Essay 3:
Can you tell if you are a Darwinist?

Theme: Darwinism is a complex set of theories about the productive capability of natural systems. Darwin himself would probably recognize few of the modern invocations of his name, and would likely repudiate some.

Like many students since his time, Darwin was undirected in college and upon graduation, he was not quite sure what he wanted to do, although his father was pushing him towards medicine. He signed up to be ship's naturalist, and an educated companion for Captain Robert FitzRoy, of the HMS Beagle. The Beagle set sail for South America on December 27, 1831, and returned to England nearly five years later. Most of that time was spent in or around South America, and in the now-famous Galapagos archipelago.

Darwin left England a knowledgeable student of contemporary biology, and returned thoroughly confused. Most confusing was the relationship between species and their localities, or biogeography. He had, of course, been educated in pious creationist Natural Theology at Cambridge, which was already finding difficulty in explaining the distribution of species.

Creationist biogeography was rooted in the Biblical story of Noah, who is warned by God of the impending destruction of all life because of the sinful ways of the local people. Noah builds a large ship, after God's specifications, and takes two of every animal, along with his family, to survive the 40 days of rain. After the flood waters recede, the ark lands on "the mountains of Ararat," and the world is repopulated by the survivors. The theme of destruction and rebirth of life is common enough in world mythology, and a cognate legend from Babylonia calls the boat builder "Utnapishtim". But it was, by the 1830s, difficult to reconcile with geological data – as all geological formations could not possibly have been laid down in a great worldwide flood a few thousand years ago!

Moreover, there was an unpleasantly unscientific sense to the way in which this theory wrestled with the fit of organisms to their environment. Taking the Biblical narrative at face value, one would have to envision penguins and polar bears, adapted to cold weather, alongside camels and scorpions, adapted to hot weather. Assuming for the sake of argument that the ark landed somewhere in west Asia, such as Armenia or Turkey, it was difficult to imagine how those differently-adapted kinds of animals could have gotten to where they now live, and are well-suited to, without going through a prolonged period of maladaptation in getting there, which they would most certainly not have survived! This was, of course, a classically teleological explanation – the animals were adapted to where they were destined <u>to end up</u>, not to where they presumably <u>were</u>. And it was seen as highly problematic on that basis.

Darwin was intrigued by the relationships between the extinct fossils he collected in South America, and the species he saw there alive; and between the living animals in different South American climates. For example, Darwin knew that horses in the New World had been brought there by the Spanish; but he found evidence that essentially modern horses had been indigenous to the New World and had gone extinct thousands of years ago. "Certainly it is a marvelous event in the history of animals," he later wrote, "that a native kind should have disappeared to be succeeded in after ages by the countless herds introduced by the Spanish colonist!"

Another fact that impressed him was a fossil glyptodont, a large extinct animal covered in armor like an armadillo. Glyptodonts were known only from the southern part of the New World. Armadillos were known only from the same regions. Might it be meaningful that two such uniquely similar kinds of mammals would be found together, and nowhere else? And the animals to which they were in turn most similar – sloths and capybaras – were also found in the same area. Was this a miracle, or the signature of an unknown, but interesting, natural process?

Natural theology waved away this issue by saying that God, in his wisdom, created animals to be adapted to their surroundings. One could, of course, thereby predict that South American steppes would have the same kind of animals as West Asian steppes – yet they don't. They seem to have different kinds of animals adapted in different ways to similar environments. Likewise with the animals of the South American and Central African rain forests.

Further, given that the islands of an archipelago, like the Galapagos, are all environmentally very similar, it is not at all clear, under this theory, why similar animals should differ in form slightly from island to island.

It seemed that geographical proximity and history, not crude environmental similarity, best correlated with the distribution of biological resemblances among fossil and living species. He wrote in his *Journal of Researches*, later known as *The Voyage of the Beagle*, in 1839: "This wonderful relationship in the same continent between the dead and the living will, I do not doubt, hereafter throw more light on the appearance of organic beings on our earth, and their disappearance from it, than any other class of facts."

Darwin's argument

Darwin returned from his voyage on October 2, 1836, and re-established contact with the leading biologists of the age, who studied the specimens he had collected. He wrote several books and monographs and developed a reputation as an able and competent biologist himself.

By the mid-1840s, Darwin had satisfied himself that there was a way to explain these biogeographic questions and other diverse issues in biology The key lay in the writings of a social scientist, Thomas Malthus (1766-1834). In his *Essay on Population* (1798; Darwin read the 2nd edition of 1802), Malthus had observed that people regularly out-reproduce their subsistence base. The result was competition, or what Malthus called a "struggle for existence". And if you thought the present was bad, the future would only be worse, given the high reproductive rate of the poor. Malthus called for sexual abstinence (after all, that was where babies came from), and the denial of assistance to the poor (which would only permit them to have more babies, which were, as he saw it, the heart of the problem).

Darwin accepted Malthus' argument of a struggle for existence, but failed to see why it should only apply to humans. After all, don't mice and dragonflies and sharks multiply faster than their food supply as well, leading to a struggle for existence in them? And at all stages of the life cycle there are far more cockroaches than can possibly multiply satisfactorily. Only a small proportion of them actually do leave descendants. Perhaps, then, some invisible hand selects those who will leave descendants, out of the many possibilities. And if those "selected" to reproduce preferentially are not perfectly average representatives of their group, the second generation will appear to differ slightly from the first. Thus Darwin transformed Malthus' conservative and static social agenda into a dynamic biological one.

