Journal of Philosophical Theological Research
ISSN Print: 1735-9791 Online: 2538-2500

The Revival of Teleology After its Death by Darwin[1]

Nima Narimani

Ph.D., Department of Philosophy of Religion, Faculty of Theology and Islamic Studies, University of Tehran, Tehran, Iran. narimani.nima@ut.ac.ir

Abstract

Two distinct teleological perspectives emerge from the ancient Greek tradition. 1) Platonic teleology, which represents teleology as the result of intentional agency and is the origin of the idea of design; and 2) Aristotelian teleology, which introduces teleology as the result of natural and intrinsic causes. The preceding framework for understanding nature was superseded by the advent of the modern era and the establishment of the scientific method. Nevertheless, despite the prevailing skepticism regarding the possibility and utility of teleology in the modern era, it is asserted that several prominent scientists of the modern era are staunch defenders of teleology (design). However, with Darwin's proposal of the theory of evolution, the path to the destruction of teleology was initiated. This article examines the interconnection between Darwin's theory of evolution (then Neo-Darwinism) and teleology, focusing on how this theory effectively undermines the teleological perspective. However, it seems that recent findings in the field of biology challenge this dominant view and open the way for the revival of teleology.

Research Article

Keywords

Teleology, philosophy of biology, Darwin, Neo-Darwinism, reductionism.

Received: 2024/02/12 ; **Received in revised form:** 2024/03/29 ; **Accepted:** 2024/04/28 ; **Published online:** 2024/05/01

▣ Narimani, N. (2024). The Revival of Teleology After its Death by Darwin. *Journal of Philosophical Theological Research*, 26(3), 107-134. https://doi.org/10.22091/jptr.2024.11464.3151

Introduction: teleology in antiquity

The term ‘teleology’ is derived from the Greek roots ‘telos’ (meaning ‘goal’ or ‘purpose’) and ‘logos’ (‘an account or explanation’). Consequently, teleology can be defined as a field of study that provides explanations based on the concept of goals or purposes (Dresow & Love, 2023, p. 102; Rocca, 2017, p. 2). The world and its constituents have traditionally been explained in one of two principal types, particularly in instances where said phenomena display purposeful or remarkable characteristics or behaviors in terms of complexity and sophistication. These two principal explanatory approaches are the materialist and the teleological approach. The materialist approach posits that these phenomena can be explained through material causes without recourse to an overarching purpose or intention. In contrast, the teleological perspective asserts that there is an underlying purpose or intention that cannot be fully explained by material causes alone, and to fully account for at least some of the phenomena observed in the world, it is necessary to consider teleological explanations (Ariew, 2007, p. 161).

Although it seems that the materialists were effective in Greece before Socrates (for another view, see (Sedley, 2007)), with the emergence of Socrates, the idea of teleology was offered and strengthened more seriously in Greece. In the *Phaedo*, Socrates affirms Anaxagoras’ statement and states that a mind behind this world created its order and placed it in the best condition. For Socrates, the fundamental order of the natural world is divine in origin. Consequently, his perspective provides the foundation for design reasoning (Rocca, 2017, pp. 3-4). Plato further pursued and elaborated on the idea of Socratic teleology. In his various works, especially the *Timaeus*, Plato proposes teleology in multiple fields such as cosmology, biology, human actions, and ethics and introduces it as the result of the purposeful action of the Demiurge (Scolnicov, 2017). In this way, teleology for Plato is ultimately based on and the result of the purposeful action of an intelligent agent who made the external form of the world and its various components based on the ultimate goal of the final good.

However, this is not the only view that exists in Greece towards teleology and to explain the order of the world and its parts. Aristotle, Plato’s most prominent student and, at the same time, his most severe critic, proposed a very different view of teleology. Despite agreeing with Plato in rejecting the materialistic and mechanical view of the world and the need to resort to the final cause to understand the world and its parts (Wattles, 2006, p. 449), Aristotle’s view of teleology differs significantly from Plato’s. While Plato’s

teleology relies on an external agent and intelligence that organizes the world based on a conscious purpose and plan, Aristotle's teleology is natural and nonintentional. Nature itself is a cause moving towards an end. Such teleology is internal in Aristotle, and it is not the case that an external factor has formed the creatures according to a purpose outside of nature, but it is the "realization of pre-existing potentials for form." However, like Plato, Aristotle criticizes purely mechanical and materialistic views of nature. For Aristotle, it is not the case that the behavior of nature in general and creatures in particular is only a result of the interaction of chance and causal determinism. However, unlike Democritus, he believes that causal determinism itself is an indication and result of the purposeful process in nature (Wattles, 2006, p. 449). However, some believe that Aristotle's mechanical and teleological explanations are compatible and do not exclude each other (Johnson, 2017). Anyway, despite the difference in their views, in both Platonic and Aristotelian views on teleology, objective goodness is considered to have explanatory power. Thus, in Plato, the objective goodness of the world and its creatures is a basic introduction to explain why the creator created the world and its creatures. In Aristotle's theory, the natural growth of creatures is explained by realizing the objective good of creatures (McDonough, 2020, p. 183).

