

Article

Strong and Weak Teleology in the Life Sciences Post-Darwin

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Abstract: It is often assumed that direction and purpose in nature—teleology—is a dead relic of the past, a result of Charles Darwin’s *Origin of Species* (1859) and *Descent of Man* (1871). But teleology has had a long and complex relationship with science. This paper will trace its general history with an emphasis upon the life sciences, especially biology. Particularly important is the fact that all teleology is not equal; strong (transcendent) teleology (designated T_s) should be distinguished from weak (purely descriptive and utilitarian) teleology (designated T_w). A working definition of teleology in its most meaningful aspects is then given. The challenges that Darwinism faced in dealing with purpose in nature are discussed, as is their proposed solution in the evolutionary synthesis, and the persistence of T_s following that synthesis is outlined and critiqued. Evidence of T_s persistence in the life sciences is presented with several relevant examples, and strong teleology is further differentiated by specific (T_{s+}) and nonspecific (T_{s-}) varieties. This essay concludes that T_s remains an ongoing and integral part of the life sciences and will likely remain so, even though it may be true but not verifiable empirically.

Keywords: teleology; teleonomy; teleometry; Darwinism; neo-Darwinian synthesis; evolution; Lecomte du Noüy; Edmund Ware Sinnott; Pierre

1. Teleology’s Historical Relationship to Science

Teleology in its most basic form is about purposes in nature. These very often can be found in teleological descriptions that involve “in order to” statements relating phenomena in a goal-directed or goal-seeking way (Woodfield 1976, pp. 24–25). Etymologically, the term is rooted in *telos* (τέλος in Greek) meaning end or goal. At least as old as Plato’s *Phaedo* and *Timaeus* (360 BC) and modified and elaborated upon by Aristotle (350 BC), its original expression came from the Ionian Anaxagoras one hundred years prior (Barnes 1982, pp. 416–18). But Aristotle offered its most complete explanation. One of his fundamental concepts was that mechanical causation was not independent of teleological description but actually *required* it (Wattles 2006, p. 449). As a feature of scientific inquiry, teleology was an ever present feature, and it reigned uncontested up through the mid-1400s (Lindberg 2007, p. 364). Thus, to call teleology unscientific would be to ignore the very foundation of science in the Western world.

In fact, Western science was impelled by a teleological imperative. The height of that imperative was the Middle Ages. Far from a benighted period erroneously dubbed the “Dark Ages,” science was, in fact, spurred on by the attribution of design. As the twelfth-century theologian Hugh of St. Victor put it, “The whole of the sensible world is like a kind of book written by the finger of God” (Hannam 2011, p. 58). As James Hannam has written, during this faith-infused, teleologically permeated era, “the most significant contribution of the natural philosophers of the Middle Ages was to make science even conceivable . . . Their central belief that nature was created by God and so worthy of their attention was one that Galileo wholeheartedly endorsed. Without that awareness, modern science would simply not have happened” (Hannam 2011, pp. 342–43). Of course, teleology has also played

a role in other faith traditions' understanding of science and nature; the Islamic concept of *taskhir* and certain Hindu practices are notable examples (Setia 2004; Fox 2015). Furthermore, Jewish theology and science have long been known to be premised upon teleological foundations (Wolfson 1912). So, historically speaking, the notion that teleology is somehow inherently at odds with science is unpersuasive. It is just a variation on the old threadbare science/religion warfare thesis offered by the historian/educator Andrew Dickson White and scientist/philosopher John William Draper. No historian of science takes this notion seriously today (Numbers 2009, pp. 1–6). As a whole, teleology and teleological thinking has fueled far more scientific investigations than it ever extinguished.

Teleology and science were inseparable during the Renaissance. Galileo Galilei, Nicolaus Copernicus, Johannes Kepler, Andreas Vesalius, William Harvey, and Conrad Gessner, all assumed teleological perspectives. Moreover, it was during this time that historian Daniel J. Boorstin has argued that “communities of science became parliaments of scientists conducted in the vernacular languages” (Boorstin 1983, p. 386). Everyone could now participate in the grand scientific project with the *arcana lingua* removed.

Nevertheless, it would be naïve to ignore the general attitude, freely acknowledged if not necessarily accepted, that teleology (especially in biology) became a “dirty word,” a dark and dangerous “forbidden practice which should not even be discussed” (Dennett 2019, p. 355). The source of this attitude will be covered in the next section, but teleology's opponents can be found in roots as deep as those from which it was born in the atomism of Leucippus and Democritus (Barnes 1982, p. 414). For them, the universe was composed entirely of indivisible and miniscule atomic particles, all governed by natural laws. Here was a program and a metaphysic in absolute opposition to teleology in any form. But it would be erroneous to connect the materialism of these Presocratics to today; “modern atomism” is a myth and their materialism was purely philosophical (Barnes 1982, pp. 343–44). Until the so-called Enlightenment, such extreme materialistic reductionism was rare, discontinuous from its ancient roots, an idiosyncratic minority view that was considered not only false but scandalous. Eventually, however, the teleological science of Augustine, Aquinas, and leading natural philosophers from Galileo to Newton shared the intellectual stage with anti-teleological materialists like Pierre Gassendi, Julien Offray de La Mettrie, Baron d'Holbach, and assorted *Encyclopédistes* led by Denis Diderot and Jean le Rond d'Alembert.

2. One Word, Different Meanings

In a sense then, Plato and Aristotle set off a teleological world view that drew in elaboration and increasing sophistication on the one hand and reformation into tamer proposals of more modest means and ends. “Aristotle blazes the trail for later thinkers,” Jeffrey Wattle observes, “including Monod and Dawkins, to speak of teleonomy and design without implying any higher conscious purpose or intention whatsoever behind the natural process. At the same time, Aristotle's progress in articulating teleology gives theists a more adequate vocabulary in terms of which to acknowledge the difference between conscious teleology and the teleology implicit in organisms and ecosystems” (Wattle 2006, p. 451).

Whatever their emphasis, the concept of teleological purpose and end-directness was largely assumed in both the earth and life sciences. Certainly the great taxonomist, Carl Linnaeus, considered it essential (in *both* senses of the word) and built into his *systema naturæ* a “teleology immanent in the overall equilibrium of nature” (Solinas 2015, p. 76). Some of it was based upon a centuries-old faith in transcendent purpose, such as Charles Lyell's uniformitarianism that presumed a teleological universe of divine providence. While Lyell's geological world had no need of this transcendence, organisms (especially humans) were another matter. Ultimately, he looked to traditional teleological explanations for living organisms and even believed the inorganic world to be, if only secondarily through efficient causes, at its base providentially directed (Bartholomew 1973, p. 287). Others, like Lamarck, based their evolutionary system on a naturalistic doctrine of acquired characteristics that was inherently teleological—e.g., the giraffe's neck grew “in order to” reach the tops of the tenderest leaves, the speed of the cheetah was developed “in order to” catch prey on the open

savannah, and so on. This variety of teleology is rather modest, it is like saying the monarch butterfly migrates to warmer climates in order to escape the winter and continue its life cycle. Purpose here is immediate, related to survival (utilitarian), and not in any sense transcendent. Lamarck's deism would not permit him anything more than a rather "pallid teleology smuggled in to complete his evolutionism" (Ruse 1999, p. 91). These two forms of teleology will become recurrent leitmotifs: the former, transcendent teleology will be designated strong teleology (or T_s) while the latter type will be referred to as weak teleology (or T_w).¹ (See Table A1 in the Appendix A.)

Throughout most of this history, science simply assumed both types of teleology. The heart of science was not to be found in T_w observations (those were interesting and worthy of study but all-in-all trivial), but in T_s assumptions: a nature made up of orderly and predictable laws that required a law-giver. Talk of randomness and chance was expected perhaps in the atheistic salons of Paris, but the proper English attitude towards science was based upon natural law, an orderly universe composed and managed by a designer. By the mid-nineteenth century, all the important scientists of Britain assumed T_s as a prerequisite to rational inquiry: the great science polymaths John Herschel and William Whewell; mathematician and inventor of the proto-computer, Charles Babbage; geologist/cleric Adam Sedgwick, and even Lyell himself all assumed this as a matter of course. Anything less was unreasonable and most assuredly *unscientific*, the attempt to build an understanding of complexity upon the sands of chaos (Snyder 2011, p. 197). But a true revolution was in the offing, a revolution that struck at that heart of T_s . This is undoubtedly what geologist and geographer William Morris Davis, the so-called "father of American geography," meant when he addressed the St. Louis Congress of Arts and Science in 1904 and referred to "the revolution that replaces the teleological philosophy of the first half of the nineteenth century by the evolutionary philosophy of the last half" (quoted in Cohen 1985, p. 277). The birth of Charles Darwin's revolutionary "child"—common descent and modification by means of natural selection—would attempt to make T_s an orphan to science, an attempt persuasive to many. This Darwin factor changed everything.

