Epigenesis and the Emergence of Cell Theory

More than a century before Charles Darwin published his celebrated *On the Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life* (1859), Pierre Louis Moreau de Maupertuis described his understanding of the overall process of biological evolution:

"May we not say that, in the fortuitous combination of the productions of Nature, since only those creatures *could* survive in whose organization a certain degree of adaptation was present, there is nothing extraordinary in the fact that such adaptation is actually found in all those species which now exist? Chance, one may say, turned out a vast number of individuals; a small proportion of these were organized in such a manner that the animals' organs could satisfy their needs. A much greater number showed neither adaptation nor order; these last have all perished" (Focher, 2014).

So how do such variations come about and why are they propagated?

"Could one not explain by that means [mutation] how from two individuals alone the multiplication of the most dissimilar species could have followed? They could have owed their first origination only to certain fortuitous productions, in which the elementary particles failed to retain the order they possessed in the father and mother animals; each degree of error would have produced a new species; and by reason of repeated deviations would have arrived at the infinite diversity of animals that we see today; which will perhaps still increase with time, but to which perhaps the passage of centuries will bring only imperceptible increase" (Glass, 1959, p. 77).

Indeed, Maupertuis' *Venus Physique* (*Earthly Venus*) published in 1745 presented a detailed description of biological evolution and natural selection which in numerous aspects matched, if not surpassed, Darwin's *Origin of Species*. The Frenchman Maupertuis had just ascended to arguably the most politically influential position in European science as the inaugural President of the Berlin Academy of Sciences following a prolonged personal recruitment effort by Frederick the Great of Prussia. Despite his fame, Maupertuis' extraordinary insights into biology quickly became ignored. While both personal and international intrigue soon gave rise to the precipitous collapse of his scientific standing, ultimately the disregard for his biological analysis fundamentally reflected a more basic political challenge. Along with various other biological scientists of the eighteenth century, Maupertuis understood his intellectual mission to be explaining how the vast diversity of species has come into being. This approach reflected the Galilean principle that all observables arise from physical causality and the role of scientific hypothesis and analysis is to characterize/quantify each process so as to yield robust predictions/correlations among the corresponding observable data. As Galileo so famously learned before the papal court, his approach conflicted with the political demands of Natural Philosophy whose role is to establish that the political hierarchy within human society when ruled by the *Best* (Gr. *aristos*, best; *kratia*, to rule) is simply a reflection of how Nature itself is ordered. Maupertuis' analysis of species evolution provided no clear explanation for how the *Best* within the human species are to understand their intrinsic superiority over the human *Cattle* that they rule. As such, the ruling class had little political incentive to embrace Maupertuis' explanation of biological evolution. A century later, Charles Darwin would not make that same mistake ("Monkey See – Monkey Do" – the Foundations of Darwinism).

For centuries, the ruling class had embraced the principle that the quality of being the *Best* must be understood to pass directly between the generations. The traditional explanation for that process was provided by the 'man-seed' principle ('sperm' comes from Latin for 'seed'). According to this principle, all significant inherited traits, most notably maleness itself, are passed through the male seed which is implanted in the soil of the female womb to grow. The quality of the individual is held to be directly determined by the quality of his male lineage. The man-seed theory of heredity was complemented by the preformationist theory of development. According to this theory, the physiological development of the individual is seen as a cyclical process of growth in which the role of sexual intercourse is merely to trigger a new round of growth. As popularized during the late seventeenth century when the first microscopic images of sperm cells were being described, some of these scientists believed that they had detected a small 'homunculus', a miniature human just waiting to be planted in the womb to grow into a newborn child. As envisioned in a series of nested Russian dolls, all of the future generations of that lineage were assumed to have been preformed as a series of ever smaller homunculi. The alleged plausibility of this repeating cycle of growth of predetermined organisms was largely drawn from analogy to plant seeds. Based upon the observation that all seeds of a plant tend to look alike, it was widely claimed that plants must be asexual organisms, and their repeated cycles of growth only require being planted in fertile soil. Despite centuries of evidence which suggested that plants are in fact sexual organisms, it was not until 1735 when Linnaeus (Carl von Linné) caused an extraordinary political splash by publishing a detailed biological classification system based upon the distinct sexual organs of the flower that the European intellectual world was forced to re-examine their belief in the preformationist doctrine. While many doubled down on that doctrine, others turned to the classical doctrine of epigenesis.