Thus, three principal perspectives on teleology have their roots in Greece. The first is the negation of teleology and accepting a wholly materialistic and mechanical worldview. The second is the external acceptance of teleology and its explanation based on the designer's intentional action. The third is the acceptance of teleology as natural and internal, without reference to external, intentional agency.

Teleology in the Middle Ages

In this article, we only briefly review teleology in the Middle Ages to show the continuity and consistency of the teleological view in this period. In general, it can be said that in the Middle Ages, Muslim, Christian, and Jewish thinkers formed and developed a combination of Aristotelian and Platonic views that were connected with their Theistic ideas (Wattles, 2006, p. 451). For example, Ibn Sina (980-1037), as one of the most influential thinkers of the Middle Ages, both in the Islamic and Western tradition, accepted the Aristotelian framework and considered the final cause as one of the four main causes. By criticizing the views of the Greek materialists, especially Empedocles and his followers, he states that the explanation of natural phenomena based on the chance interaction of material components is not enough, and for example, to

explain the growth of a plant from the initial seed, a purposeful principle is needed that transforms the seed into what the final living organism (whole plant) becomes. Ibn Sina, while emphasizing that a detailed understanding of the parts of living beings shows that all of these parts have a purpose, ultimately considers it based on divine providence (Richardson, 2020).

In the same way, Ibn Rushd (1126-1198) emphasizes that the existence of an end for nature is a fundamental principle in both physics and biology, so anyone who is engaged in research in these fields should consider it as a self-evident principle that the natural world is purposeful. Also, he believes that without the final cause, the entire Aristotelian framework will be lost, and without the teleological framework, it cannot be proved that God has a relationship with the natural world (Pasnau, 2020, p. 91). A similar view exists in the Christian tradition. For example, Thomas Aquinas (1225-1274) places one of the foundations of his theology on the ultimate nature of nature and states that the ultimate cause is the first cause among causes (Pasnau, 2020, p. 91).

In this way, the teleological view of the world was established in the Middle Ages, strengthening its theological aspects. On the one hand, teleology in nature is connected with the concept of goodness because medieval thinkers considered existence and its beginning and end good (McDonough, 2020, p. 181). On the other hand, natural teleology (i.e., the teleology of nonrational beings in nature) is finally explained by appealing to God's intelligent and external agency (Pasnau, 2020, p. 94).

However, doubts about natural teleology arose, especially in the late Middle Ages. Perhaps most importantly, William Ockham (1278-1347) hesitated to attribute ends to natural causes. Although he accepts the purposefulness of the actions of rational and willful beings, such as humans, he justifies attributing the purpose to natural causes only based on faith, in the sense that faith requires maintaining that God has a plan for everything (Pasnau, 2020, pp. 99-100).

Teleology in the modern world (setting the stage for Darwin)

In the context of the advent of modern science, the concept of teleology experienced a notable transformation, entering a new and distinct phase. On the one hand, the skepticism that emerged in the Late Middle Ages regarding natural teleology was reinforced and expanded by some of the most influential figures of the modern era to the extent that the initial concept of teleology is being challenged as an incoherent notion. Conversely, despite rejecting the

entire Aristotelian framework for studying and understanding the world, other distinguished scientists of the modern period proposed an alternative (Platonic) concept of teleology. This novel approach to teleology exhibits two principal characteristics. Firstly, it is founded upon novel scientific methodologies and findings. Secondly, it is external and grounded in the intentionality of an agent, namely God.

This situation can be primarily attributed to rejecting the Aristotelian framework and its four causes (most notably the final cause) and adopting the mathematical-mechanical method in studying the natural world. To elaborate further, the modern scientific approach eschews the Aristotelian notion of causal powers. Instead, the world is conceived as a system of atoms governed by immutable laws. As a result, the concepts of intrinsic formal and final causes are rendered irrelevant, and the notion of the final cause is either eliminated or subsumed by external teleology, known as design (Silva, 2019, pp. 64-65). Therefore, Aristotelian teleology (nonintentional) could not remain a viable concept within the mechanical framework of natural philosophy in the modern period. Consequently, teleology's negation (or skepticism) or the Platonic (external and intentional) approach could be considered concerning teleology, and the Aristotelian concept of teleology was marginalized.