3. The Darwin Factor—"The Course Which the Wind Blows"

Teleology in the post-Darwinian era cannot be appreciated until precisely what the Down House naturalist brought to the arena of scientific discourse is thoroughly understood. It happened on Thursday, November 24, 1859, when *On the Origin of Species* first rolled off the press of John Murray in London. Murray sent nearly forty copies out for review, and Darwin himself sent more than eighty complimentary copies out at his own expense. Anticipating high demand, Murray increased the print run to 1500 copies, which promptly sold out on the day the book was released. More importantly, 500 copies went to Mudie's Circulating Library, an acquisition that assured Darwin would get a wide audience (Browne 2002, pp. 88–89). And indeed it did.

Darwin's book was unique in that it was driven by a mechanism—natural selection—that provided a means of explaining the descent and diversity of life without recourse to any vitalistic or supernatural force. Put another way, "For Darwin, differential death rates caused by purely natural factors created new species. God was superfluous to the process" (Larson 2004, p. 69). This primary—even primordial—creative power of natural selection and its theological implications created all the controversy then and now.

Michael Ruse speaks to this point. He has said of Darwin that "though his nontheological theory is often portrayed as taking the teleology out of biology, if anything Darwin was bringing it back in! Adaptation, with its orientation towards ends, was a more significant facet of the organic world for Darwin than it was for Huxley [who questioned natural selection]" (Ruse 1999, p. 184).

¹ The association of T_s with transcendence, in the sense of being above and independent of the material universe, should not be confused with the transcendental, a literary and philosophical system associated with certain Kantian principles that emphasize epistemological truths attained beyond experience.

Ruse's statement is true enough, but he fails to make a crucial distinction. Darwin freely admitted T_w (a purely utilitarian teleology harkening to Lamarck) only to ban T_s (the teleology of Herschel, Whewell, Sedgwick, and Lyell). T_s is strictly ruled out by this theory. Instead, Darwin explained virtually *everything* through naturalistic means.

If Darwin's theory is based on anything it is based on chance; this is the meaning of Darwinian evolution from start to finish. Darwin himself admitted, "There seems to be no more design in the variability of organic beings, and in the action of natural selection, than in the course which the wind blows" (Darwin [1893] 2000, p. 63). As such, it could surely *never* invoke any form of T_s causation. As one historian has put it, "This was his decisive departure from scientists who otherwise were sympathetic to his theory" (Johnson 2015, p. 3). But it *also* explains why there was such general resistance to his theory despite his concerted efforts to make it as convincing as possible. To the older generation of scientists, the ruling out of transcendent purpose (T_s) was ludicrous, even irrational. It is undoubtedly what prompted John Herschel to rather famously (or infamously) refer to natural selection as the law of "higgledy-piggledy"; his colleague, William Whewell, was equally unimpressed and was rumored to have refused a copy of *Origin* on the shelves of the Trinity College library (Browne 2002, p. 107). Teleology was at the heart of the dispute. All previous proposals for a "transmutation" of species, whether by Lamarck, Herbert Spencer, Robert Chambers, or even Darwin's own grandfather Erasmus, assumed some form of overall progress, some goal-directedness—in other words, T_s evolution. Thomas S. Kuhn explains:

For many men the abolition of that teleological kind of evolution was the most significant and least palatable of Darwin's suggestions. The *Origin of Species* recognized no goal set either by God or nature. Instead, natural selection, operating in the given environment and with the actual organisms presently at hand, was responsible for the gradual but steady emergence of more elaborate, further articulated, and vastly more specialized organisms. Even such marvelously adapted organs as the eye and hand of man—organs whose design had previously provided powerful arguments for the existence of a supreme artificer and an advance plan—were products of a process that moved steadily *from* primitive beginnings but *toward* no goal. The belief that natural selection, resulting from mere competition between organisms for survival, could have produced man together with the higher animals and plants was the most difficult and disturbing aspect of Darwin's theory. What could "evolution," "development," and "progress" mean in the absence of a specified goal? To many people, such terms suddenly seemed self-contradictory (Kuhn 1970, p. 172).

For Kuhn, the controversy surrounding Darwin's theory of evolution and its eventual acceptance is an almost perfect example of the structure of a scientific revolution.²

This elimination of T_s became the source of more than just a scientific revolution, but a revolution in worldviews about the nature of life and humankind in general. Whether Darwin intended it or not, despite efforts of so-called "theistic" evolutionists to suggest otherwise, Ruse is quite correct in his assessment that, in many ways, Darwin's theory "became something more. It became a secular religion, in opposition to Christianity. In the second half of the nineteenth and into the first part of the twentieth century Darwinian evolutionary thinking ... became a belief system countering and substituting for the Christian religion: a new paradigm ... We do not have two world pictures talking past each other but right at each other" (Ruse 2017, p. 82).

There can be little question that the religious—perhaps better put, the *metaphysical*—nature of Darwinism would become an important factor in the crafting of a new evolutionary synthesis in the

² These revolutions refashion perspectives and agendas so thoroughly that scientific advance may be regarded as a largely noncumulative process. In effect, these revolutions remake the scientific discipline anew. Kuhn argues that scientific disciplines rest upon paradigms (i.e., 'universally recognized scientific achievements that for a time provide model problems and solutions to a community of practitioners'), and that accumulating anomalies push these paradigms to the breaking point. The ensuing crisis develops into a full-fledged revolution in which the old order collapses and a new one emerges transforming the nature of the discipline itself under a fresh paradigmatic structure.

twentieth century. That would be realized in the builders of the neo-Darwinian synthesis with Ernst Mayr as its undisputed doctrinal leader.³ This was more than a scientific theory rising to paradigmatic status; it is closer to what the *Annales* historians might call a new *mentalité*, a set of shared sociocultural ideas, beliefs, and values (i.e., a worldview coincident to a particular time and place).

But even this was only the capstone to a historic transformation wrought by Darwin himself. What *Origin* and *Descent of Man* proposed to replace was nothing short of Western Civilization's conception of the cosmic order leading to the *ens perfectissimum*—the most perfect being—God. Plenitude, continuity, and gradation could be demoted to struggle; the Great Chain of Being was broken, no longer a *scala naturæ* ruled from above but a branching tree of life rising from below. From 1800 to at least 1812, Friedrich Schelling led the revolt against the Great Chain of Being (Lovejoy [1936] 1964, pp. 317–26). Darwin's revolt completed it a generation later. His achievement was so complete that Arthur O. Lovejoy—who was influenced by the Darwinian paradigm early on (Lovejoy [1909] 2007)—was forced to regard the Great Chain of Being as one of the most outstanding failures of human thought (Lovejoy [1936] 1964, p. 329). Nothing looked more anachronistic than the Great Chain of Being against the Darwinian world that heard his famed William James lectures at Harvard in 1933, lectures that formed the basis for the book that would make him famous.

4. The Neo-Darwinian Synthesis and Teleology's Undertaker, Ernst Mayr

The rise of scientism in the nineteenth century found teleology in serious retreat among Anglo-American scientists. This left the history of modern biology in the hands of committed Darwinists. Its first great expression came with *Darwin and Modern Science: Essays in Commemoration of the Centenary of the Birth of Charles Darwin and of the Fiftieth Anniversary of the Publication of the Origin of Species*, edited by the Cambridge botanist Albert Charles Seward. It consisted of twenty-nine articles on the marvelous achievements of Darwinian evolution as told by his devoted followers, effectively putting society on notice, the secular equivalent of Martin Luther's ninety-five theses nailed to the Wittenberg church door. Published by Cambridge University Press in 1909, it appeared during the height of the alleged "eclipse" of Darwinism (Bowler 1983). But this title, perhaps more than any other, belies the supposed "deep trouble" Darwinism was in from about 1880 until the so-called "modern synthesis" was established in the 1930s and 40s. Seward wrote, "The divergence of views among biologists in regard to the origin of species and as to the most promising directions in which to seek for truth is illustrated by the different opinions of the contributors. Whether Darwin's views on the *modus operandi* of evolutionary forces receive further confirmation in the future, or whether they are materially modified, in no way affects the truth of the statement that, by employing his life 'in adding a little to Natural Science,' he revolutionized the world of thought" (Seward 1909, p. vii).

