken, splitting them off. But evolution is a historical process, and as such beyond counterfactual exploration as opposed to speculation. It seems to be a case where they can provide a philosophical argument of a more technical kind, and hence one that should carry more weight. They also point out that the source of Darwin's inspiration, artificial breeding is a poor analogy to natural selection, the breeder

[12] There is a fundamental distinction between retrodiction and prediction, in the former case we know the answer, and what should be falsified is much harder to do. Any fool can falsify a prediction, if living long enough to see the end of the tale, to falsify a particular explanation is far more slippery. To explain a given fact, such that the existence of an organism, is like proving a theorem you know to be true. A mathematical theorem has many proofs, and there is no way of saying which one is the right one. In the same way you can concoct a variety of selective reasons why a given organism should exist at all.

does after all have intentions, and he can indeed be thought of as selecting for traits (in the process being saddled with many unintentional). But Darwin did not confuse the two, his crucial insight was that breeding could be unconscious and unintended, such as when people only brought with them animals with whom they were comfortable, with no conscious thought of breeding them. This led to his idea that selection could indeed be automatic and unintentional. The authors attack Darwinism from the left, eager to do away with any vestiges of a consciously designing actor. But clearly such notion as the Blind Watchmaker or Selfish Gene are mere figures of speech, not expected to be taken seriously by anyone except fools.

It appears to me that the crucial case against selection made by the authors, is that evolution is not driven so much by the filtering one by the environment on the phenotype but by endogenous constraints. Genetic change is not so much a case of random generation (mutation) as an intrinsically driven affair. But I fail to be instructed on how this is really effected. Such a theory would have provided a real alternative to natural selection. True at the lower scale of sex-less reproduction, there is not only vertical transmission but also horizontal, and hence there is no tree of life, in the sense of graph-theory. Sexual reproduction, which according to Maynard-Smith is one of the three major innovations of evolutions (the other two being multi-cellular organism and language). This in one sense simplified the process by making it more structured. But what are the evolutionary advantages, as far as one can speak of such, considering that a majority (biomass? number of species?) of reproduction is still sex-less. With this view it is not surprising that the case of convergent evolution (analogy not homology) seems to be a bone of contention to the authors, although they do not develop the case[13]. Do they not believe in it, as they hint when they refer to some underlying gene being responsible. Thus a case of genetic determinism. Still no matter what one cannot deny the consequences of non-viable phenotype.

Nature makes in fact a few experiments, as when the slate is wiped clean after say a meteoritic impact (incidentally the mammals had not adapted themselves to such contingencies, circumstances changes and while the solutions of yesterday usually work well for today, this is not always the case), or that convergent eco-systems evolve on isolated continents, such as the marsupial fauna of Australia. One may never draw detailed conclusions as we are also unable to do in weather forecasts, but principal ones (whatever that means) should not necessarily be out of range, just as we with great confidence can predict the future oncoming of seasons[14]. Darwin was very alerted to eco-systems and their intricate balances in his 'Origin of the Species' and pointed out that systems that have evolved under tough competition in large geographical areas necessarily trumped those which had

[13] The similarities between fish and whales constitute a case in point, and even more strikingly the similarity between the eye of a vertebrate and a mollusk such as an octopus. The history of the former involves an outgrowth of the brain and in the latter a case of a skin-fold

[14] The speed of evolution is a case in point. To estimate it with any accuracy is of course impossible, but Darwin himself was dismayed at the early estimate of the age of the sun proposed by Kelvin. Why this estimate of a very long time? Because he thought of evolution as being in tandem with geological processes for which estimations of time are much easier?

evolved under less exacting pressure[15]. Thus rabbits thrived in Australia but kangaroos would have a tough time in Europe, diffusion not necessarily being a symmetric process. All of that is not meant to be conclusive in any way but merely suggestive.

The authors want to start a debate but seem, judging from their added comments in the subsequent editions of the book, not to have gotten any serious takers. They point out the complexity of evolution and the genetic material (more than I have done in this review) but they do not in any way suggest an alternative. This is not so surprising as Darwinism is not very specific, and in many ways more of a metaphysical stand than a collection of evolutionary laws; just as the Popperian notion of falsifiability as central to any attempt at demarcation of science. Being non-falsifiable it is eminently pliable and can easily accommodate its apparent contradictions. It cannot serve as a manual for doing biology, much less so for cognition and psychology, but can provide inspiration, useful as well as mis-leading[16]. Undeniably Darwin's vision has, for better of for worse, supplied biology with a grand theme and stimulated much research. This is what metaphysics is good for in science.

Finally Darwinism, or maybe rather naturalism, is so pervasive that not only are our cognitive functions to be explained but also what is supposed to be the nature of truth. This leads to the real philosophical problems caused by natural selection, not only such as the mind-body problem but also that of epistemology. Is truth simply what is compatible with survival and reproductive advantage? A case of radical pragmatism, towards which many philosophers have been drawn. Is all our knowledge constrained by our cognitive abilities? To a mathematician the logical contradictions of self-reference are hard to neglect. What about our theories of evolution itself? Are they influenced by our evolutionary history? Dawkins ends his book on the Selfish gene by an appeal that we should liberate ourselves from the tyranny of our genes. What prompted such an appeal, it can hardly have been genetically forced. This is the classic problem, by contemplating a complete system, we invariably position ourselves outside of it.

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[15] Europeans going to the new world imparted deadly diseases to which the natives had had no natural immunity, but it did not work the other way round. Unfortunately (?) the colonizers were not killed en masse by diseases prevalent among the Natives. The standard explanation is that Europeans along with many Asians had lived in congested areas and developed protection against a variety of emerging diseases, which the nomadic Indians, pursuing healthier life-styles had been spared, as well as not developing any of their own. Of course any statement of that kind has to be qualified, syphilis may be an exception, as a disease traveling the other way.

[16] One may very well be an effective researcher in say micro-biology or bio-chemistry without believng in Darwinism. And definitely one can be a good doctor even if one believes in the literacy of Bishop Ussher's estimate of the age of the earth, (as well as its flatness for that matter).