In the sphere of skepticism, several prominent thinkers significantly influenced the decline of teleology during the early modern period. The first such figure was Francis Bacon (1561-1621). In *New Organon*, he suggests a pragmatic argument that the final cause is far from useful in the natural sciences. Therefore, it should not be included in the explanations aimed at understanding the nature (as cited in Lennox & Kampourakis, 2013, p. 431). He believed that the search for final causation in natural philosophy hinders the progress of science except in the case of human action (Silva, 2019, p. 65). He called the final causes in the study of nature "barren virgins."(Lennox, 2013, p. 153). Similarly, Thomas Hobbes (1588-1679) posited that the concept of the final cause should be discarded in favor of the efficient cause. In the first step, he stated that the final cause has no place in creatures that do not have a will, but in the next step, he stated that even in creatures that have a will, such as humans, the final cause does not have a place, and the active will (i.e., efficient cause) is the complete and sufficient cause (Lennox & Kampourakis, 2013, p. 432).

The other important figure was René Descartes (1596-1650), whose rejection of final causes in his physics indicates a broader move away from teleological explanations among proponents of mechanical philosophy

(Mcdonough, 2011, p. 179). In addition to the fact that Descartes's analytical-mechanical method did not allow for teleological explanations in the natural realm, he put forth a theological argument for eschewing the concept of a final cause in natural explanations. He considered the pursuit of final causes in physics presumptuous, as it implies that the Creator's intentions can be discerned from natural phenomena (McDonough, 2020, p. 151; Silva, 2019, p. 65).

Finally, perhaps the most vital position in the early modern period against teleology belongs to Baruch Spinoza (1632-1677), who, based on strict determinism, believed that natural events have no purpose and are the definite result of previous causes that ultimately back to the essence of God (that is Nature, based on the pantheistic view of Spinoza) (Lennox, 2013, p. 153). In the following step, he stated that ultimate causes are nothing but human fictions that distort our understanding of the world (McDonough, 2020, p. 151). Therefore, Spinoza should be considered a point of complete separation from the traditional and medieval worldview, in which either external (intentional) or internal (nonintentional) teleology was considered the central pillar of understanding the world. Consequently, he paved the way for the negation of teleology and questioning the coherence of teleological explanations (McDonough, 2020, p. 151).

One of the exciting features of the early modern period is that while the prominent philosophical figures, as mentioned, are against the use of teleology in the study of nature and as a result of that, some of the prominent scientists of this period are the leading defenders of teleology in the study of nature. It is also noteworthy that these eminent scientists were proponents of the type of external (intentional) teleology that, in contrast to Aristotle's perspective, does not necessitate additional religious or philosophical efforts (which the theistic philosophers of the Middle Ages should have made) to connect it with theistic worldview. Instead, this approach directly posits that the intelligent agent (i.e., God) is the foundation of the complex and sophisticated structures of the universe (either cosmological or biological). Accordingly, in this teleological approach, despite the final causes not being attributed to the intrinsic powers of nature, in contrast to the preceding Aristotelian perspective, the intricate and sophisticated structures of the universe and the laws of nature demonstrate the creator's wisdom and intention. In this way, although modern science, by abandoning the Aristotelian framework and primarily intrinsic formal and final causes, proposed an atomistic and mechanical view of the world, contrary to what it seems today, for many prominent scientists of the modern period,

this did not mean a weakening of teleology and even theism. Instead, for them, the new scientific method could more powerfully reveal the signs of God's wisdom and power. Accordingly, prominent scientists such as William Harvey, Robert Boyle, and Isaac Newton believed that the final causes can be understood and observed in the structures of the components of the natural world, both in the biological and cosmological areas (Mcdonough, 2011, p. 187; Silva, 2019, p. 65).

Robert Boyle (1627-1691), the father of modern chemistry, was an ardent proponent of the view that final causes could be discerned in the natural world. Furthermore, he advocated for the compatibility of a mechanistic universe with a belief in external teleology. Boyle published a comprehensive treatise entitled "On the Final Causes of Natural Things." In this treatise, Boyle examines the relationship between teleological ideas and their implications for the natural sciences (Silva, 2019, p. 66). He introduces two groups as critical opponents of speaking of teleology in natural philosophy: Epicureans and Cartesians. Epicureans oppose it based on the fundamental negation of teleology, believing that the world is based on chance and that there is no purpose. While Cartesians believe that the world and its parts have a purpose, their divine purposes are so sublime that they cannot be grasped. In response, Boyle distinguishes two levels of teleological reasoning. The first level is physical reasoning, in which, from the natural purpose of a natural system, such as the eye, conclusions can be drawn about how its parts should work, for example, that the eye is for seeing. Its internal structures must be suitable for that purpose; for example, it has light-sensitive cells and the capacity to process optical signals. However, the second level is metaphysical reasoning, at which, by understanding the goals and purposes of creatures and natural structures, one can understand some of God's purposes in creating them. For example, God gave man the eye as a tool for seeing the natural world (McDonough, 2020, p. 163). Boyle introduces four categories at the metaphysical level: 1) Universal ends concern the universe as a whole, 2) cosmic ends concern the celestial bodies, 3) animal ends concern the substructures of animals, and 4) human ends concern the purpose of parts of nature for the sake of man, either spiritual (mental aspects) or terrestrial (physical aspects) (McDonough, 2020, pp. 165-166).