In fact, the alleged "eclipse" of Darwinism is really part of a triumphalist narrative told largely by Julian Huxley, Thomas Henry Huxley's grandson, Harvard biologist Ernst Mayr, and given credence by historian Peter J. Bowler. According to this tale, Darwinism was in serious decline until certain researchers combined modern genetics with Darwin's theory of common descent by means of natural selection, rescuing it from an almost certain demise—the cavalry riding to the rescue of the beleaguered biological pioneers under attack. Some of the leading players were Ronald Fisher and his 1930 book *The Genetical Theory of Natural Selection*, Theodosius Dobzhansky's *Genetics of the Origin of Species* (1937),

³ The term *neo-Darwin* and its suffixes (*-ist*, *-ism*, *-ian*) require a brief explanation. Neo-Darwinism was coined by George Romanes in 1895 to denote a theory of evolution that combined Darwin's common descent with modification with the ideas of August Weismann and Alfred Russel Wallace, emphasizing natural selection over the Lamarckian doctrine of the inheritance of acquired characteristics. Romanes clearly meant neo-Darwinism as a derogatory term, what he regarded as an unwarranted deviation from "the unadulterated doctrines of Darwin" and his "recognition of use and dis-use." However, today it is more often used in reference to the evolutionary synthesis developed in the 1930s and 40s by wedding Mendelian genetics to Darwin's common descent by means of natural selection (see Smocovitis 1992, p. 56; Larson 2004, pp. 233–43). In this essay neo-Darwinism *always* refers to this later usage. Still, it remains useful and appropriate to designate the entire period from *Origin* to present as simply Darwinian with the twentieth-century synthesis implied.

Julian Huxley's *Evolution: The Modern Synthesis* (1942), and Ernst Mayr's *Systematics and the Origin of Species* (1942). It was all capped off by David Lack's 1947 book, *Darwin's Finches* (Smocovitis 1992).

By 1959, nothing seemed more secure than Darwin's theory. It was being portrayed as irrefutable as gravity! In that year, of course, the centennial of Darwin's *Origin of Species* was celebrated at a huge conference held at the University of Chicago, 24–28 November 1959. It drew 2500 participants with almost 250 delegates from 189 colleges. Many of the synthesizers of modern genetics with Darwinian evolution were there. This rather curious event did two things. First, it trumpeted the striking victory the neo-Darwinian synthesizers had achieved in a remarkably short period of time, by proclaiming with loud fanfare “the agreement over the centrality of natural selection as *the* mechanism of evolution,” thereby enhancing the “sense of unity and consensus,” but at the same time it also gave “rise to a constricting new orthodoxy—as the panel discussions and somewhat exclusive invitation list indicate. This ‘hardening’ of the synthesis around a selectionist orthodoxy established the clear contours of the neo-Darwinian paradigm” (Smocovitis 1995, p. 321). This conference put *everyone* on notice. More interestingly, the Darwin Centennial Cerebration—and the three-volume published proceedings that emanated from it—had all the attributes of a religious encyclical. From here on, everyone working in the life sciences would be expected to show some fealty to the neo-Darwinian paradigm. As historian Betty Smocovitis observes, the event “had little to do with the historical Darwin or the development of his work; instead it revealed much about postwar American culture and its embrace of a new synthetic science of evolutionary biology, a science that could potentially redirect the future of ‘modern man’” (Smocovitis 1995, p. 323). This was scientism exerted with religious force, the *mentalité* of a new socioscientific order.

Only recently has this just-so story of triumph been challenged. Ron Amundson has brought considerable expertise to bear upon what he calls “Synthesis Historiography, or SH.” He regards this as a largely mythical creation of Ernst Mayr (Amundson 2005, p. 11; 2014). According to Amundson, Mayr made essentialism “the central pillar” of SH by equating essentialism with typology, or typological thinking, as the source of species fixism before Darwin, an assertion that is simply historically false” (Amundson 2005, pp. 13, 25). In fact, despite Mayr's claim suggesting rampant pre-Darwinian fixism rooted in Platonist essentialism, only Louis Agassiz could be considered a true Platonic species fixist (Amundson 2005, p. 81). Richard Owen, Darwin's principal rival, surely was not. While Amundson admits that the alleged “decline” of Darwinism was largely due to a change in what “Darwinism” meant (in 1909, for example, it meant belief in descent with modification, then with Julian Huxley's book in 1942, it was refashioned to mean descent with modification *by means of natural selection, genetic drift, mutation and migration*), this really represents a cooption that extends beyond what Darwin knew or could have known. If Huxley played his part, it was Mayr who solidified it. Huxley and Mayr distorted Darwin's views by stripping him of his Lamarckian sense of heredity and crediting him with population thinking (phylogeny), even though Darwin incorporated ontogeny (development) into his theory as well (Amundson 2014, p. 266). In any case, the “history” of the neo-Darwinian synthesis lacks coherence and accuracy. Others have agreed with Amundson's analysis (Winsor 2006; Wagner 2007). Amundson's critique is damning, Günter Wagner calling Mayr's SH a “cartoon version of the history of biology” (Wagner 2007, p. 151).

But even if the term itself changed meaning, there remains little reason to assume an “eclipse” of Darwinism, even between 1909 and its supposed restoration by Julian Huxley and Ernst Mayr in the 1940s. In fact, one wonders exactly when this “change” in meaning allegedly occurred or if it really mattered. Long *before* the synthesis had been completed, prior to Huxley and Mayr's assuming the “rescue” of the theory, paleontologist Robert Broom, no friend of Darwinian evolution, noted that the Zoological Section of the British Association meeting held in London in 1931 found a majority in support of Darwinism defined as “fortuitous variation and the *action of selection on its results* [emphasis added]” (Broom 1933, p. 21). In any case, eclipse or not, there seems to be more caricature and propaganda than history in Huxley and Mayr's synthesis story. The life sciences deserve a more realistic picture.

But, more immediately, attention needs to be directed to Mayr's frontal assault on teleology. Mayr points out that Darwin, "gave up teleology soon after he had adopted natural selection as the mechanism of evolutionary change" (Mayr 1992, p. 119). The problem is Darwin could never wholly divorce himself from teleological language. For example, he described the allegedly blind functions of natural selection as "daily and hourly scrutinizing, throughout the world, every variation, even the slightest; rejecting that which is bad, preserving and adding up all that is good; silently and insensibly working, whenever and wherever opportunity offers, at the improvement of each organic being in relation to its organic and inorganic conditions of life" (Darwin [1859] 1998, p. 84). Mayr understood this. He had to change the concept of teleology itself, and he did so by reducing it solely to a doctrine of empirical final cause. Mayr asserts, "All endeavors to find evidence for a mechanism that would explain a general finalism in nature were unsuccessful or, where it occurs in organisms, it was explained strictly causally. As a result, by the time of the Evolutionary Synthesis of the 1940s, no competent biologist was left who still believed in any final causation of evolution or of the world as a whole" (Mayr 1992, p. 119). According to Mayr, teleology inappropriately introduces anthropomorphism into biology. Having then ruled teleology preemptively out of court, he displays his ideological hubris by charging all those who suggest otherwise with incompetence.

To get around obviously goal-directed language in biology, he then introduces the term *teleonomy* (Mayr 1992, pp. 126–30). Instead of invoking finalistic ends, and by implication teleology, "biological function and goal directedness are treated as purely mechanistic, only giving the appearance of purposive design. They are teleological in description only—that is, merely teleonomic (to use a term invented by Colin Pittendrigh [1958] to describe the presumably nonteleological but teleology-like processes in organisms and other cybernetic mechanisms, such as thermostats)" (Sherman and Deacon 2007, pp. 890–91). More specifically, Mayr identifies teleonomy with a program defined as "coded or prearranged information that controls a process (or behavior) leading it toward a goal. The program contains not only the blueprint of the goal *but also the instructions of how to use the information of the blueprint* [emphasis in the original]." Mayr dismisses what he refers to as "cosmic teleology"—our T_s by definition—as either being explained by wholly "teleomatic processes" that are ends explained by natural laws, or by teleonomic, goal programmed processes." This, Mayr considered, one of Darwin's major contributions to modern thinking (Mayr 1995, p. 322).

Attempting to invoke Charles Sanders Peirce (misspelled throughout the paper as "Pierce") for support, Mayr insists that Peirce's "finious" processes are really his teleomatic processes (Mayr 1992, p. 125). But Peirce is a dangerous philosopher for a biological reductionist like Mayr to invoke. For one thing, Peirce himself was not a reductionist and even less an adherent of naturalism or materialism. There was always a religious and mystical tone or quality to his writing, and Peirce's argument for an empirical and experientially justified theism would be distasteful to Mayr (Brent 1998, pp. 36, 301–2, 312–13). More to the point, Peirce agreed that teleological finalism was anthropomorphic, but Menno Hulswit explains that for Peirce, "anthropomorphism is simply unavoidable. All our ideas in one way or another refer to our human experience. The same holds for our theoretical concepts and scientific explanations" (Hulswit 1996, p. 184). And this points up Mayr's problem with Peirce: his biological reductionism runs up against Peirce's non-reductionism, only to be then out-flanked by Peirce's pragmatism. But there is more. While Mayr suggests that teleological final cause and blind efficient cause preclude one another, according to Peirce, relying upon Aristotle, efficient causation is actually *required* for final causation. As Hulswit puts it, Peirce argued that "*every teleological process implies a triadic relationship between an individual efficient cause, a general final cause and an individual effect. Final causation and efficient causation are complementary inasmuch as each act of causation involves both an efficient component and a final component* [emphasis in the original]" (Hulswit 1996, pp. 190–91). Furthermore, Mayr bases his rejection of teleological evolution on three doubtful assumptions: First, an erroneous concept of "goal"; second, the identification of teleology with a straightforward determined development toward an end; and third, the association of final causation with *backward* causation. Contra Mayr, goals *explain* a general tendency; they need not be specific.