Rejecting the paradigm of biological development being nothing more than a repeated cycle of growth from a preformed lineage, the epigenesist views physiological development as a process of introducing order to disorder. The conventional representation was that of the chicken egg which begins as apparently a uniform globule of fluid yolk surrounded by a qualitatively similar globule of egg white. Yet over time, that yolk and egg white is transformed into a little chick, despite being sealed away within its shell. Although intuitively appealing in general terms, the epigenesist faced a major challenge when trying to further develop this idea. If order is being organized out of disorder, does that not require an 'organizer'? Furthermore, that organizer must be inheritable and thus pass into the next generation of embryos. If such an inheritable organizing structure exists, how could it be identified? That question would stump epigenesists for another century.

In addition to the predictable political opposition of the preformationists, the epigenesists were attacked from the opposite direction by those advocating an atomistic theory of molecular vitalism. From this perspective, not only could biology be understood in an explicitly anti-theological mechanistic fashion, atoms were claimed to naturally possess within themselves the spontaneous tendency to associate together to form living material. Unsurprisingly, the preformationists quickly lumped together the epigenesists and the molecular vitalists to condemn them as godless heretics. As much of this controversy played out in France, the victorious counter-offensive against the French Revolutionary doctrine quite directly attacked and suppressed both epigenesists and the advocates of spontaneous generation with the result that when those doctrines began to re-emerge in the mid-nineteenth century, they emerged tied to a distinct political perspective.

The two quotations from Maupertuis given above were selected, in part, due to their explicit invocation of the physiology of organisms being ordered in terms of their organization of internal organs. Among Maupertuis' broad range of scientific contributions, he was arguably the most insightful epigenesist of the eighteenth century. In formulating his organ-based theory of pangenesis, Maupertuis recognized that the organs of a body are often composed of a single predominant form of tissue. When fully developed, these organs interact with each other to carry out the various functions of the body. In Maupertuis' theory, each type of tissue gives off fragments/particles which are capable of growing back into a complete organ (Maupertuis, 1966, pp. 54-58). These particles from the various organ types are passed into the sperm and egg where upon fertilization the particles of each organ type assemble together due to their enhanced affinity for each other. Since the male and female forms of each tissue are more similar to each other than to other tissue types, they will spontaneously combine together to jointly grow into the mature organ. Maupertuis referred to these hereditary particles as elemental as they correspond to the irreducible component of each organ type and are capable of generating that organ by a process of growth (Maupertuis, 1966, p. xxix). In this model, the positioning information is embodied in an elevated affinity between particles of the same tissue type and a lesser affinity for the particles of neighboring tissue types so that the individual organs form within themselves and then bond to the other organs that normally surround them. As for the rest of fetal development, it is represented by a straightforward set of parallel growth processes. In Maupertuis' theory, additional biological complexity can evolve by the introduction of new organs.

Maupertuis' organ-based theory of pangenesis provided a plausible mechanism for the particulate intermixing of biological inheritance from both parents, something that the theory of preformation could not provide. The direct stimulus for this aspect of Maupertuis' theory of epigenesis was his recently published analysis on four generations of a family in which roughly half of the individuals exhibited six fingers and/or toes on each of their extremities (Glass, 1959, pp. 62-67). This trait of polydactyly was passed through both male and female parents. To strengthen the conclusion that these variations must have been directly transferred by biological inheritance, Maupertuis accompanied his report with the first ever statistical analysis of genetic inheritance which quantified the extreme unlikeliness that these cases within the family could have all occurred at random. Along with a similar independent study by R. A. F. de Réaumur of another family possessing this polydactyly trait, the conceptual ground of particulate inheritance had been set for Gregor Mendel's studies 120 years later. While in contrast to the genetically dominant mutation of polydactyly, Mendel focused his attention on the ultimately more informative recessive mutation of wrinkled peas. Nevertheless, in both instances, the significance of these fundamental genetic analyses would be ignored for years.