William Harvey (1578-1657), the prominent English physician and discoverer of the circulatory system, stated that teleology could play a central role in science, in contrast to the views of people like Bacon and Descartes, who considered the final cause and teleology in natural philosophy fruitless.

Despite his Aristotelian leanings, he saw nature as God's creation and believed that since nature is God's creation and perfect, "it does not do anything in vain." Nevertheless, in addition to the theological reasons, Harvey's important work was to show, based on scientific and experimental evidence, especially concerning the functioning of the circulatory system and other structural components of living organisms, that the teleological view can lead to new discoveries as well as better explanations (Kampourakis, 2013, p. 433; McDonough, 2020, pp. 157-161).

However, the most prominent scientist of the modern age, considered by some to be one of the main pillars of the formation of the modern secular view, is undoubtedly Isaac Newton (1642-1727). On the contrary, not only did Newton not consider modern science to be opposed to theistic and teleological views of the world, but he also considered it the best way to realize the greatness and wisdom of God. On the one hand, he said about the cosmic system, "This most beautiful system of the sun, planets, and comets could only proceed from the counsel and dominion of an intelligent and powerful Being"(McGrath, 2011, p. 54). On the other hand, regarding the complexities and subtleties of the structures of life, he believed that the experimental shreds of evidence show the intelligence and infinite power of the wise creator. Newton's statement is worth quoting :"How came the Bodies of Animals to be contrived with so much Art and for what ends were their several Parts? Was the eye conceived without Skill in Opticks and the Ear without Knowledge of Sounds? How do the Body's Motions follow from the Will, and whence is the Instinct in Animals? Moreover, these things being rightly dispatch "d, does it not appear from Phaenomena that there is a Being incorporeal, living, intelligent, omnipresent, who in infinite Space, as it were in his Sensory, sees the things themselves intimately, and thoroughly perceives them, and comprehends them wholly by their immediate presence to himself... And though every true step made in this philosophy brings us not immediately to the knowledge of the first cause, yet it brings us nearer to it" (as cited in Silva, 2019a, p. 68). And so he concludes, "Such a wonderful uniformity in the planetary system [and] the uniformity in the bodies of animals . . . can be the effect of nothing else than the wisdom and skill of a powerful ever-living agent" (as cited in Harrison, 2019, p. 65).

Darwin and teleology

Although we have reviewed the idea of teleology in general so far, from this section, we will focus on teleology in biology because the fate of teleology

from Darwin's era onwards is strongly affected by its status in biology. Teleology is still alive and effective even before Darwin's theory of evolution. In particular, before Darwin, two outstanding scientists in biology promote two types (Platonic and Aristotelian) of teleology (Kampourakis, 2013, p. 433).

Georges Cuvier (1769-1832), the founder of comparative anatomy, was inspired by the works of Aristotle and held a teleological view of the world of life. Cuvier's view of life was shaped by his belief in the fundamental role of purpose in biological structures. He proposed that understanding life's ultimate purpose could inform the discovery and interpretation of life's functional structures. To illustrate, he postulated that recognizing the integrated and holistic nature of biological organisms and their inherent tendency towards collective well-being makes it possible to comprehend the function and characteristics of other biological parts by examining a single component of a living organism's biological structures (Ruse, 2000, p. 214). William Paley (1805-1743) is another distinguished biologist who postulated the teleological view of life before Darwin formulated the theory of evolution. Paley's approach to teleology can be described as Platonic. In his renowned work, *Natural Theology or Evidences of the Existence and Attributes of the Deity* (1802), Paley employs a comparative approach, drawing parallels between the intricate mechanisms of the natural world and the precision engineering of a pocket watch. He postulates that just as we perceive the deliberate design of a sophisticated watch, we can also discern the remarkable intricacies of the living world, thereby inferring the existence of a wise, intelligent creator (McGrath, 2011, pp. 91-97).

After all, Charles Darwin (1809-1882), With his theory of evolution, not only revolutionized biology and put it into a new framework but also laid the foundations for a new worldview (naturalism), which became the dominant worldview after him, at least in the Western academic world. Before Darwin, the mechanical method of science was established and developed to understand the world's natural phenomena. However, this mechanical view was still within a purposive framework, whether it was the Aristotelian teleology that prevailed before modernity (albeit in a theistic context) or the Platonic teleology that, as mentioned, prevailed after modernity. Nevertheless, with his theory of evolution, Darwin attacks the very basis of this purposive framework and not only proposes the possibility of explaining the world of life (the origin and diversity of species) without the need for divine purposiveness but even destroys natural and unintentional (Aristotle) purposiveness. To enter

into the issue of why and how the development of the theory of evolution questions the basis of the teleological framework before him, we must first take a brief look at Darwin's theory of evolution.