Moreover, teleology is by definition *not* deterministic insofar as it implies choice. Finally, while future events can surely have no effect on present ones, this hardly implies that there can be no final causation. Since final causes do not belong to concrete events, only to anticipated or desired events, final causation has nothing to do with backward causation. Hulswit's illuminating review of Mayr's concept of teleology when subjected to the light of Peirce's philosophy reveals its significant shortcomings:

Mayr's mistakes are largely due to two false premises which are characteristic of nearly all contemporary debates on teleology. The first of these is that he regards final causes as belonging to the same genus as efficient causes. A hundred years ago, Peirce has shown that this is a category mistake: contrary to efficient causes, final causes are not individual events or facts, but general principles.

The second false premiss [sic] is the assumption that we have a clear concept of efficient causation. Harmful though both premisses may be, the second of these is by far the most ferocious. The failure to see that causation is a philosophical problem instead of a clear-cut, self-evident idea, proves to be fatal to Mayr's analysis (Hulswit 1996, pp. 208–9).

Ernst Mayr lived to the ripe old age of 101. It is fair to say that no other individual served as a more thorough presumptive undertaker of teleology than he, presiding over its funeral and showing the way to its grave. Through his powerful position at Harvard and through nearly eighty years of publications, Mayr defined evolutionary biology as few others could. During that time, he was able to promote his loves—systematics, functionalism, the neo-Darwinian synthesis and all it entailed—and bury his hatreds—Platonism, essentialism, creationism, anthropocentrism, and teleology. By the end of the twentieth century, teleology in biology, thanks largely to Mayr, was about as dead as a concept could get. Its eulogy was ignobly pronounced as follows:

Teleology *n.* the doctrine of final causes, the invalid view that evolutionary developments are due to the purpose or design that is served by them; similar type of explanation applied to biological or cellular process, or animal behavior, which presupposes an impossible awareness of a particular goal. (Lawrence 1995, p. 587)

It is rare to find in a biology reference work so subjective and value-laden a definition as this, but it is a clear indication of exactly how disreputable the term had become. It is fair to say that teleology in biology some twenty-five years ago was held in utter disdain. But that was about to change.

5. Teleology's Reluctant Return

Because of the powerful explanatory role teleology plays in a wide range of life sciences (e.g., biology, medicine, genetics, psychiatry, anthropology, etc.), today it is considered an ineliminable feature of discussions in these disciplines (Allen and Jacob 2019). This has been widely acknowledged, and detailed analyses of the varieties of appropriate applications of teleological language can be found in the literature (Perlman 2004; Toepfer 2012; Buzzoni 2015). Despite a general agreement on the necessity of teleology in biology specifically and throughout the life sciences generally, a very wide range of opinions exist on exactly how it should be used and even what exactly it is or should entail.

One instructive example comes from a *littérateur*-turned-systems analyst, Victoria N. Alexander. Her interesting background has led her to propose a cross disciplinary approach to teleology. If the evolutionary synthesis unified biology, Alexander offers to unify the whole of epistemology itself—a teleology of science and the humanities. Citing J. B. S. Haldane's famous quote that "teleology is like a mistress to a biologist: he cannot live without her but he's unwilling to be seen with her in public," Alexander accepts it as "the biologist's mistress," but goes on to develop an idea of purposefulness in nature (following Kant) as part of an internal principle that spontaneously guides natural processes so that, on the whole, there emerges an inevitable probabilistic order (Alexander 2011, p. 160). For her, teleology is based upon emergent wholeness whose source can be found in systems and complexity theory. This, she believes, can be extended into the arts and humanities in such a way that teleology

must be invested as much in aesthetics as in other purposeful endeavors. She is adamantly opposed to any religious connotation to the concept, insisting that “Teleology is not theology. Teleology comes closer to a transcendental [transcendent?] way of animating nature and recognizing some kind of proto-intelligence and creativity *in events themselves* rather than attributing their organization to a Being in control of nature. I say, *comes closer to* because it does not go that far or quite in that direction. Teleology seeks naturalistic explanation for real, natural phenomena. Nature is ... *self-organizing*” (Alexander 2011, p. 10). Although this sounds very much like the Gaia hypothesis of James Lovelock and Lynn Margulis, Alexander recognizes that their formulation is too narrow for her broader, all-encompassing teleological views. In this she is no doubt right, since Lovelock has been quite clear on this: “Neither Lynn Margulis nor I ever proposed a teleological hypothesis. Nowhere in our writings do we express the idea that planetary self-regulation is purposeful, or involves foresight or planning by the biota” (Lovelock 1990, p. 100).

But Alexander’s presentation seems plagued with uncertainty and vagueness. How can something be “transcendental” (or transcendent) on the one hand and purely naturalistic on the other? What exactly does “some kind of proto-intelligence” mean? And if teleology is all due to emergent, self-regulating properties in nature founded in systems, why should they be goal-directed towards creativity and greater complexity? Furthermore, from whence do these “systems” come? Finally, she wants to extend teleology to the arts and humanities and yet reduces the concept to “form and function,” eschewing it in beauty and goodness. But what possible meaning could any of the arts and humanities have apart from beauty and goodness? Until these questions can be answered with some clarity, it is hard to see where Alexander’s grand unifying teleology is going or what it really means.

What is striking about all the examples of what might be called teleology’s comeback is that they all fall into the T_w category. All reductionist forms of teleology—utilitarian or otherwise—are what might be regarded as various expressions of T_w principles in action.

6. Toward a Working Definition of T_s —Learning to Swim Again

In getting past the various permutations of teleology, it is best to trim away what is *not* absolutely essential to its application. Here, philosopher Robert C. Baldwin provided the answer many years ago. He argues that teleology need not be defined by final cause but instead by the concept of order (Baldwin 1936, p. 114). Where finality may still have usefulness it cannot be simply an internal property, as often happens in T_w formulations. Baldwin is clear: “Either accept a teleology that has not been bled dry of meaning, and prepare to take the consequences of your decision (and the consequences are serious) or consistently refuse to have commerce with teleology altogether. It may be nothing at all, but it can not be purely internal and be anything at all” (Baldwin 1936, p. 115). For Baldwin, teleology’s significance is founded in considerations of value. So we have here two key concepts or principles—*order* and *value*. Chance, of course, requires no explanation. It is what it is. But where complex relationships exist, meaning is invested in order and value. Baldwin anticipated the contradictions within Alexander’s emergent systems teleology—a problem plaguing many T_w proposals—thus: “The teleology of the organic whole wishes to sit at the table of mechanistic determinism, largely out of deference to the demands of what is regarded as exact science, and yet bow its head for the blessing of some principle of value ... Its single conclusion ... is that ... if teleology is to have a meaning, it must abandon the notion of simple systematic unity—of a totality which is perfection—and fall back on the idea of purpose as somehow valid and ultimate” (Baldwin 1936, p. 124).

With a teleology based upon *order* and *value* we can refine our concept of teleology by ruling out any necessary a priori assumptions about the supernatural. It has been constructively pointed out that teleology is an organizational and codifying construct that is, by its very nature, transcendent (Page 2006, p. 431). Echoing the pragmatists James and Peirce, teleology in order to be meaningful must be experiential, based upon *our* experiences with it. This being the case, Lyman A. Page has explained that “The translocation of religion to the supernatural allows for contemplation unfettered by the constraints of the natural world. That goal can be achieved by the human imagination without such

a transfer" (Page 2006, p. 432). This is not to argue against the supernatural per se, only to suggest that it is not necessary for teleological considerations. In fact, the transcendent nature of the cosmos can, at least to some extent, be empirically measured and observed through functional magnetic resonance imaging (fMRI) as demonstrated in the religious, spiritual, and mystical experiences of Carmelite nuns (Beauregard and O'Leary 2007, pp. 255–88). Science can now actually see spirituality at work.

The idea of a teleological nature is really to be found in our experience with nature—we are, in fact, central to it. We are so used to our cosmic insignificance—a product of today's scientism—that this idea of external truths discovered within our own subjective experience seems counterintuitive. This is the alleged inheritance of the Copernican Principle, but Copernicus had nothing to do with demoting humans to cosmic insignificance (Keas 2019, pp. 4, 94–104). That came from Charles Darwin. He wrote in his Notebook C, "Why is thought, being a secretion of the brain, more wonderful than gravity a property of matter? It is our arrogance, it is our admiration of ourselves" (Darwin 1987, p. 291). Of course, the answer to Darwin's question is that we have a teleological order and value, whereas gravity does not. Again, in Notebook C he writes, after comparing humans with monkeys, "Man in his arrogance thinks himself a great work, worthy the interposition of a deity, more humble & I believe true to consider him created from animals" (Darwin 1987, p. 300). But Owen Barfield, the Oxford Inker and lifelong friend of C. S. Lewis, captures the error of Darwin's equating of the human mind with gravity and monkeys, as a form of idolatry. Darwin's elevation of chance to an explanatory mechanism was fatal because "chance is precisely what a hypothesis is devised to save us from. Chance, in fact = no hypothesis. Yet so hypnotic, at this moment in history, was the influence of the idols and of the special mode of thought which had begotten them, that only a few—and their voices soon died away—were troubled by the fact that the impressive vocabulary of technical investigation was actually being used to denote its breakdown; as though, because it is something we can do with ourselves in the water, drowning should be included as one of the different ways of swimming" (Barfield 1988, p. 64).