To support his idea, Darwin spoke to real-life selectors, animal breeders. He knew their predecessors had created diverse breeds of dogs and pigeons in just a few thousand years. Could not the hand of nature mimic the hand of the breeder, although with less intensity and over untold more generations, and act as a "natural" selector? It would only require the environment to determine which traits were better, and therefore which animals should be favored in the struggle to survive and reproduce. The result would be something like the diversification of the dachshund, Great Dane, terrier, spaniel, bulldog, and Labrador Retriever from one another – only writ large, over the whole history of life. And the fact is, if we didn't know that those domestic stocks were all descended from a common ancestor, we would probably classify them as different species and genera because they are so different from one another!

Darwin named this hypothetical process "natural selection, " juxtaposing it against the "artificial selection" of the breeder – although of course the "artificial" selection process was in fact the only one that was known to be real. Further, Darwin didn't postulate the existence of any conscious selective agent for the "natural" selection process – rather, it proceeded as if there were an invisible hand guiding it.

The structure of his argument boils down to connecting a simple series of observations and inferences. In the first place, organisms reproduce more than their resources readily permit them to, leading to the "struggle for existence" deduced by Malthus. Since all populations consist of variable members with slightly different features, and those features are often under some hereditary control, it follows that the particular features of those individuals best suited to their conditions of life will predominate in successive generations. The result would thereby be a transformation of the population through time, in which specific descendant populations diverged from their ancestors, and from other descendant populations, in ways that fit them to their local environments. Extrapolated over the vastness of geological time, the implication was that all life was genealogically connected, the product of extensive “descent with modification”.

Recognizing that his ideas would be controversial, Darwin set about to amass an insurmountable quantity of data in support of his argument, and to convince his friends in the scholarly community. His hand was forced, however, when he received a manuscript from a colleague he had never met, a young naturalist named Alfred Russel Wallace, detailing the same basic ideas as a result of his own reflection on what he had seen of the animals in the Malay archipelago. Darwin consulted with friends and arranged for himself and Wallace to present papers jointly in 1858 at the Linnaean Society. Then he rushed to get his ideas into print.

The book was published on November 24, 1859 as *On the Origin of Species by Means of Natural Selection, or the Preservation of Favored Races in the Struggle for Life*. The first printing sold out that day. It was, in the words of biologist Ernst Mayr, “one long argument,” making three basic points.

- There exists heritable variation between individuals in any population.
- The nature of the environment causes some individuals to survive and reproduce more successfully than others.
- This changes the composition of the population in later generations, as succeeding generations of the population take on the characteristics of its reproducing members.

Where people fit in

Darwin recognized that the most contentious implication of his theories would be to remove the human species from the direct image of God, and situate it zoologically among the primates, where of course Linnaeus had placed it over a century earlier. The difference, however, was that Linnaeus was simply describing a pattern of resemblances, while Darwin was ostensibly talking about historical origins – as indeed Buffon had feared people would.

Darwin, however, sought to defuse that bomb by coyly refusing to deal with humans in the book. The only mention our species gets is in the third-to-last paragraph, when Darwin tells us: “Light will be thrown on the origin of man and his history.” In a later edition Darwin felt secure enough to expand on that thought, and modified the single mention to: “Much light will be thrown on the origin of man and his history.”

One member of Darwin’s circle was an anatomist who, like Darwin and Wallace, had made a scientific reputation upon returning from a sea voyage, Thomas Huxley (1825-1895). Shortly before its official publication date, Huxley received a copy of *The Origin of Species* from Darwin. Although he had some quibbles with it, he wrote his friend back immediately, “I finished your book yesterday. . . And as to the curs which will bark and yelp – you must recollect that some of your friends at any rate are endowed with an amount of combativeness which (though you have often & justly rebuked it) may stand you in good stead – I am sharpening up my claws and beak in readiness.”

Huxley was already involved in a very nasty public dispute with the distinguished anatomist and paleontologist, Richard Owen, over the similarity between the ape’s brain and ours. Huxley maintained there was no difference in basic form, just in size; Owen insisted that the human brain had a particular region, the hippocampus minor, that the ape’s brain lacked. Darwin’s work would mesh nicely with that.

The British Association for the Advancement of Science organized a debate at Oxford University in 1860, so that the followers of Darwin could confront, and be confronted by, their critics. One critic, a friend of Richard Owen, was Samuel Wilberforce, Bishop of Oxford. At the end of his presentation, the story goes, he sarcastically asked Huxley whether he thought he was related to the apes on his grandfather’s side or his grandmother’s side. Given the choice, replied Huxley, between “a miserable ape for a grandfather” or a clever man who would use his gifts of wisdom and speech in the service of ignorance and prejudice, “I unhesitatingly affirm my preference for the ape.”

Huxley himself would write the first book on human evolution in 1863, *Man’s Place in Nature*. Our place is, as Linnaeus noted, amongst the primates, and more specifically amongst the apes; but now, Huxley argues, we are driven inescapably to recognize that place as being the consequence of an intimate biological history that we share with the apes.

The sacrifice

A new international generation of biologists rallied around Darwinism, and expanded on the new biological ideas. Asa Gray in America, Huxley and others in England, and Ernst Haeckel in Germany all wrote extensively in favor of the new biological ideas.

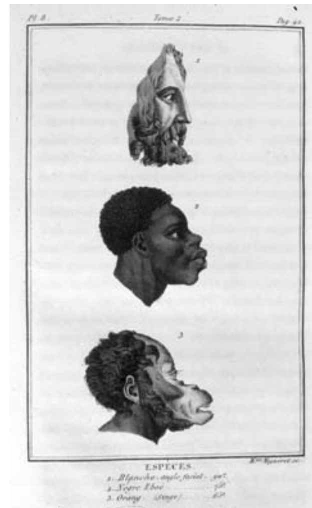
Haeckel in particular developed a single scheme encompassing the biological evolution from amoebas to people, and continuing on to link the transformation of species to the rise of human races and the emergence and domination of political states. In other words, he saw the evolution of humans as a rise from the apes, the evolution of Europeans as a rise from the other kinds of people, and reaching its zenith with the Aryan Prussian state.