Douglas Futuyma states that *The Origin of Species* consists of two main theories. The first theory is descent with modification, which says all species have descended from one or a few original life forms. The second theory is natural selection, which states that the main factor shaping the path of evolution is the chance of organisms to survive and reproduce in the struggle for life within populations (Futuyma & Kirkpatrick, 2017, pp. 13-14). It seems that the study of Malthus's "Essay on Population" played a vital role in forming the idea of natural selection for Darwin (Ridley, 2004, p. 10). With a more complete analysis, it can be said that Darwin's theory of evolution has five essential components (Futuyma & Kirkpatrick, 2017, p. 14): 1) Changing the characteristics of organisms over time. 2) Common descent. 3) Gradualism. 4) Populational change, and (5) natural selection, which "accounts for adaptations, features that appear "designed" to fit organisms to their environment. Because it provided an entirely natural, mechanistic explanation for the adaptive design that had previously been attributed to divine intelligence, the concept of natural selection revolutionized not only biology but Western thought as a whole"(Futuyma & Kirkpatrick, 2017, p. 14).

Although all the essential components of Darwin's theory of evolution play a role in challenging the previous views related to teleology, the most crucial role, as the quoted phrase confirms, should be given to natural selection. Contrary to its title, natural selection is never a selection in its ordinary sense. Instead, it is an unintentional and blind process that causes the removal of creatures with lower fitness. This process is nothing but the struggle of creatures for survival and reproduction. Those organisms (vehicles of genes) more capable of survival and reproduction (i.e., have more fitness) will have more offspring in the next generation, and those less capable are gradually eliminated. In this way, natural selection is only a 'passive filter' that not only excludes external (Platonic) teleology but is also unfriendly to internal (Aristotelian) teleology (Solinas, 2015, p. 123). In other words, natural selection opens the way to an entirely mechanistic explanation of life. The way that, although strengthened with the emergence of modern science, as mentioned above, always has been ultimately in the teleological context, especially in the context of intentional teleology (design) in modern times. Now, Darwin puts forward an idea that provides a complete explanation of life without the need for any purposeful mechanism. Therefore, Darwin's theory

of evolution should be seen as the development of a mechanical view of the world of life, which closes the space to the previous teleological views (Leidenhag, 2021, p. 400).

Darwin and Platonic teleology (or design)

The prominent view with which Darwin's theory of evolution contracts in a first step and more explicit way is the Platonic view of teleology, which, as mentioned, William Paley had powerfully proposed and defended in Darwin's time. Before proposing the theory of evolution, Darwin was thoroughly familiar with and agreed with Paley's point of view. However, after proposing the theory of evolution, he found Paley's ideas no longer tenable. He describes the story as follows: "The old argument from design in Nature, as given by Paley, which formerly seemed to me so conclusive, fails now that the law of natural selection has been discovered. We can no longer argue that, for instance, the beautiful hinge of a bivalve shell must have been made by an intelligent being, like the hinge of a door by a man. 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"(McGrath, 2011, p. 161).

In this way, Darwin's explanation for the designed structures of life (adaptations), in contrast to Paley's, is that they were not actually designed but arose in a gradual and cumulative natural process without any need for intentional action. Thus, according to Darwin's theory, design cannot be inferred from biologically apparent designed structures. Thus, Francisco Ayala said that Darwin's most fundamental discovery is that the process of creating life lacks consciousness, and this is a great scientific revolution that Darwin completed. Everything in nature, including the world of life, results from a natural process based on the laws of nature (Ayala, 2004, p. 64). According to Ayala, Darwin's hypothesis is opposed by religious circles because of the natural causal mechanism–natural selection–which excludes God as an explanation for the existence of design in creatures. Based on this, the composition of the world is not the result of God's design but a blind and aimless process (Ayala, 2004, p. 58).

Of course, significant efforts were made to reconcile Darwin's theory of evolution with God's design of life during and after Darwin's time. (For a recent interesting example, see Kojonen, 2021). His colleague and Harvard biologist, Asa Gray, made one of the most significant contributions during Darwin's lifetime. Gray attempted to present a compatible and "needs-design" picture of evolution in numerous direct and indirect conversations with

Darwin. On the one hand, he presented the process of evolution as purposeful. On the other, he considered God to be the cause of the changes necessary for evolution to occur purposefully. In a review of *The Origin of Species*, Gray said:"[A]t least while the physical cause of variation is utterly unknown and mysterious, we should advise Mr. Darwin to assume, in the philosophy of his hypothesis, that variation has been led [by God] along certain beneficial lines"(Beatty, 2013, p. 148). Although Darwin did not oppose Gray's ideas initially, he later found these ideas incompatible with the theory of evolution. He, in response, said: "The view that each variation has been providentially arranged seems to me to make Natural Selection entirely superfluous, and indeed takes the whole case of the appearance of new species out of the range of science. [...] Gray's notion seems to me to smash the whole affair" (as cited in Beatty, 2013, p. 148, and Kojonen, 2021, p. 100). Thus, as Darwin continues to reflect on the idea of reconciling evolution and divine providence, he realizes that this task is much more difficult than he first imagined (Beatty, 2013, p. 146). However, Darwin does not want to present an atheistic interpretation of evolution without room for divine agency. So he ends by saying, responding to Gray's efforts, that "I am inclined to look at everything as resulting from designed laws, with the details, whether good or bad, left to the working out of what we may call chance" (as cited in Beatty, 2013, p. 148).