We need to learn to swim again, and, more recently, historian John Lukacs has tried to teach us. As if in reply to Darwin's charge of human arrogance, Lukacs insists:

No. The known and visible and measurable conditions of the universe are not *anterior* but *consequent* to our existence and to our consciousness. The universe is such as it is because in the center of it there exist conscious and participant human beings who can see it, explore it, study it. (For those readers who believe in God: the world and this earth were created by Him for the existence and consciousness of human beings.) This insistence on the centrality and uniqueness of human beings is a statement not of arrogance but of humility. It is yet another recognition of the inevitable limitations of mankind. (Lukacs 2009, p. 27)

Teleology may reveal itself ever so dimly in something as simple and yet profound as recognition of our own mortality and of the honor accorded to those who have departed before us. This, as Lukacs reminds us, is not a product of our "intelligence" but *interlegere*, Latin for the faculty of understanding, more the quality of reading between the lines (Lukacs 2016, p. 21). But perhaps Michael Polanyi more nearly captured our ability to perceive teleology and teleological processes as a sort of Kantian "mother wit" the nature of "which cannot be replaced by the operation of explicit reasoning" (Polanyi 1962, p. 1). This type of reasoning extends to our self-perceptions and perceptions of things, but also to nature and to science itself. It derives from a complex of integrated sources of observations and impressions filtered through associated habits of thought. "This act of integration," writes Polanyi, "which we can identify both in the visual perception of objects and in the discovery of scientific theory, is the tacit power we have been looking for. I shall call it *tacit knowing*" (Polanyi 1966, p. 3). Polanyi rejected reductionism and called for a reinstitution of an epistemology that allows for order and value. We must, he insisted, regain "a view of the world in which the universe, per se, is not 'value-free.' Some intelligible directional lines must be thought to be operative in it" (Polanyi and Prosch 1975, p. 161). In other words, for Polanyi, *teleology* is indispensable for true intelligibility. Neither a monkey nor gravity "knows" these things.

Therefore, the teleology of nature and transcendent—even religious—teleology have the same source: *ourselves* and our *experience* (Page 2006, p. 428). To have meaning, teleology, as Barfield and Lukacs have said, must be personal and participant. Teleology (T_s) can now be defined thus: *purpose found in order and value conveyed through the participation of personal experience*. Moreover, by experience is not just meant the empirically observed or sensed, but more complex *interlegere* and tacit knowing, understood in ways that express meaning at mundane levels up to the numinous. If teleology is anything less it is at best a utilitarian descriptive convenience (which makes it, in a sense, a triviality) and at worst a mirage in search of meaning; if it is anything more, it is beyond our epistemic grasp and, therefore, incomprehensible. T_s has nothing to do with God or theism, but by no means rules it out. It makes no assumptions one way or another concerning the supernatural. If anything, followers of the Abrahamic religions might regard teleology in this context as theistically self-referential; we are imbued with the capacity to recognize transcendent purpose by a creator who is Himself the very essence of that teleology. The less religiously inclined might simply see teleology, as it is described here, in terms of a recognizable process of order and value that we as human beings are in a unique position to understand and appreciate. Thus, all T_s formulations assume human exceptionalism.

Insofar as T_s refers to order and value, it necessarily implies at some level *design*. But this is not to suggest in any sense a formal design argument. Rather, it is intended as what Alvin Plantinga has called a “design discourse” (Plantinga 2011, pp. 247–48, 251–64). “Consider teleological arguments (arguments to design),” explains Plantinga, “not as giving an argument for design, but as ‘design discourse’, where the aim is not to give an argument, but rather to put the reader in the position of *perceiving* that the item in question is designed [or the process teleological]. And . . . there might be an epistemic advantage here, in that *arguments* can be criticized in ways that *design discourse* cannot be criticized” (Plantinga 2014, p. 87). Plantinga readily admits that this does not make teleological or design discourse immune from demonstrative failure, and he offers several examples, but it *does* insulate it from the kinds of criticisms often leveled by neo-Darwinists.

Suggestive here is that T_s has endured in spite of a rising empirical reductionism associated with the neo-Darwinian paradigm. Philosophers and historians such as Lyman Page, Owen Barfield, John Lukacs, and Alvin Plantinga have offered recent defenses in its behalf. But powerful examples from the life sciences can be offered that demonstrate a continuous line of descent from those scientists who assumed—even insisted—that nature has purpose. While clear examples can be found coextensive with Darwin’s theory itself (e.g., Richard Owen, Alfred Russel Wallace, St. George Mivart, James Dwight Dana), the immediate focus here is on those scientists contemporaneous with the evolutionary synthesis that formed neo-Darwinism.

7. Examples of Post-Darwinian T_s

Four representative scientists will make the point. In roughly chronological order they are: Lecomte du Noüy, Edmund Ware Sinnott, Pierre-Paul Grassé, and Michael Denton. While many others could be given, these are just a few life science professionals who have argued that some T_s formulation is necessary to make their fields intelligible.⁴ Moreover, developing their ideas during or after the paradigmatic neo-Darwinian synthesis, their voices speak out against a neo-Darwinian triumphalist

⁴ Even a partial list of prominent T_s proponents from this and many other fields is impressive. French philosopher Henri Bergson (1858–1941) founded his *L’Évolution créatrice* (1908), translated *Creative Evolution* (1911), on *élan vital* (creative force) and won the Nobel Prize in 1927; Bergson ignited T_s in the Jesuit paleontologist Teilhard de Chardin (1881–1955) whose *Le Phénomène Humain* (1955), translated *The Phenomenon of Man* (1959), remains popular to this day; chair of zoology at the University of Geneva, Emile Guyénot (1885–1963), pioneered genetic studies and experimental biology and emphasized orthogenesis and the evolution of form over function in his very non-Darwinian *L’Origine des Espèces* (1944), translated *The Origin of Species* (1964); Arthur Koestler (1905–1983) introduced the T_s concept of “Janus-faced entities” called holons in 1978 (see references); astrophysicist Fred Hoyle (1915–2001) abandoned his earlier atheism for a T_s cosmology fully explained in his *Intelligent Universe* (1983); and the Nobel laureate neurophysiologist John C. Eccles (1903–1997) rejected materialist accounts of the human brain, attributing “the uniqueness of the Self or Soul to a supernatural spiritual creation” in his *Evolution of the Brain* (1991). See Appendix A for more.

like Jacques Monod who insisted that, “Pure chance, absolutely free but blind, at the very root of the stupendous edifice of evolution: this central concept of modern biology is no longer one among other possible or even conceivable hypotheses. It is today the *sole* conceivable hypothesis, the only one that squares with observed and tested fact” (Monod 1971, pp. 112–13). The years have not tempered the neo-Darwinians’ confidence one bit; to them the issue is settled and is as secure a biological “fact” as our understanding of gravity in physics (Hordijk 2017).

Lecomte du Noüy suggests otherwise. Du Noüy was born on 20 December 1883, in Paris, France. He trained in biophysics in France and worked in the famous laboratory of Dr. Alexis Carrel at the Rockefeller Institute from 1920 to 1928. In the 1930s, he carried on in his native country by working in the bio-physics division of the Pasteur Institute. He escaped Nazi occupied Paris in 1943 by fleeing to the United States. By then, he had gained his reputation for novel scientific work with his early research on surface tension and especially for his work on physical/physiological time (du Noüy 1937). By carefully correlating age with wound healing during World War I (a process he was able to express clearly in mathematical terms), du Noüy was able to establish a human timetable that is still referenced approvingly (Alimov and Kazantseva 2007; Bruneau 2012). Du Noüy’s most popular contributions, however, came in philosophy. His *Human Destiny* presented his teleological worldview defined as *telefinalism*, that which “orients the march of evolution as a whole and has acted, ever since the appearance of life on earth, as a distant directing force tending to develop a being endowed with a conscience, a spiritually and morally perfect being” (du Noüy 1947, p. 87). For du Noüy, telefinalism confirms Christianity. Both spiritual and moral, it seeks the perfection of humankind on a personal level. In this sense, he rejects Teilhard de Chardin’s universalism, though the two men corresponded and deeply respected one another. His is a “Christian mysticism” based in science founded “on liberty and respect of human dignity” (du Noüy 1947, p. 268).