Rudolf Virchow, on the other hand, thought that evolution did not call for the rise of racist nationalism, and disputed Haeckel's view of evolution. Haeckel's response was telling: he claimed to speak for evolution, and if you didn't buy the whole package, then you were anti-evolution. Virchow did not buy the whole package, and by the terms of the argument he became an opponent of evolution. When the fossils of Java Man were discovered in 1891, Virchow would refuse to accept them as human ancestors. Why? Because to admit them as evidence for evolution would have been to accept them as evidence for the political part of Haeckel's evolutionary program, which was far worse.

After Virchow's death, Germans did tend to see evolution just the way Haeckel outlined it. This, of course, was the evolutionary view that the Nazis would later adopt. Virchow's divorce of biological evolution from social and political forms, however, would be picked up by his young German protégé, who would emigrate to the United States in the 1890s, and ultimately be responsible for professionalizing academic anthropology in America – Franz Boas.

But Darwin's first-generation advocates were all faced with a problem when dealing with human evolution – there was virtually no fossil evidence for it. A single skull from Gibraltar that we would now classify as Neandertal, had been found in 1848; and the eponymous skull from the Neander valley in Germany was discovered in 1857. But the Gibraltar skull had not attracted much attention, and it was anyone's guess what the Neander skull was. And yet to link ape and human genealogically, you presumably required something to brandish as an intermediate form.

They solved this problem by reviving aspects of an older theory, the Great Chain of Being. Rather than ranking living beings as higher or lower than one another, now it might be "more or less evolved". So where were the missing transitional forms between person and ape? Actually, they're there, said these first-generation Darwinians – the non-white peoples of the world grade into the ape on one end and into the European on the other.



The slander was familiar, as Robert Chambers had said as much in *Vestiges of Creation*; and pre-evolutionary writers had for decades very casually drawn Africans as intermediates between Europeans and apes, so the image itself was a familiar one. But the Darwinians were in a war with an earlier, pre-modern biological comprehension of the place of humans earth; and so the full humanity of non-white peoples was sacrificed. That would turn out to be a hard idea to unload from evolutionary theory, as well.

Implications for Pattern

The most immediate result of the Darwinian revolution was that it explained the pattern in nature that Linnaeus had discerned over a hundred years earlier. Species clustered together into genera because they shared a recent intimate biological history; genera clustered into families because they shared a more remote common ancestry; and so on.

Where earlier evolutionary theories, such as Lamarck's, had worked within the framework of the Great Chain of Being, there was no way to fit the observed pattern (the nested hierarchy) to the evolutionary process. Suddenly, in Darwin's work, it all became clear – for Darwin's theory incorporated the divergence of species from one another. "I am fully convinced," he wrote, "that species are not immutable; but that those belonging to what are called the same genera are lineal descendants of some other and generally extinct species, in the same manner as the acknowledged varieties of any one species are the descendants of that species."

Darwin has here not only grounded Linnaeus' hierarchy in an underlying evolutionary process, but he has also linked the production of new breeds or varieties of animals – evolution below the species level, or microevolution – to the production of new species – evolution above the species level, or macroevolution.

Implications for Species

Much of modern science is concerned with freeing itself from an ancient philosophical stance known as *essentialism*. This was first formulated by the Greek philosopher Plato in his "Allegory of the Cave" in Book 6 of *The Republic*. Imagine, he suggests, that you are a prisoner chained to a rock in a cave. You cannot see outside, but the fire casts ever-changing shadows on the wall. Since you cannot see outside, you do not know what is causing the shadows, and for all you know, they are all there is. But in fact, says Plato, the shadows are caused by some people or things that are outside of your direct perception – their flickering, dancing, and changing shapes are illusory. They are simply forms caused by real things outside. And your job as a scholar is to see through the apparent variation of the world of forms, to the underlying uniformity in the world of essences – the things of which the shadows are simply pale copies.

His student Aristotle applied this to biology, arguing that the basis of a species lay in just such an essence – a transcendent ideal that existed, perhaps, in the mind of God. All earthly representatives of a species were simply forms, like those shadows on the cave wall. The task of the biologist, then, would be to see beyond the diverse variations that exist in a species and try to imagine what the ideal form, the essence, of that kind of animal would be.

The problem is that this approach subverts the empirical basis of knowledge. It invites you to ignore what you can see, and to imagine what you cannot see – and defines the imaginary part as the true reality. The variations that are part of the world of our experience are here dismissed as mere imperfections, or as degeneracy from the ideal.

Naturalists had, by 1700, begun to reconceptualize species from "animals that look alike and partake of a common essence" to "animals that can reproduce together and share a common history". But these weren't necessarily incompatible; one could still imagine the "idea in the mind of God" on which those real animals who could reproduce together were based. And another important implication of Darwin's work, then, was to stand the old view on its head.

If we accept that a species is really about reproductive compatibility, then the "essence" or "ideal" that they all share is irrelevant. More than that, it is imaginary. The reality lies in the variations themselves, the differences among the animals within a species. These are the qualities that allow an animal to survive and to reproduce in the face of competition from other members of the species. Consequently the variations should be studied – for they are real and important – and the underlying invariant "essence" is actually neither.

We will encounter essentialism in various guises throughout the study of human diversity, for example in the study of gender and race (where you may be defined by a single aspect of your ancestry or makeup, which infuses your entire identity with imaginary properties), and in the Human Genome Project (where the basis of being human would be imagined to reside within a single genetic representative). This of course is a testimony to the power of Plato and Aristotle in shaping European thought. For the present purposes, we can just observe that shaking off two millennia of metaphysical speculation about species in favor of an empirical, real-world approach was a major advance in biology; another contribution of Darwin's.