However, it should not be assumed that this famous statement and other sentences in which Darwin expresses a slight desire to see evolution in the context of theism make evolution compatible with design. The first reason is that, along with all the analyses and other reasons Darwin gives against the compatibility of divine providence and the evolutionary process, he is not talking about a reason but his inclination ("I am inclined to"). Secondly, as articulated by Darwin, the concept of design applies to the fundamental laws of nature that fall outside the domain of biology. These laws are not explicitly designed for biology or the origin and diversity of life. Instead, they are fundamental laws that govern the universe, particularly in physics.

It could be argued that Darwin effectively excluded the design debate from the domain of biology. For instance, about the eye, one of the most remarkable examples of life's impressive structures, which many leading scientists before Darwin considered sufficient to prove a designer, he said, "I see no necessity in the belief that the eye was expressly designed"(as cited in Kojonen, 2021, p. 175). The third reason relates to another factor that Darwin considers to be the cause of the evolution of life apart from laws, namely chance. The

attribution of chance to evolutionary processes, even though, in Darwin's view, it does not mean inherent and ontological chance, as it is said to be in quantum mechanics, is against (at least, the need for design) design or intentional action (Beatty, 2013, p. 148 but for contrary and interesting view see Kojonen, 2021).

Thus, in the first and crucial step, Darwin's theory of evolution seems to challenge the ideas of Platonic, intentional teleology, or design. Even if we do not say that Darwin's evolution is incompatible with the design of life and its mechanisms, it should be said that Darwin, quite unlike Newton, Boyle, Harvey, and Paley, makes the realm of biology without the need for intentional teleology or design. However, the story of Darwin and teleology continues after the denial of the need for design. Another critical issue to be explored is the relationship between Darwinian evolution and internal, natural, or Aristotelian teleology.

Darwin and Aristotelian teleology

Although Darwin is more explicit in some of his statements that evolution does not require intentional teleology or design, some of his words refer to a kind of unintentional purposefulness in evolution. For example, he says of natural selection that "daily and hourly scrutinizing throughout the world, every variation, however slight; rejecting that which is bad, preserving and adding up all that is good … natural selection can act only through and for the good of each being" (as cited in Lennox, 2013, p. 154). Also, he states in a letter to Gray that "It is not that designed variation makes, as it seems to me, my deity "Natural Selection" superfluous; but rather from studying lately domestic variations and seeing what an enormous field of undesigned variability there is ready for natural selection to appropriate for any purpose useful to each creature."

Such phrases have caused people during Darwin's time and after (such as Lennox, 1993) to consider Darwin as a supporter of teleology. Nevertheless, what should be emphasized is that, firstly, such phrases do not seem to show that Darwin is associated with Aristotelian teleology, and secondly, Darwin's theory of evolution is never aligned with Aristotelian teleology. The main reason for the latter is that, unlike Aristotle's teleology, which is the result of internal tendencies and formal causes that purposefully control the way forward, Darwinian evolution is based on the two ingredients of random changes and natural selection, none of which are the result of purposeful internal tendencies. Darwinian evolution proceeds from the path of production

and elimination of unfit organisms, and organisms with fitness are created not based on internal control mechanisms but through the aimless production of many samples and, again, the unpurposeful elimination of unfits. The critical point is that the changes made in the organism, in itself, have nothing to do with being fit with the environment, and most of these changes are removed through natural selection (Ariew, 2007, p. 178). However, in the second step, it should be emphasized again that natural selection is not a selection but a process of natural elimination of less-fit samples.

However, a more exciting case for misunderstanding the relation between Darwin's and Aristotle's teleology is the mistake that Darwin makes in quoting a phrase from Aristotle. At the beginning of the fourth edition of *The Origin of Species*, Darwin mentions a quote from Aristotle: "So what hinders the different parts [of the body] from having this merely accidental relation in nature? The teeth, for example, grow by necessity, the front ones sharp, adapted for dividing, and the grinders flat and serviceable for masticating the food; since they were not made for the sake of this, it was the result of accident. And in like manner as to the other parts in which there appears to exist an adaptation to an end." Then he stated, "We here see the principle of natural selection shadowed forth, but how little Aristotle fully comprehended the principle is shown by his remarks on the formation of the teeth"(Solinas, 2015, pp. 1-2). However, first of all, what is observed in this phrase is not the Aristotelianization of Darwin but the Darwinization of Aristotle. Secondly and very interestingly, the phrase that Darwin quoted from Aristotle is the phrase that Aristotle quoted from Empedocles to criticize him fundamentally. Because Darwin seems to have never opened the book of Aristotle's physics, he made such a big mistake (Solinas, 2015, p. 2). In this way, due to the reasons mentioned, it seems that Darwin's theory of evolution is not aligned with Aristotle's teleology.