Maupertuis applied his theory of pangenesis toward a more accurate understanding of hybridization. In referring to the crucial process of assembly for the paternal and maternal components of the various forms of hereditary particles in generating the 'seed' for each type of organ, "if the elements come from animals who no longer have between them sufficient analogy, the elements not being able to assume, or not being able to retain a suitable arrangement, generation becomes impossible" (Glass, 1959, p. 70). Maupertuis' proposal that two subpopulations of single species might become sufficiently distinct from each other so as to eventually give rise to two separate species may not seem surprising in hindsight. However, the political reality was that in his day the conventional understanding of how new species might be generated (many rejected that possibility as well) was that members from two species would merge by becoming cross-fertile. That scenario was seen as being more compatible with the idea that all of the 'original' species could have been represented on Noah's Ark.

The widespread intolerance of all things related to biological evolution which was felt across most of Western Europe for the first few decades of the nineteenth century was applied to the topic of epigenesis as well. The tide began to shift with the introduction of the first two principles of the emerging theory of the biological cell in 1839 - all organisms are composed of cells and these cells are the basic unit of structure and organization in organisms. Co-founder Theodor Schwann compared the role of the cell to that of the organism (Richmond, 2000):

"We must, in fact, ascribe an independent life to cells – i.e., the combination of molecules which take place in a single cell are sufficient to set free the force, in consequence of which the cell has the power of attracting new molecules. The case of nutrition and growth lies not in the organism as a whole, but in the separate elementary parts – the cells."

What was then to unfold was one of the most egregious lost opportunities in the history of biological science. The defining characteristic of epigenesis theory is the process of introducing order into disorder. The theory of the biological cell emerged virtually simultaneous with the emergence of the field of thermodynamics which would ultimately provide the theoretical basis for understanding why the biological cell provides the crucial properties of a functional mechanism for epigenesis. Instead, that realization was politically crippled at the time and indeed remains largely crippled to this day. Cell theory also emerged just as the traditional version of the man-seed doctrine was beginning its final collapse. In that case, it would be Charles Darwin who came to the rescue of the *Best*.

The Schleiden-Schwann theory of the cell quickly gained widespread discussion for its view of life being founded upon a "republic of cells". This idea that Nature itself vindicated the rising call for the overthrow of the European noble class was by no means incidental to the coming series of revolutions. A revival of the French Revolutionary spirit had briefly swept across Paris in July of 1830. Although that revolt was firmly suppressed, resentment toward the restoration of the pre-French Revolution style of noble rule had continued to build not only in France but across most of Western Europe. This call for a more democratic society burst forth in 1848-49 in series of largely disconnected rebellions. As directly illustrated by the example of the local revolution that emerged in the northern Italian city of Padua which briefly drove out their Austrian overlords in 1848, two key leaders in that local revolutionary movement were the brothers Andrea and Giuseppe Meneghini, Giuseppe being a leading pioneer in the emerging field of cell biology (Dröscher, 2021, pp. 165-200,261-278). In part due to their frustration that Pope Pius IX had refused to support the Italians in the north in their effort to throw off their Austrian overlords, the Roman populace rose in rebellion against him. Fleeing in disguise to the famed fortress of Gaeta, the pope threatened blanket excommunication of the protesters in Rome and refused to even meet with their emissaries (Rostenberg, 1940). In his efforts to rally the 'faithful', Pius IX then sent his encyclical *Ubi Primum* (1849) to the bishops of the Church stating his intent to formally declare that Mary had been immaculately conceived. On the more practical level, he appealed to Louis Napoleon, leader of the recently successful revolution in France who had just been installed as President. To the utter disbelief of the leadership in emerging Italian Independence movement, Louis Napoleon dispatched the French Army to conquer Rome and reinstate the pope.