The modern concept of species builds on this distinction. It tells us that a species is not a group, or a set, in which membership is defined by the possession of certain features. Rather, a species is an individual (like an organism or a cell), composed of parts that stand in a specific pattern of relationship to one another. That relationship is participation in a common reproductive community, yielding the ability to share descendants. In the same way that your body is composed of cells, and you don't think of your cells as "members" of your body, but rather as your body's organized subunits, we no longer think of organisms as "members" of a species, but, rather, as "parts" of a species. (However, we do occasionally lapse and articulate it the old way.) This is a genealogical, evolutionary, and hierarchical concept of a species.

Implications for Biological History

Darwinism also explained the cause-and-effect of adaptation in a way that made sense in the modern scientific sense of the times. Granted that species are adapted to their surroundings, how did that come to be? – especially if they all started out in Noah's ark!

Darwin again reversed the traditional way of thinking about the problem. Rather than thinking of organisms in Noah's ark as built to survive where they will end up – their future circumstances dictating their present structure – Darwinism explained contemporary adaptation in terms of the survival and proliferation of ancestors living in the distant past. Thus, it is a theory of biological history, not of biological teleology (where the end, or *telos*, determines the present state).

This is a far more satisfactory kind of explanation, for philosophical reasons that had been developing for two hundred years, as we have already seen.

This helped establish Darwinism as a more scientific alternative than any of its competing theories. Even the early evolutionary theory of Lamarck, which saw evolution as an "unfolding" in which species responded to ecological pressure by climbing one link up the Great Chain, was still teleological in that the structure of the Great Chain was not of this earth. It was something presumably located in the mind of God. The future state (the next link on the Chain) is what determined the present state, which is not the way thing seem to happen.

Darwinism, however, affords a different view. Life is not heading towards the next link, but merely towards survival. Thus at any time, you are a product of the past, not a slave of the future. You are what you have inherited from your ancestors, not what you will pass on to your descendants. After all, you definitely had ancestors, but you may not have descendants!

Darwinism was thus a theory in which not only was there a deep history of life, but a deep history of human life as well. There was no knowable future, only a knowable past. It was that past that shaped the way we are today; and it is the way we are today and the conditions we will face that affect what we will become. Thus, it no longer made scientific sense to speak of a "biological destiny" or a "next step" in human evolution.

One still commonly hears this assumption, however – for example, in the question, "What will the person of the future look like?" This question assumes that the future is within us, and only needs to be teased out; and that response to environmental pressures (which we cannot foresee) is irrelevant to answering. We will see in much later how a modern approach to evolution might frame an answer to that question. For the present purposes, we can simply note that Darwinism *historicized* biology, and replaced an older teleological explanation for adaptation with an historical one.

Implications for relating humans to other animals

Humans have always related themselves to the animals. Some of the earliest art, for example, seems to depict half-human, half-animal figures. Mythologies universally give animals human characteristics and teach us how we can become more self-aware when we attend to those traits. In European literature, the master of the genre was Aesop, who wrote in 500 BC about the evil wolf, the honorable mouse, the jealous raven, the clever monkey, not to mention the wolf in sheep's clothing, the race between the tortoise and the hare, and the goose that laid golden eggs. In modern culture we know, among many others, the smart-aleck bunny ("Bugs"), the irascible duck ("Donald"), and the sly, if unlucky, coyote ("Wile E.").

The idea of blurring the boundary between human and animal is thus an old one. People widely invoke animals to learn about human qualities, or to demonstrate right from wrong, or simply for entertainment. They know ducks don't really wear four-fingered gloves and the top half of a sailor suit, but there is something self-revelatory about seeing our own characteristics and shortcomings in such a creature.

The human animal, with characteristics of both, is thus a staple of the narrative form. This of course, is a literary device, a metaphor, telling us that animals are like humans in some interesting and meaningful way. But Darwin showed that there was another way to compare animals and humans that wasn't merely metaphorical, but rather was historical. If humans and apes, for example, shared a recent common ancestry, then their similarities are something of a different order than the similarity of a person to a wise owl or a busy bee. The human-ape similarity is a similarity of biological correspondence due to history. They are similar because not too long ago, geologically speaking, *they were the same thing*.

These relations were later distinguished as *analogy*, a correspondence of fundamentally different structures that are nevertheless superficially similar – such as a mosquito wing and a bat wing, or a centipede leg and a chicken leg, or an octopus arm and a monkey arm; and homology, a correspondence of fundamentally similar structures, due to common descent, that are nevertheless superficially different – such as the paw of a dog and hoof of a horse, or the snout of a pig and nose of a person, or the wishbone of a chicken and the collarbones of a human.

The difference is that the first is still a meaningful symbolic correspondence, but the second is a meaningful biological correspondence. While we can use the same word to denote the "wing" of a mosquito and a bat, that is simply a word-game, for the two are fundamentally different structures – developmentally, structurally, and functionally. In both cases the thing does flap to propel its bearer through the air, but it does so in quite different ways. Conversely, although we may use different words to denote the dog's paw and horse's hoof, they are developmentally, structurally, and functionally very similar. Their relationship of homology isn't a word-game, but a reflection of the common biological underpinnings due to common ancestry.

This takes on considerable importance in the post-Darwinian analysis of the evolution of behavior. If a jointed supportive appendage of an ant is not a leg, but a "leg" – that is, an analogy or word-game linking two fundamentally different things – then what of slavery in ants? Shouldn't it be "slavery"?