However, it is worth mentioning the relation between the theory of Darwinian evolution and Lamarckian evolution. Lamarckian evolution has this vital difference from Darwinian evolution, in which the acquired traits of organisms created due to their needs and purposeful behavior are inherited (Futuyma & Kirkpatrick, 2017, p. 10). Thus, Lamarckian evolution is teleological. Although, in the Lamarckian view, the features of organisms do not have their design, the needs of organisms cause purposeful behaviors in them, and these behaviors cause the production of adapted features. These traits are inherited and transmitted, thus shaping the evolution process. However, in Darwin's theory of evolution, unlike Lamarck's, there is no

meaningful causal relationship between the needs of an organism and the traits that it transfers to the next generation. Instead, the next generation, if lucky, will inherit good random changes, and if it is unlucky, it will be eliminated by the sieve of natural selection. In this way, it seems that Lamarckian evolution is goal-directed and progressive and leads to fit and complex structures based on internal purposeful mechanisms, while Darwinian evolution is not, and Darwin himself pointed out this significant difference in a letter to Charles Lyell in 1863 (Forber, 2020, pp. 259-260).

Anyway, although some of Darwin's friends and opponents have once attributed teleology to Darwin, his theory was not teleological in a sense before that. As Ernst Mayr states, Darwin "gave up teleology soon after he had adopted natural selection as the mechanism of evolutionary change." In this way, with a better understanding of the Darwinian theory of evolution and its deep comparison with Platonic and Aristotelian teleology, it has never been aligned with teleology in a way that existed before him .It seems that still today, the dominant understanding of evolutionary biologists regarding the relationship between Darwin's theory of evolution and teleology is as follows as Futuyma, for example, says: "The implications of Darwin's theory, which revolutionized Western thought, include the ideas […] that biological phenomena, including those seemingly designed, can be explained by purely material causes rather than by divine creation; and that no evidence for purpose or goals can be found in the living world, other than in human actions" (Futuyma, 2017, p. 22). Hence, it seems that Darwin's theory of evolution has turned teleology into a myth, at least in the vital area of life (Ghiselin, 1994, p. 489), or as Thomas Huxley (1825-1895) claimed in 1864, "teleology, as commonly understood, had received its deathblow at Mr. Darwin's hands."

Neo-Darwinism and teleology

In general, with all the ups and downs that have occurred after Darwin's theory of evolution, with the formation of the Modern Synthesis in 1940 and its evolution within the Neo-Darwinist framework, the opposition between the theory of evolution and classical teleology is strengthened and established. As Ernst Mayr said, "All endeavors to find evidence for mechanisms that would explain general finalism in nature were unsuccessful or, where it occurs in the organism, 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). This section will provide a brief overview of the most significant events that shaped the evolution of evolutionary theory from its Darwinian roots to its Neo-Darwinian form. This will serve as an introduction to analyzing how the opposition between evolutionary theory and teleology became a fixed aspect of 20th-century thought.

After Darwin's theory of evolution, it was not the case that especially the primary mechanism of evolution, that is, the existence of random changes (the origin of which was unknown to Darwin himself) and natural selection (which had the role of purposeless sieving of changes), was accepted by the majority of evolutionary biologists. Alternative theories to Darwinian evolution existed, more aligned with teleology than the Darwinian theory of evolution. These included the Neo-Lamarckian and orthogenetic theories (Futuyma & Kirkpatrick, 2017, p. 15). Nevertheless, alternative theories of Darwinian evolution were refuted in the 1930s and 1940s, and the successor idea called modern synthesis or Neo-Darwinism was formed by combining findings from genetics, paleontology, and mathematics. The basis of the new theory of evolution was that the random changes created in the genome are like raw material for natural selection, which also operates based on statistical principles at the population level (Futuyma & Kirkpatrick, 2017, p. 16).

Many vital events (discoveries) took place in the evolution of Darwin's theory of evolution, among which two cases have had a fundamental role in establishing the relationship between evolution and teleology. First, and very important, was the discovery of the basic structure of the genome, that is, DNA, and the mechanisms of inheritance, and an important discovery in the continuation of this first discovery was the discovery of the mechanism of change and variation at the genetic level, that is, mutation. Mutation is essential in advancing evolution; evolution is never possible without it. As has been said, "These mutations are the ultimate source of genetic variation in all organisms. Without these errors, there would be no variation, no evolution, and no life." However, in the Neo-Darwinian view, mutations are not the result of a directional control mechanism but an error in copying genetic information, which some consider an inevitable consequence of the second law of thermodynamics (Futuyma & Kirkpatrick, 2017, p. 88).