In a replay of the post-French Revolutionary suppression of 'epigenetic' evolutionary biology, the "republic of cells" was similarly cast onto the political dustbin following the defeat of the 1848-49 revolutionaries. In Britain, where that political fever did not reach the level of revolution, it was Thomas Henry Huxley who would lead the intellectual charge against the "republic of cells". While soon to become more famous for his skills as a polemist in serving as "Darwin's Bulldog", T. H. Huxley condemned Schwann for purportedly having claimed "that the cell as such possesses powers which are not inherent in its separate molecules" (Richmond, 2000). Huxley's principal line of attack against the advocates of cell theory was to condemn them for being preformationists (Reynolds, 2010), a charge of considerable irony given that, during the previous century, the epigenesists in search of an inheritable organizing structure were condemned by the preformationists as being advocates of spontaneous generation. Huxley latched onto the popular criticism that the 'cell' was only a passive surface container within which the far more biologically relevant 'protoplasm' resides. This controversy which pitted those who advocated for the vital 'protoplasm' and the irrelevant cell container against those who saw the cell as a biological whole would continue on into the early twentieth century.

It is perhaps not surprising that during the still early stages of developing the field of thermodynamics, Darwin might have been oblivious to the significance of the cell boundary as a crucial thermodynamic partition. However, by the early twentieth century, such an oversight by his disciples had ceased to be excusable. Much of the more serious theoretical discussions of the requirements of life during the first half of the twentieth century were focused upon the biological cell acting as a non-equilibrium thermodynamic system. Key to this idea was the cell being bounded by a semi-permeable membrane via which the cell could control what molecules would be selectively taken up from the surrounding solution and through which specific internal molecules could be selectively secreted from the cell. Such a biological system must require the net input of chemical energy to drive these otherwise thermodynamically unfavorable uptake and secretion processes. The molecules to be taken up must include not only the components needed to build and maintain the structure of the cell but also food molecules for which their metabolic breakdown would provide the chemical energy needed to drive the necessary biological processes. Yet to this day, the field of evolutionary biology has continued to turn a blind eye to the fact that the requirements of thermodynamics must be met.

Virtually every form of differentiated cell in an organism contains the same genomic DNA information. It is the reciprocal interactions among the cells of an organism which lead to the progression into the various states of cellular differentiation. Given that understanding, it is far past time that physiology be more robustly interpreted in terms of the long lost "republic of cells". As described by Edmund B. Wilson, a leading scholar in the field of cell biology at the beginning of the twentieth century, "the analysis of biological phenomena is made definite and effective by the conception that the cell constitutes a primary organic unit both of structure and of action" (Wilson, 1925, pp. 4-5). Needless to say, the paradigm of the living organism being based upon a "republic of cells" continues to be rejected by the neo-Darwinist orthodoxy who see the philosophical role of evolutionary theory as providing the scientific basis for distinguishing the hierarchical distinction between the *Cattle* and the *Best*. Indeed, the political motivation to purge thermodynamics from biological evolutionary thought has only accelerated since the 1960s. Darwin had published his *Origin of Species* at the peak of British self-confidence in the 'self-made Man' as master of the Industrial Revolution. Throughout the following century, Darwin and his neo-Darwinist disciples had focused upon justifying why the individual successes of the *Best* must imply the optimal pathway for the advance of the species as a whole. A crucial transition that largely unfolded during the 1960s was the political abandonment of this cult of 'Progress'. With a heightened paranoia regarding increasing world population and diminishing natural resources, the modern standard of success has come to be measured in terms of one's ability to seize a larger slice of a shrinking pie. Reflecting that political transformation, during that decade preeminent neo-Darwinist W.D. Hamilton led the way in redefining his field according to the principle that parasitism is the driving force of biological evolution. Building upon the implicit significance of Ronald Fisher's celebrated *Fundamental Theorem of Natural Selection* (aka the Racial Purity Theorem), Hamilton explicitly defined the criterion for evolutionary success as the genetic lineage which captures the gene pool of the species, regardless of whether that conquest condemns the species to extinction (Hamilton, 1970). Central to that analysis was the defining away of any plausible positive significance to the concept of 'altruism'. In the present day neo-Darwinist orthodoxy, any form of group selection-based analysis of genetic propagation is explicitly excluded. If a mutational variant does not directly benefit oneself and one's immediately related relatives, it cannot be allowed to be assigned a selective evolutionary advantage. The pointedly ignored mixability analysis of Marcus Feldman and colleagues has put the lie to that 'disproof' of group selection (Evolutionary Advance by Progeny Investment and Socialization).