The concept of homology gets another twist when we consider that many organisms are composed of repeated parts, which also develop during from a single common ancestral structure. These would include the segments of a centipede, the vertebrae of your backbone, and the relationship between your arm and your leg. This relationship is called *serial homology*. While the serial homology of bodies is relatively minor, that of the genes is quite extensive, with duplication of genetic structures occurring throughout the chromosomes, which we will examine in the next essay.

Phylogeny: The core of Darwinism

After recognizing that organisms share a common ancestry to greater or lesser degrees, and that this is why they seem to resemble each other to greater or lesser degrees, the next question is: How do we read the history of life?

To a first approximation, the more similar two species appear, the more closely related they are. This is a simple consequence of the fact that physical differentiation is partly a function of time, and therefore species that have been separate longer are likely to be more different. To a second approximation, however, rates of evolution are not constant, and therefore a rapidly-changing lineage may leave several slowly-changing lineages looking rather similar to one another, while not being very closely related to one another.

Consider, for example, the vervet monkey, spider monkey, and orangutan. While the two monkeys appear to be more generally similar, that is actually a result of the apes having diverged radically from the ancestors of vervet monkeys. In fact, when we zero in on <u>key</u> features, we find that the orangutan and vervet monkey match in the details of their teeth, noses, and bony ear chambers more closely than the two monkeys do. The reason that the two monkeys look more similar is because the orangutan has become very different, not because the two monkeys share the most recent common ancestry. Actually the most recent common ancestry is shared by the vervet monkey and orangutan, which we classify together within the primate infraorder Catarrhini.

This kind of phylogenetic reconstruction is predicated upon the fact that above the species level, animal lineages do not grow back together, they only become more separated. Since we define species partly by virtue of their inability to interbreed, it follows that animals belonging to different general or families cannot interbreed and thereby cannot become more similar to each other.

But <u>below</u> the species level, however, that can certainly happen. In other words, populations can be similar either because they share recent common ancestry, or because they have been in genetic contact. These biological histories are not divergent, like classical macroevolutionary phylogenies, but *reticulate*, like blood vessels, sometimes branching and sometimes re-uniting.

Other Darwinisms: Social Darwinism

As in the days of Haeckel and Virchow, we still find that proponents of other theories will claim to speak in Darwin's name, and try to legitimate their own ideas by associating them Darwinian evolution. One such school of thought is called "Social Darwinism," which had its heyday in the latter part of the 19th century. It was more the brainchild of Herbert Spencer, a philosopher-psychologist-sociologist-biologist, who developed a theory of the "survival of the fittest" – and then convinced Darwin that it was the same as "natural selection".

There were two important differences, however. Spencer's ideas involved seeing "survival of the fittest" as an engine driving species toward increased perfection, rather than just towards greater adaptation. Thus, he saw improvement – not just divergence – as the goal of evolution. Second, he believed a parallel process occurred in society. The fittest thrived, and if you weren't thriving, it was because you just weren't fit.

Combining those ideas, he saw society progressing by virtue of competition, or survival of the fittest. Since it was obvious that wealthy British men were at the top, it followed that they had outcompeted the rest of the world. And since the world was obviously in good shape and getting better all the time, it followed that the social hierarchy that placed colonial powers above other nations, Britain over other colonial powers, and the wealthy above the poor, was a good situation and represented just the playing out of natural processes.

There were two direct social implications. The non-European nations had obviously lost out in the competitive struggle. If they died out, then, it was just the way of the world. So one could easily see in this doctrine a natural justification for colonial oppression, if not outright genocide.

The second implication concerned the relations between social classes in Europe. The poor had obviously lost out in the competitive struggle, as well. For whatever reason – bad genes, bad work ethic – they were where they deserved to be. Competition makes the cream rise to the top, said this doctrine.

Moreover, any attempt to improve the lot of the poor (much less to stem the greedy practices of the oil and railroad monopolies) could be seen as tantamount to subverting the laws of nature. Thus any government regulations to try to improve the lot of the poor, such as child labor laws, or unionization, or even breaking up monopolies, would be bad for both the human species and for the progress of civilization!

By the turn of the 20th century, it was widely recognized that the social and political ideas piggybacking on Darwinism did not really derive justification from it. Rather, Social Darwinism seemed just to be a rationalization, by recourse to "the natural way of things," of the vices of the wealthy and powerful – greed, unscrupulousness, and exploitation. However, these ideas do crop up in various forms time and again. In 1994, a best-selling book called *The Bell Curve* argued that (1) IQ is a measure of innate intelligence, (2) wealthy people have higher IQs than poor people, and therefore (3) programs designed to ameliorate educational deficits among the poor should be abolished because they are doomed to failure, as they are thwarted by nature. This, clearly, was just a cosmetically altered version of the Social Darwinist ideas in vogue a century earlier.

Other Darwinisms: Neo-Darwinism

Darwin's ideas seemed to run aground on a thorny issue of genetics. Evolution by natural selection began with the <u>assumption</u> of a variable population. Darwin didn't know where the variation came from, but for natural selection to act, there must be variation present in the population.

A critic named Fleeming Jenkin, however, pointed out that natural selection would be opposed by the predominant model of heredity at the time, known as blending inheritance. Imagine a hypothetical population of yellow creatures and a hypothetical population of blue creatures. They meet and mate. Under blending inheritance, the resulting offspring are all green. The green ones can mate with one another, and their offspring will also be green; or they could mate with some leftover yellows and have chartreuse (greenish-yellow) offspring, or mate with blues, and have teal (greenish-blue) offspring. What Jenkin pointed out, however, was this: variation is being lost every generation. Under blending inheritance a population moves closer to homogeneity every generation. You can never recover the original blues and yellows!