His other philosophical work, *The Road to Reason*, first written on the eve of World War II in 1941, was edited and translated for an English-speaking readership eight years later by his wife Mary. Here du Noüy expands his teleology to include not just biology but cosmology. More interestingly, his approach is similar to Lukacs, whose view of reality is phenomenological; in other words, it is personal and participant and, therefore, subjective. But du Noüy attacks what he considers the Vienna Circle’s subjective positivism “which replaces scientific ideas by stenographic summaries of experiments” (du Noüy 1949, p. 27). Instead, he points out that no scientific fact would exist without human receivers who collect and interpret the data they experience. “Our direct knowledge,” he writes, “can only be relative and does not in any way entail an identity between the real universe and the image it creates in our minds” (du Noüy 1949, p. 28). We are consequently urged toward a scientific humility borne of our own limitations. Du Noüy admits his great admiration for science, but insists that the “reason for showing the fragility of its answers is to caution the layman against the scientific mystic which cannot withstand an honest examination but which has been used as a tool, or rather a weapon, against the spiritual mystic” (du Noüy 1966, p. 194).

Of course, finalism is thoroughly rejected by neo-Darwinists, who regard it as an obscure form of essentialism (Mayr 1995, pp. 320–21; 2001, pp. 75–76). This objection, however, has been thoroughly answered by Pierre-Paul Grassé, a subject that will be covered shortly. But finalism was not the major target of du Noüy’s critics, it was his insistence that life could never be duplicated in the laboratory, and in this sense, humans could never initiate an evolutionary process. For du Noüy, life is a miracle “unexplainable” by any scientific principles (du Noüy 1947, p. 36). Sidney W. Fox insists, on the contrary, that his lab has made great strides in showing how evolution could occur by Darwinian means through “a primitive kind of binary fission and growth by accretion, as well as through budding” (Shuster and Thorson 1970, p. 17). Fox became famous for his thermal synthesis of polypeptides that he called “proteinoids.” Of course, it is true that Fox’s objections notwithstanding, he “still does not seem to really speak to the main point of du Noüy’s objections, namely, that such organizational synthesis could not have taken place in pristine times without intelligent direction” (Centore 1971, p. 529). But more importantly, it has been demonstrated that Fox’s thermal synthesis of polypeptides is falsified because

these proteinoids fail to resemble natural peptides, are indistinguishable from random sequences of non-catalytic (i.e., inert) amino acids, and assume primordial conditions constructed by means of confirmation bias rather than likely reality (Thaxton et al. 2020, pp. 215–16).

It is unfortunate that an impassioned and inspirational scientist like du Noüy is virtually unknown today. He evolved from agnosticism to his own Christian mysticism he saw embodied in Catholicism, and he sought to share that with a world he saw reeling from the Nazi atrocities that nearly destroyed his country. His *Human Destiny* was read by millions in the 1940s and his reputation even won him a commemorative conference held at Notre Dame, 23–25 October 1967. His ideas deserve better than the dusty shelves of antiquarian bookstores, the only sources for his works that could be found at this writing. Du Noüy died on 22 September 1947, but in various ways his idea of a teleological world confirmed in nature itself has not.

Our next example comes from America. Edmund Ware Sinnott. Sinnott was born in Cambridge, Massachusetts on 5 February 1888, with a lifelong “overpowering dedication to New England” (Whaley 1983, p. 351). An early interest in ornithology prompted him to first study zoology, but the offer of an assistantship in botany would set the course of his professional career. He obtained his PhD from Harvard in 1913 and, while at the Connecticut Agricultural College at Storrs, gained an interest in genetics and its influence over morphological forms (Whaley 1983, p. 353). From 1928 to 1939 he was a professor of botany at Columbia University, but in 1940 he became Sterling Professor of Botany at Yale, a position he would retain until retirement, rising to become director of Yale’s Sheffield Scientific School and president of Yale’s Board (Whaley 1983, p. 361). His publication record in the sciences is prodigious. His collaboration with Leslie C. Dunn on *Principles of Genetics* (3rd to 5th eds., 1925–1958) and his forty-year collaborative authorship of *Botany: Principles and Problems* (1923–1963) firmly established his scientific career.

But Sinnott had a philosophical bent that led him to develop a distinctive view of science that pushed against the reductionist tendencies of his colleagues. His central position was a kind of monism in which “biological organization (concerned with organic development and physiological activity) and psychical activity (concerned with behavior and thus leading to mind) are fundamentally the same thing” (Sinnott [1950] 1961, p. 48). In terms of teleology, he adopted a rather Peircean position, although he expressed it perhaps more extremely by saying that his position was “to reconcile efficient with final causes, mechanism with teleology, by showing that they are essentially the same” (Sinnott [1950] 1961, p. 83). His argument that “living stuff has the remarkable organizing capacities which the student of development has demonstrated” he called *organicism*, and it was in organicism that Sinnott saw all the unifying power of nature influencing all of life from amoeba to humankind (Sinnott 1955, p. 110). For Sinnott, this led to an immanent teleology supposedly divested of mysticism that even accounted for conscious purpose (Sinnott 1953, p. 124–25).

Sinnott’s philosophical works became immensely popular. In fact, the release of his *Two Roads to Truth* in 1953, in which he emphasized the complementarity of science and religion, won a feature review article and the cover of Norman Cousins’s weekly magazine *Saturday Review*. The reviewer, however, found Sinnott’s monism disconcerting. If everything could be reduced to this “organicism” then biological processes expressed through their developmental power to organize might just be considered as a form of overweening naturalism. “Throughout much of the book,” writes the reviewer, “Professor Sinnott uses ‘materialism’ as a whipping boy, only in the end to come close to endorsing it” (Smith 1953, p. 12). If it seemed that way in the popular press, the academy issued a similar verdict. University of Texas philosopher David L. Miller accused Sinnott of talking out of both sides of his mouth, at one point criticizing Ernst Haeckel for his materialism only to succumb to it in his own brand of philosophical monism (Miller 1958, pp. 644–46). But Alfred P. Stiernotte of Quinnipiac College answered Miller’s charge of Haeckelism, calling it “a serious misinterpretation of his whole position which is not at all obscure but belongs to the general category of philosophies of emergent evolution which accentuate the emergence of the new, the formation of wholes which are more than the sum of

their parts, the hierarchical order of patterns of organization which possess new regulative properties quite different from the mechanical sum of the properties of their parts" (Stiernotte 1959, pp. 654–55).

The verdict must come down in favor of this latter interpretation. Sinnott acknowledged the power (although not the persuasiveness) of the materialist's answer to life's question, adding, "But it is not the only possible answer. For many of us the description it gives to man seems far too simple" (Sinnott [1950] 1961, p. 105). According to Sinnott, biology suggests a "goal-seeking, upward thrust of life" unaccountable by solely chemico-physical mechanisms. Sinnott clearly states his "own preference for ... aggressive idealism" (Sinnott [1950] 1961, p. 107). Moreover, it is an idealism that has a clear place for a god (whether Abrahamic, Aristotelean, or otherwise), "as that Power which creates organized living systems and sets up in them the goals toward which they move and which culminate in the aspirations of the spirit" (Sinnott 1955, p. 172). One could hardly find a more complete T_s expression. When Sinnott died on 6 January 1968, he was perhaps the most accomplished and prominent American scientist proposing an alternative to Darwinian reductionism. Although, after seventy years, his principal contribution *Cell and Psyche: The Biology of Purpose* remains in print, he is hardly the public figure showcased in *Saturday Review*.

The third example of a T_s proponent returns us to France. Pierre-Paul Grassé was born in Périgueux in southwestern France on 27 November 1895. He studied medicine and biology at the University of Bordeaux and served as a military surgeon during World War I. He received his PhD in biology from the University of Montpellier in 1926 and spent most of his career at the prestigious Sorbonne becoming a respected entomologist specializing in termites. Grassé was editor of the encyclopedic multi-volume *Traité de zoologie* and author of more than 300 articles. His magnum opus, however, is his *L'Évolution du Vivant* (1973) translated in 1977 as the *Evolution of Living Organisms: Evidence for a New Theory of Transformation*. Grassé's neo-Lamarckian approach to evolution has been described as a "frontal attack" on the neo-Darwinian paradigm in all its many guises (Johnson 1992).