The idea that the parasite is the driving force of biological evolution was introduced to the general public in Richard Dawkins' *The Selfish Gene* (1976). In a flamboyant revivalist preacher style, Dawkins has succeeded in establishing an explicitly 'anti-religion' cult around the basic concept that life is fundamentally the process of self-replication and the organism is merely the gene's way of achieving its own self-replication. Much of the subsequent discussion on the topic has looked to viruses or RNA molecules as more suitable models for the desired evolutionary replicator. It is deeply revealing that the favorite models used to represent the generic self-replicator are invariably thermodynamic absurdities. Clearly, a more politically significant consideration than that conceptual indiscretion is the fact that the self-replicator paradigm has enabled key elements of the traditional man-seed doctrine to be successfully resurrected. This perspective demands a sharp distinction between the process of insuring one's own replication and the process of reproduction which entails regenerating the life forms needed to carry out that replication. While in the era of Political Correctness no self-respecting evolutionary biologist would dare acknowledge the implicit sexual assignments for the evolutionarily superior replicator and evolutionarily servile reproducer, the status of the female in this political hierarchy is transparently obvious.

Given the fact that Richard Dawkins' claim to fame rests entirely upon a nearly fifty year old book, it might be surprising for younger readers to learn that in 2013 an international panel composed largely of U.S. and UK experts selected Richard Dawkins as the most important thinker in the present day world (Dugdale, 2013). Even more extraordinary, in July 2017 the Royal Society of London published a poll among its readers who were asked to identify the most influential science book of all time. Richard Dawkins' *The Selfish Gene* won the top slot, pushing aside not only Charles Darwin's *Origin of Species* but Isaac Newton's *Principia Mathematica* as well (Armitstead, 2017). The principal basis for Dawkins' long lasting fame comes from his having applied the 'selfish gene' paradigm to the social realm by inventing the concept of the 'meme', a mental parasite which infects and transforms human culture.

"Memes should be regarded as living structures, not just metaphorically, but technically. When you plant a fertile meme in my mind you literally parasitize my brain" (Dawkins, 1976, p. 206).

Despite that sham claim of humility, there cannot be the slightest doubt on what side of the parasite/parrot-cite divide that Richard Dawkins sees himself. In his classic book, Dawkins states that "memes propagate themselves in the meme pool by leaping from brain to brain via a process which, in the broad sense, can be called imitation" (Dawkins, 1976, p. 206). Dawkins then goes on to explain how he came to select "a name for the new replicator, a noun that conveys the idea of a unit of cultural transmission, or a unit of *imitation*" (Dawkins, 1976, p. 206). He noted that the word 'mimeme' comes from a suitable ancient Greek root for 'imitation', but he preferred to shorten it to 'meme' as that sounds more similar to 'gene'.

It took the emergence of social media to transform 'meme' into a ubiquitous reality of modern life. That familiar ubiquity helps encourage the belief that its widespread use has taken the edge off of the vicious political intent which Richard Dawkins first bestowed upon it. Such an optimistic attitude is grotesquely misplaced. By design, the meme is intended to serve as a tool for creating a totalitarian state by the systematic destruction of the social self (*Deconstruction of the Social Self*). The social media industry has largely constructed its economic success on the basis of having efficiently monetized the meme.

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