Losing variation every generation would kill natural selection as an agent of evolutionary change, if natural selection proceeds from the assumption of a variable population. Darwin realized he needed some kind of an engine to crank out more variation as it became blended away, and finally sought refuge in Lamarck's theory of the inheritance of acquired characteristics. But the premise of Jenkin's critique was that blending inheritance was the mechanism of heredity, and Mendel's contribution was to show that was wrong.

By the 1880s, a movement had arisen within biology to jettison Lamarckian inheritance once and for all – even though Mendel's work was not yet known. It might not have been clear where the missing variation might come from, but it wasn't coming from Lamarck; and Darwin was surely right about natural selection, regardless of the theoretical objections from Fleeming Jenkin.

The biological theory that arose shortly before the turn of the 20th century involved accepting Darwinian natural selection and rejecting Lamarckian inheritance, and came to be known as neo-Darwinism. It has been said that these scientists "out-Darwinned Darwin" in accepting natural selection as the exclusive agent of evolutionary change. This was too narrow a view, and was later supplanted by a broader theory.

Other Darwinisms: The "Synthetic Theory"

In the early 1930s the field of population genetics was invented in the mathematical work of Ronald Fisher (1890-1962), J. B. S. Haldane (1892-1964), and Sewall Wright (1889-1988). They showed that the study of microevolution could be reduced in principle to a small number of genetic processes, which could be quantitatively analyzed, and which would have predictable effects upon natural populations of organisms. Thus was Darwinism "synthesized" with population genetics.

A few years later, a second group of biologists showed that not only was the work of the population genetics compatible with what was detectable within real species, but the ideas were compatible as well with something the population geneticists didn't examine – the formation of new species. Led by the Russian-born geneticist Theodosius Dobzhansky (1900-1975), who worked on fruitflies, the ornithologist Ernst Mayr (1904-2005), and George Gaylord Simpson (1902-1984), who worked on fossil mammals, the "Synthetic Theory of Evolution" was in place by mid-century, and so-named by biologist Julian Huxley (1887-1975), the grandson of Thomas.

The Synthetic Theory was Darwinian in two fundamental senses. First, it held that micro-level processes could be extrapolated to explain macro-level phenomena; thus, the processes by which dog breeds diverged from one another are essentially the same as those by which dogs diverged from cats and bears. And second, it held that species achieve and maintain a fit to their environment through natural selection. However, it went beyond Darwin in integrating advances in cellular and theoretical genetics, and showing that mutation (creating genetic diversity), selection (causing adaptation), genetic drift (causing random change), and gene flow (homogenizing populations) were all that one needed to explain the diversity of life.

Other Darwinisms: Evolution at the molecular level

Darwin became such a figurehead, much like Newton before him, that he became both myth and symbol. Like Newton, legends developed around him: that the Galapagos finches had convinced him of evolution; that he had accepted Jesus as his personal savior on his deathbed; that he was a rank amateur with no credentials at the time he published *The Origin of Species* (all false). Darwin also became symbolic of the new modern biology, as Newton had been of the new physics; as we have seen, with each generation's pet theorists trying to piggyback on Darwin.

Sometimes a symbol may be so culturally charged that it can be invoked in two seemingly opposite ways. In fact, Darwin became such a powerful symbol that newly emerging schools of biological thought have either aligned themselves <u>with</u> him, to exploit his symbolic value as the forward-seeing father of modern biology; or diametrically <u>against</u> him, to emphasize Darwin as the originator of the powerful orthodoxy of modern biology.

One such school that arose in the late 1960s as orthodoxies of all kinds were being attacked, emerged in the study of molecular evolution, the comparison of homologous proteins and genes across species. When you compared bio-molecules across species, you weren't confronted with evidence of a wise design and precision craftsmanship. Far from it; rather, you were struck by the amount of "slop" in the system.

Diabetics, for example, needed to take injections of insulin. But what they took at the time was pig insulin, which was slightly different in structure from human insulin. And yet it still worked. In other words, you could change the structure and yet not compromise the functional integrity of the hormone. This hardly suggested precise engineering and a perfect fit of the organism to its environment; rather, it suggested the body to be making due with what's there, and the detectable molecular differences between species to be just kind of random, not really adaptive.

These two propositions coalesced as the core of a new field of "molecular evolution" which cast itself as "non-Darwinian evolution". If the fundamental changes to DNA, resulting in changes to proteins, were neither harmful nor beneficial to their bearers, but were merely neutral, then they would not (by definition) be affected by natural selection. Rather they would evolve by a random mathematical process known as genetic drift. Perhaps, then, evolutionary theory had overstated the case for evolution being adaptive; maybe much of it was just random change that at least didn't hurt you, and could allow the body to go on functioning passably. This came to be known as the "neutral theory of molecular evolution," articulated by the Japanese statistical geneticist Motoo Kimura (1924-1994).

While it is now fairly clear that protein structure and function are generally indeed under selective constraints of varying intensities, and thus are indeed often subject to selection, it is also clear that most DNA changes are not even expressed in any form within the cell or the body. Thus, they are indeed neutral, since if they are not expressed as any kind of physical differences they cannot have an effect on the survival or reproduction of the organism. Molecular evolution thus constitutes a paradox: the evolution that it studies comprises for the most part neutral, unexpressed, non-adaptive differences between species; but what make evolution interesting are the tangible physical differences that arise between species and affect their form and survival.

Thus the paleontologist George Gaylord Simpson could ridicule non-Darwinian molecular evolution as the study of "the minor features of evolution". He had written a classic book on *The Major Features of Evolution*.