Most interesting from the perspective of teleology is Grassé's strident voice against the Darwinians' rejection of finality in nature, about which he had much to say. First, he rejects their assumption regarding natural selection that it is unguided or undirected, calling it "*a very grave philosophical and truly anthropomorphic error* [emphasis in the original]" (Grassé 1977, p. 128). Grassé charges the neo-Darwinists with rejecting teleological finality only to introduce it in another way: "The selective act is inseparable from an end, whether directed by man in the case of artificial selection, or in the case of natural selection by death—death which never strikes at random, but, on the contrary is an efficient agent in natural selection. In reality, the very purpose of selection is to finalize life (Grassé 1977, p. 129). It is worth recalling that the Darwinian definition of natural selection is "the process by which in every generation individuals of lower fitness are *removed* [emphasis added] from the population" (Mayr 2001, p. 288). In fact, the Darwinian invocation of "pseudoteleology and teleonomy" (what has been designated here as T_w) is, Grassé charges, used to "designate the finality which they at the same time deny ... Actually, the terms pseudoteleology and teleonomy are the homage paid to finality, as hypocrisy pays homage to virtue" (Grassé 1977, p. 165). Teleological finality, however, must be grounded in some genuine building process, some progressive and directive orthogenesis of which Grassé writes approvingly (Grassé 1977, pp. 160, 259). Grassé refuses to identify the author of this orthogenetic finality he believes exists, admitting in this case that "biology can go no farther: the rest is metaphysics" (Grassé 1977, p. 246).

When Theodosius Dobzhansky, one of the founders of the evolutionary synthesis, reviewed Grassé's book he found this yielding to metaphysics "disturbing." It can hardly be said that Grassé knew less biology than Dobzhansky. The problem was, as Phillip Johnson observed, Dobzhansky believed "that the most distinguished of French zoologists did not understand the rules of scientific reasoning" (1992). Dobzhansky simply could not allow that a problem was beyond the reach of science. For him, *every* problem was answerable by science even if it had to rely upon some future promise of discovery. The irony is that Dobzhansky's attitude towards Grassé's admission of room for metaphysics in answering questions about nature, the discomfort with metaphysics that prompted

his furrowed brow, is itself a metaphysical position. Indeed, what *are* the limits of scientific inquiry? If Dobzhansky is right, namely, that there are, in principle, *no* questions beyond the reach of science, then it would be hard to avoid seeing this as simply a form of scientism. But scientism in the hands of Dobzhansky or anyone else is fraught with serious logical and philosophical difficulties (Hughes 2012; Woelfel 2013; Stenmark 2018). Grassé died on 9 July 1985. Thirty years later (twenty-six years after the English translation of Grassé's *Evolution*), he was still remembered as “clear, feisty, and eloquent when attacking the mutation-selection mechanism” and contributing significantly to an emerging debate between neo-Darwinian defenders and a growing body of doubters (Woodward 2003, p. 40).

The most current T_s proponent presented here is English Australian physician/ biochemist Michael Denton. Denton created controversy and converts with his uncompromising critique of the neo-Darwinian paradigm in *Evolution: A Theory in Crisis* (1985). More importantly, he subsequently established a positive argument for a T_s world:

Contrary to [Paul] Davies and others, I believe the evidence strongly suggests that the cosmos is uniquely fit for only one type of biology—that which exists on earth—and that the phenomenon of life cannot be instantiated in any other exotic chemistry or class of material forms. Even more radically, I believe that there is a considerable amount of evidence for believing that the cosmos is uniquely fit for only one type of advanced intelligent life—beings of design and biology very similar to our own species, *Homo sapiens*. I do not agree with Davies when he claims, “The physical species of *Homo sapiens* may count for nothing”. (Denton 1998, p. xiii)

More recently, Denton has extended and updated his neo-Darwinian critique with *Evolution: Still a Theory in Crisis* (2016), stating, “I have adopted a much more structuralist conception of organic order and particularly of the Types” (Denton 2016, p. 12). Siding with the influential anatomist and leader of British structuralism, nineteenth-century anatomist Richard Owen, Denton is clearly endorsing Owen's view that the laws of nature can act as “causal agents within a comprehensive teleological framework” (Denton 2016, p. 40). However, Denton, an agnostic, is careful in his attributions. Conceding that this kind of fine-tuned biology is “a first step back to teleology,” he is not yielding to any particular intelligent designer or calling for a return to Platonism. He is instead issuing “an ontological verdict on the fabric of reality” that is based in science (Denton 2016, p. 281). While he treats T_s gingerly, wary of treading on definite theological ground, his own view of the source of this guidance is agnostic. But failure to identify a designer in no way impacts the attribution of design.

These examples reveal an added nuance to T_s propositions, which is that they can be specific (T_{s+}) or nonspecific (T_{s-}) in their transcendence. As mentioned earlier, T_s has nothing to do with God per se but certainly allows for such theism. Du Noüy and Sinnott offer a T_s that is specific; for them, it pointed to deity. Grassé and Denton, however, used T_s nonspecifically. A natural world fine-tuned for human exceptionalism is certainly full of meaningful purpose (it goes well beyond trivial utilitarianism), but its source may be intrinsically telic or perhaps, as Grassé put it, a metaphysical mystery. In any case, T_s expresses itself in *otherness*, in that numinous sense that behind life and the cosmos something *more* than nature red in tooth and claw is going on.

These four examples hardly exhaust the matter. In fact, it appears that T_{s+} in the life sciences is surging. British biologist Rupert Sheldrake, former director of studies in biochemistry and cell biology at Clare College, Cambridge University, has developed a vitalistic theory of nature in *The Presence of the Past: Morphic Resonance & the Memory of Nature*, first published in 1988 and now in its fourth revised and expanded edition. Furthermore, Sheldrake questions the scientific assumptions of the reductionists in his *Science Set Free* (2012), an effort to reformulate science as an open and unencumbered methodology and mode of practice instead of a materialistic belief system. Other recent examples include Douglas Axe, Maxwell Professor of Molecular Biology at Biola University, who offers an explication of T_s principles in the life sciences with *Undeniable: How Biology Confirms Our Intuition That Life is Designed* (2016); biologist and physiologist J. Scott Turner at the State University of New York, who doubts the ability of neo-Darwinian mechanisms to explain life and instead offers his own alternative in

Purpose & Desire (2017); Lehigh University biochemist Michael J. Behe, who offers a serious critique of neo-Darwinian explanations for speciation (expanding on his *The Edge of Evolution: The Search for the Limits of Darwinism*, 2007), arguing instead for T_s as intelligent design in *Darwin Devolves* (2019); and finally, Brazilian chemist Marcos N. Eberlin who most recently supported T_s with *Foresight: How the Chemistry of Life Reveals Planning and Purpose* (2019). These T_s proponents demonstrate that the concept is not going away any time soon. T_s may restore sight to Dawkins' "blind watchmaker" or, at the very least, serve as the braille that allows us to read nature's book of secrets in ways he could never imagine.

8. Conclusions

The examples representative of T_{s+} and T_{s-} are many and varied. But they all display some common conclusions. In general, there are two negative and three positive positions held by most T_{s+} and T_{s-} proponents. They are as follows:

1. rejection of all reductionist accounts of humankind and/or nature;
2. belief that neo-Darwinian propositions are at best incomplete and at worst wholly erroneous;
3. insistence that science and religion or spirituality are not in opposition but are complementary;
4. affirmation of human exceptionalism;
5. general emphasis upon evolutionary form over function or, put differently, structuralism over functionalism (evo-devo).

The sum total of these five positions leads away from methodological naturalism (i.e., the notion that scientists must invoke only natural processes functioning via unbroken natural laws in non-teleological ways) and towards a practice of science unencumbered by a priori suppositions about what is privileged as evidence. It also fosters epistemic modesty about the capacity of science to answer every question about biological life and the cosmos. It might very well be that hard verification will forever elude T_s propositions, only to be supported at best as a logical abductive inference to the best explanation (Douvan 2017)—Polanyi's "mother wit." Perhaps physicist Freeman Dyson is correct in proposing that T_s is an order of phenomena that is real but beyond the grasp of ordinary scientific verification. Known as Dyson's hypothesis, it suggests that T_s is a complementarity (like light that can be observed as a wave or a particle but never both at the same time); nature's empirical world and its genuinely purposeful activity may be, in Dyson's words, "two descriptions of nature [that] may both be valid but cannot be observed simultaneously." In other words, he finds "it plausible that a world of mental phenomena should exist, too fluid and evanescent to be grasped with the cumbersome tools of science" (Dyson 2006, p. 331).

The acceptance of Dyson's hypothesis is too unsettling for a paradigm rooted in the strong verificationism of positivism. This suggests that the biggest problem with neo-Darwinism is not its science but its positivist philosophy.⁵ Positivism subjects Darwinism, including its modern synthesis, to a host of objections. These objections—its dogmatic verificationism, its dismissal of all metaphysical statements as meaningless, its rigid empiricism symptomatic of a diehard commitment to physicalism—cannot be examined here, but they are real and intractable (Wiener 1935; Feibleman 1951; Putnam 1995; González-Castán 2014; Henning 2015). Other evolutionary theories, less dogmatic, reductionist, and more teleology friendly have been suggested (Flannery 2017).