On the other hand, scholars trained in molecular evolution often come to general issues in the field with a healthy skepticism toward the view that organisms are precisely engineered instruments, finely tuned by natural selection. Indeed, in an interesting twist, we find the great French anthropologist Claude Lévi-Strauss explaining the origin of myths in his classic, *The Savage Mind* (1961). Myths, he says, are neither passed on perfectly intact, nor made up from scratch every generation. Rather, they are cobbled together by mythmakers from available motifs, and jerryrigged to fit the time and circumstance. Lévi-Strauss called the raw materials *bricolage*, and the mythmaker a *bricoleur*, usually translated as "tinkerer". And when the molecular geneticist François Jacob looked to a metaphor to express his views on evolution, he took inspiration from Lévi-Strauss, declaring that "evolution is like a tinkerer, not like an engineer".

Other Darwinisms: Punctuated equilibria

Another self-proclaimed anti-Darwinian evolutionary theory arose in the 1980s, with a criticism of Darwin's extrapolation from microevolutionary to macroevolutionary phenomena, spearheaded by the paleontologist Stephen Jay Gould (1941-2002). Rather than a smooth transition from populations through species into genera, perhaps the literal origin of species was accompanied by a break with the direct past, so that different processes may act above the species level than below the species level. We know, for example, that above the species level there is generally no interbreeding, but below the species level there is – perhaps the smooth extrapolation is therefore an over-simplification.

This was also accompanied by a critique of the engineering implied by seeing natural selection and adaptation as the fundamental processes of evolution. Darwinian theory and its successors generally held species to be continuously adapting to continuously changing environments. This naturally implies that species are in some sense fundamentally unstable, and always shifting in shape. Instead, however, one could see species as fundamentally stable units (for, say, a few million years) that only changed noticeably at the brief time when they formed (over, say 50,000 years). The history of a lineage might then look somewhat different, consisting of long-term stasis or equilibrium, interrupted by short-term change or punctuation.

Its proponents called attention to the fact that even Thomas Huxley, upon reading *The Origin of Species*, privately wrote Darwin to say that he had perhaps relied too heavily on the assumption that *"natura non facit saltum"* (nature does not make a leap). Its detractors derided it as "the theory of evolution by jerks". In fact, much of the theoretical basis for punctuated equilibria could be found in the writings of the synthetic theorists Ernst Mayr (who wrote about rapid speciation accompanied by genetic revolutions) and George Gaylord Simpson (who wrote about variation in evolutionary rates, from very slow [bradytely] to very fast [tachytely]). The argument, however, boiled down to whether species were stable fundamental units through long evolutionary time, or whether they were constantly sensitive to environmental pressures and adapting genetically to each one.

The theory of punctuated equilibria also called attention to other factors shaping the history of life, such as mass extinctions caused by ecological chain reactions (and perhaps triggered by rare astronomical events, such as meteor impacts). Thus it reopened, in a modern way, the issued of catastrophism that had been out of favor since the time of Charles Lyell.

Other Darwinisms: Sociobiology

At just about the same time that the prevalence of adaptation was being called into question both by molecular geneticists and by paleontologists, a "new synthesis" of work in theoretical population genetics and ecology set out to account for the adaptive significance of behavior. While its questions ostensibly were on odd issues like why populations regulate their growth, and the evolution of particular sterile castes in wasps, its answers cut to the core of Darwinism. Could a behavior evolve for the good of the group?

The answer was straightforward. If it were for the benefit of the group and against the benefit of the actor, it could not evolve because anything against the actor's interests are selected against, by definition. And if it were for the benefit of the group and for the benefit of the actor, then how could you ever say it evolved for the benefit of the group? As a result, a rigorous emphasis was placed upon explaining evolutionary phenomena in classically Darwinian terms: the free market struggle of one organism against another in the competition for life and babies. The principal exponent of this school was entomologist E. O. Wilson (1929-).

But there was nevertheless dissent over whether competition occurred the classically Darwinian way, between individuals – or even more basically, between genes. Here, biologist Richard Dawkins (1941-) made a case for "the selfish gene" – that is to say, primordial chemicals with no function other than to make copies of themselves. Those that did so remained, those that didn't ultimately expired without issue. One way that such copying might be aided would be if the gene were capable of producing something to assist it in copying – a protein, perhaps. Once again, those that did so remained, those that didn't perished – and the result was the development of the cellular apparatus around the genes. Cells thus arose to help the proteins helping the genes make copies of themselves. Later, groups of cells made bodies around themselves, to help them help the proteins helping the genes make copies of themselves. And finally, bodies performed behaviors to help make more bodies, to help make more cells, to help make more proteins help make more genes.

Thus (and the validity of the "thus" is a bit vexing), behaviors exist to help make more copies of genes; and the proper interpretation of a behavior is in its contribution to the production of genes. William D. Hamilton (1936–2000) derived conditions under which a behavior not to the good of the actor (an "altruistic" behavior) might evolve, if directed at relatives of the actor. Relatives, of course, have a probability of having inherited the same gene from a common ancestor. Thus, what looks like an altruistic act (against the actor's interests) may actually be in the interests of the actor's genes (and thereby selfish from their perspective). And Robert Trivers (1943-) derived conditions under which such a superficially altruistic, but genetically selfish, act could evolve, even if directed at non-relatives.

They pushed strongly to explain all behavior as an adaptation (that is, something that evolved by natural selection) either from the standpoint of genetic copies, or of physical offspring. Coming at a time when the prevalence of adaptation itself was coming into question both in molecular evolution and in macroevolutionary paleontology, it set off an ideological war, being labelled "Darwinian Fundamentalism" by Stephen Jay Gould.

Most controversial, as might be expected, was the perceived need to explain all human behavior as ultimately selfish, however altruistic it may seem at face value. Humans, after all, have created social entities that act to coerce people into doing things for the good of the group. Consider payment of income tax, which began in the US during World War I. If you give a significant chunk of your earnings away, you must to some extent reduce your probability of survival and reproduction, compared to how much better off you'd be if you had those assets to spend. So why not boycott paying taxes? Because it is against the law, and you may go to jail, which is definitely not in your interests. So the group can compel actors to act against their obvious interests by introducing coercive forces. On the other hand, your taxes do go to paying for civil defense, education, and law enforcement, so there is a sense in which your payment of taxes enhances your own welfare.