If the history of philosophy fails to sustain the Darwinian account of nature, neither does the history of teleology itself. It shatters the cozy certainties of committed Darwinists who insist that their doctrines are thoroughly secure, even unassailable (Monod 1971; Dawkins 1987; Hordijk 2017). Unable to avoid teleological language in their own discourse, they have added surrogates such as

⁵ The idea that Darwinism has been based in positivism from its very beginning is long established (Gillespie 1979, pp. 8–9, 152–55; Schweber 1979; Brown 1986).

teleonomic and teleomatic to their lexicon. At closer inspection, however, these T_w terms end up explaining very little; they replace meaningful descriptions of phenomena suggestive of transcendence to trivialities and, in the process, erect arguments that, according to Grassé, are contradictory and disingenuous. And yet, at the same time, they reveal the tenacity of purpose in nature and the reductionist's inability to escape it.

The confident asseverations of Monod and his fellow neo-Darwinians may be challenged less by their thin scientific evidence and more by their tremendous metaphysical leaps. No one saw this as clearly as the Hungarian British polymath Arthur Koestler:

Yet Jacques Monod was not a hypocrite. He was brilliant in his specialized field [biochemistry], but disarmingly naïve concerning the theoretical implications of it—what his compatriots call a '*terrible generalisator*'. This, of course, applies to many of his eminent colleagues in the neo-Darwinian establishment. Guided—perhaps unconsciously—by the maxim that a bad theory is better than no theory, they are unable or unwilling to realize that the citadel they are defending lies in ruins. (Koestler 1978, p. 192)

Their inability to provide convincing demonstrations of how fortuitous operations (real or imagined) working with selection could generate novelty in taxonomic families or higher (orders, classes, phyla, etc.) in nature, their own failure to escape from teleology beyond the mundane, and their reliance upon just-so storytelling when all else fails, represent the debris of which these ruins consist. Yet paradigms die hard. Kuhn reminds us that textbook orthodoxies exist precisely to maintain the status quo. Written by the very keepers of the reigning paradigm, they are well positioned and expressly designed to protect it. Planck's principle seems true enough: science advances one funeral at a time. But the anomalies persist and teleology appears to have buried its undertaker.

This makes scientific revolutions scary things: we jump from the known into the unknown. But it has happened before. As Koestler reminds us:

[scientific] progress was neither 'continuous' nor 'organic'. The philosophy of nature evolved by occasional leaps and bounds alternating with delusional pursuits, *culs-de-sac*, regression, periods of blindness, and amnesia. The great discoveries which determined its course were sometimes the unexpected by-products of a chase after quite different hares. At other times, the process of discovery consisted merely in the clearing away of the rubbish that blocked the path, or in rearranging the existing items of knowledge in a different pattern. The mad clockwork of epicycles was kept going for two thousand years; and Europe knew less geometry in the fifteenth century than in Archimedes's time. (Koestler [1959] 1989, p. 523)

Perhaps it is time to clear away the rubbish blocking the path and move forward without clinging to phantom certainties.

That may be the lasting point. T_s is still a viable feature of the life sciences, but there is an important subsidiary point here: it is that the "parliament of science" so ably described by historian Daniel Boorstin is not a one-party system. Seated among the majority of Darwinian reductionists is science's loyal opposition. It is a loyal opposition that started with the co-discoverer of natural selection (see the companion article, "Alfred Russel Wallace's Intelligent Evolution and Natural Theology" in this issue) and has continued through the neo-Darwinian synthesis up to the present. T_s has not been banished from the life sciences; in fact, it never really left.

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Appendix A

Table A1. A Table of Teleology from Darwin to Present: Selected Scientific, Philosophical, and Literary Examples (Weak Teleology = T_w|Strong nonspecific Teleology = T_{s−}|Strong specific Teleology = T_{s+}).

T _w	T _{s−}	T _{s+}
Charles Darwin, <i>Origin of Species</i> (1859)	William James, <i>The Varieties of Religious Experience</i> (1902)	Samuel Butler, <i>Evolution: Old and New</i> (1879)
Thomas Henry Huxley, <i>Darwiniana</i> (1899) ⁶	Henri Bergson, <i>Creative Evolution</i> (1911) ⁷	Asa Gray, <i>Natural Science and Religion</i> (1880) ⁸
Ernst Haeckel, <i>The Riddle of the Universe</i> (1899, trans. 1901)	Charlotte Perkins Gilman, <i>The Living of CPG</i> (1935)	G. K. Chesterton, <i>Orthodoxy</i> (1908)
Moritz Schlick, <i>Philosophical Papers</i> (1925–1936) ⁹	Emile Guyénot, <i>The Origin of Species</i> (1944, trans. 1964)	Alfred Russel Wallace, <i>The World of Life</i> (1910)
Albert Einstein (1879–1955) ¹⁰	Loren Eiseley, <i>The Firmament of Time</i> (1960)	Sir William Barrett, <i>Deathbed Visions</i> (1926)
Isaac Asimov, <i>Foundation series</i> (1942–1944) ¹¹	Ludwig von Bertalanffy, <i>General Systems Theory</i> (1969)	Max Planck, “Religion and Natural Science” (1938, trans. 1950)
Richard Dawkins, <i>The Blind Watchmaker</i> (1987)	Paul Davies, <i>The Mind of God</i> (1992)	C. S. Lewis, <i>The Space Trilogy</i> (1938–1945)
Michael Ruse, “Teleology in Biology” (1989)	Hans Holzer, <i>Ghosts</i> (1997) ¹²	Teilhard de Chardin, <i>The Phenomenon of Man</i> (1955)
Lynn Margulis, <i>Symbiotic Planet</i> (1998)	Freeman Dyson, <i>Imagined Worlds</i> (1998) ¹³	A. R. Peacocke, <i>Creation and the World of Science</i> (1979)
Jeff VanderMeer, <i>Annihilation</i> (2014); movie adaptation (2018)	Tom Wolfe, <i>The Kingdom of Speech</i> (2016)	Michael Behe, <i>Darwin Devolves</i> (2019)
Moritz Schlick, <i>Philosophical Papers</i> (1925–1936) ¹⁴	Emile Guyénot, <i>The Origin of Species</i> (1944, trans. 1964)	Alfred Russel Wallace, <i>The World of Life</i> (1910)
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Richard Dawkins, <i>The Blind Watchmaker</i> (1987)	Paul Davies, <i>The Mind of God</i> (1992)	C. S. Lewis, <i>The Space Trilogy</i> (1938–1945)
Michael Ruse, “Teleology in Biology” (1989)	Hans Holzer, <i>Ghosts</i> (1997) ¹⁷	Teilhard de Chardin, <i>The Phenomenon of Man</i> (1955)
Lynn Margulis, <i>Symbiotic Planet</i> (1998)	Freeman Dyson, <i>Imagined Worlds</i> (1998) ¹⁸	A. R. Peacocke, <i>Creation and the World of Science</i> (1979)
Jeff VanderMeer, <i>Annihilation</i> (2014); movie adaptation (2018)	Tom Wolfe, <i>The Kingdom of Speech</i> (2016)	Michael Behe, <i>Darwin Devolves</i> (2019)

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⁶ Huxley, who coined the term *agnostic*, writes, “there is a wider Teleology, which is not touched by the doctrine of Evolution, but is . . . the result of the mutual interaction, according to definite laws, of the forces possessed by the molecules of which the primitive nebulosity of the universe was composed.”

⁷ Bergson's principle of *élan vital* is inherently teleological, but more especially it is a panpsychic property and, therefore, nonspecific in nature.

⁸ Gray is an interesting case. Although Gray helped more than any other naturalist to disseminate Darwin's theory across the United States, he always insisted that the evolutionary process was the means of providential design. Gray never did appreciate the full degree to which Darwin relied upon chance in his theory (Johnson 2015, p. 116). Because of the role Gray played in promoting and even defending Darwin's *Origin*, he is one of the first of the Darwinian theists. More contemporary examples would include Kenneth Miller *Finding Darwin's God* (1999), Francis Collins *The Language of God* (2006), and Karl Giberson *Saving Darwin* (2008). However, Curtis Johnson's thesis makes Darwinian Theism inherently contradictory.

⁹ Schlick, leader of the Vienna Circle, views teleology as a form of causality which is functionally symmetrical. Any form of metaphysical teleology is meaningless.

¹⁰ Einstein's teleological statements are scattered and sometimes inconsistent. But his admiration of Spinoza suggests that he regarded any genuinely teleological statements as too anthropomorphic to be meaningful. For him, purpose is essentially teleonomic; in lower organisms the urge for mere survival, in people higher goal-setting and seeking (both symmetrical impulses) with no human exceptionalism implied.

¹¹ Asimov's “psychohistory” is a fictional discipline based upon sociology, history, and statistical analysis. It is predictive and deterministic, but not stochastic. Humans are the only sentient beings in the universe, and therefore teleology is solely theirs.

¹² Parapsychologist Holzer (1920–2009) believes in a purposeful, non-theistic spirit world.

¹³ Dyson's sci-fi thought experiment presents his principle of maximum diversity in which “the laws of Nature are constructed in such a way as to make the universe as interesting as possible,” suggesting a modest Anthropic Principle.

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