Which of those two explanations for why we pay taxes is superior? Is it because we have to, or because of the individual benefits it purchases? If both are right, is there a way to tell which is righter? If we take it as an article of faith that everything must be explained as a selfish act, that leaves us with the latter explanation; but why should it be an article of faith? And if humans can and do create cultural institutions that compel individuals to act in the interest of those institutions, does it not seem perverse to deny that people do it?

Other Darwinisms: Universal Darwinism

The attempt to explain all human behavior as selfish, because it must be adaptive and aid in survival and reproduction of self or genetic material for it to be there at all, is undermined by another movement that sprang from sociobiology. Inspired by the gene-selectionist Richard Dawkins, this movement begins with the proposition that the evolution of human behavior is somewhat different, because human institutions do perpetuate themselves and do compel individuals to act to their benefit. Dawkins gave the name "memes" to these replicating cultural units. Meme theorists thus explain the behavior of humans in the service of the replication of their own bodies, or their genes in their relatives' bodies, or their memes.

Since this is a metaphorical extension of Darwinism, involving not the competitive survival and proliferation of living organisms, but rather the perseverance of cultural or mental elements, it has been called a theory of "universal Darwinism". Like earlier theories based on the analogy of cultural world to the natural world (such as Social Darwinism), it is not at all clear that this process can be generalized to explain the features of interest in the cultural world sensibly. Is it at all illuminating to say that giving to charity is not "really" a selfless act, but rather is a consequence of the spread of the meme for donation (if such a thing even exists)? It is certainly the case that Darwin wouldn't recognize much of himself in this theory.

But that is precisely the point. Darwinism has come to label many ideas in the course of the last century and a half, because it is such as powerful word, calling to mind the modernization of the field of biology and the last great conflict between religious origin narratives and scientific origin narratives.

Other Darwinisms: Atheistic Darwinism

Modern science is predicated on a division between the material world, sensitive to experimental manipulation and the identification of regularity, and the spiritual world, which is impervious to both. This is a very odd view of the universe: To most human beings, the world of spiritual forces interpenetrates the world of mundane existence. Las Vegas, for example, is built on the assumption of such interpenetration (called "luck"). But if we can't rely on our perceptions, or control variables; and if the object itself is capricious and runs on miracles rather than generalizable laws, there's very little we can do with it scientifically.

Of course, we could do simulations with random number generators and make statistical predictions about long-term outcomes. But suppose that what looks to us like a random event is really controlled by forces outside our perceptible sphere?

The answer, as the first generation of scientists back in the 17th century recognized, is that, whether or not our subject is actually governed only by material forces, science can function under that assumption. Science can't work with the spiritual and the miraculous; but it also can't show their absence. All it can do is proceed is if they are absent, and see what comes of it. And of course, what comes of it are antibiotics, vaccinations, and thermonuclear bombs.

That leaves open, however, the question of the spiritual (not to mention the moral) universe. What can we say about it, from the standpoint of science? Quite simply, nothing.

Darwin did not deny miracles. He simply showed that life could multiply in form and adaptation without such interventions. And on the last page of his most famous book, he made it clear that although the origin of life itself might be miraculous, the origin of species need not be. He simply cut back on the number of miracles necessary to understand the history and diversity of life – now just "a few … or … one".

Evangelical atheists quickly adopted Darwin as a figurehead. Swept up in the tide of progress and modernity that overwhelmed late 19th century Europe and America, science has often been invoked as superseding religion – usually in a self-serving fashion that sets the speaker up as a kind of Pope.

Concurrently, apologists for science or religion have been known to argue that their domains are entirely separate – despite the obvious and constant introgressions of one upon the other. The truth lies somewhere in the middle.

First, human history is not linear and transformative; religion did not supersede magic or superstition, and religion is certainly not being superseded by science. Religion is everywhere flourishing. Second, they do come regularly into contact in the area of origin narratives, at the very least. Science can place constraints on the type of origin narrative, if the only criterion of interest is accuracy. But third, origin narratives are not widely taken as literally as scientists take their story, and accuracy may therefore not be the most criterion for people other than scientists. They might be more interested in whether it instills a feeling of belonging, or justice – or just whether it rhymes. The heavenly and moral worlds may be just more important to many people than whether they came from monkeys.

So, fourth, if science is predicated on a separation of the spiritual from the material realms, then why do scientists conduct periodic forays into areas where they have no expertise or knowledge – like theology (and human history, come to think of it)? Is it possible that with their noteworthy success in developing Weapons of Mass Destruction, scientists have come to feel – dare I say it, arrogantly? – as though they can pronounce authoritatively on subjects outside their domain? Indeed, stimulated by the aggressive atheism espoused by some scientists, like Oxford's Richard Dawkins, an equally embarrassing oppositional genre of scientific pieties has begun to emerge. The Human Genome Project's Francis Collins publicly professes his Christian faith, for example, and shows you how he reconciles his faith to his science, as if you should care. Personally, I am as skeptical of geneticists on the subject of theology as I am of theologians on the subject of genetics.

The problem is that, with "Darwinism" as a powerful and evocative cultural symbol of modernity and progress, there is rhetorical power in associating it with one's own religious (or irreligious) views. Whether God exists and intervenes actively in the world, or whether He set up laws and then let the world alone to run, or whether He doesn't exist at all – that's simply not the sphere of Darwinism. The responsibility lies with scientists themselves to differentiate answers to questions they do know about from answers to questions they don't know about – but it is rarely in their interests to do so.

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