The subsequent significant discovery for Neo-Darwinism is to understand the importance and fundamental place of random events, not only at the level of genetic change but also at the level of species populations. What is now known as genetic drift, states that in many populations of living organisms that are not large enough (for example, less than 500,000), the role of natural

selection as a sieve becomes weaker, and the role of random events in the formation and survival of the organisms' traits becomes stronger. Thus, especially in smaller populations, the remaining traits cannot simply be considered the result of natural selection filtering but rather a combination of natural selection and chance on a micro and macro scale (Futuyma & Kirkpatrick, 2017).

Based on these, the conflict between evolutionary theory (Neo-Darwinian version) and classical teleology seems to have reached its climax. Not only is the absence (non-necessity) of any intelligent agency in the evolutionary process inherited from the Darwinian version but the central position of natural selection as a mechanism that could preserve a completely naturalistic type of teleology is also lost. This is because genetic drift is added as a component that can play a key and random role in the evolutionary process. In this way, the hopes for combining the theory of evolution and teleology reach their lowest level. Hence, the dilemma for evolutionists is either to proclaim the total death of teleology in biology and try to remove it from biological concepts or to preserve its appearance and completely separate it from the classical concepts of teleology.

Developments in biology, together with the dominance of the positivist view in the philosophy of science for most of the 20th century, put terms related to teleology, even in appearance and language, into a bottleneck. For example, positivists believed that the existence of teleological terms in biology threatened its status as a basic science. Hence, discussing teleological function in science was considered legitimate only when reducible to physicalistic and non-teleological terms (Perlman, 2004, p. 4). Despite the efforts made, eliminating or reducing teleological terms to non-teleological terms in biology was not an easy task, and at the same time, teleological concepts are present in a wide range of related fields to biology (Perlman, 2004, pp. 6-7). The problem has led to many attempts in the philosophy of biology to investigate the possibility of reducing the teleological concepts in biology (Lennox, 2013, p. 156).

The emergence of teleonomy

One of the most important results of these efforts was the coining of the term 'teleonomy' by Colin Pittendrigh (1958) and the development and extension of its use in evolutionary biology (Dresow & Love, 2023, p. 101; Lennox, 2013, p. 157). The problem was that, on the one hand, it was not possible to remove teleological concepts from biology, and, on the other hand, the

biological community had abandoned the classical (Platonic or Aristotelian) concepts of teleology. In other words, there was a need to introduce a concept that could preserve the existence of apparent purposiveness in life and the language of biology, not based on basic teleological mechanisms but based on Neo-Darwinian mechanisms, such as random mutations, natural selection, and genetic drift that are fundamentally nonteleological.

Ernst Mayr was perhaps the first and foremost teleonomist. In 1961, Mayr wrote the first article on the subject, and after that, he continued to discuss teleonomy in his many works. Other prominent evolutionary biologists, such as George C. Williams (1966) and Jacques Monod (1971), also played a crucial role in developing and using teleonomy instead of teleology (Dresow & Love, 2023, pp. 106–107).

In 'The Idea of Teleology,' Mayr initially discusses the endeavors of philosophers (with a positivist inclination) who, without contemplating the language, concepts, and findings of biology, have attempted to reduce the teleological language to the language of logic and physics (Mayr, 1992, p. 121; 2007, p. 45). He deems these endeavors futile and proceeds to categorize purposefulness into four distinct categories: 1) Teleomatic process, that is, a process in inanimate nature that reaches an end stage determined by the universal laws of physics; 2) Teleonomic process, which owes its goal directness to the operation of a program and it only occurs in proximate causation; 3) Adapted features, which are a posteriori results of natural selection rather than a priori goal-seeking; and 4) Cosmic teleology, which no longer exists after the Darwinian theory of evolution. In the following article, 'The Multiple Meanings of Teleological,' Mayr adds a fifth category called 5) Purposive behavior, specific to animals (such as humans) that perform purposeful behavior based on thinking (Mayr, 1992, 1998, 2007, p. 49). With this categorization, Mayr's advice is this: "To avoid confusion, it is advisable to restrict the use of the word 'teleological' to cosmic teleology and to use instead other more specific terms for the other phenomena to which the term teleological had been applied in the past."(Mayr, 1998, p. 36) However, Mayr's subsequent significant contribution argues that all legitimate teleological concepts in biology result from blind and mechanical fundamental processes. They do not indicate an intelligent or fundamental teleological mechanism. In reference to the seminal work of Richard Dawkins, *The Blind Watchmaker* (1986), he asserts that Darwin's theory of evolution elucidated that the purposeful characteristics that have manifested in life are not the consequence of basic intentional or teleological processes (Mayr, 1992, p. 131).

Thus, teleology in the age of Neo-Darwinism faces two main approaches. The first is to try not only to remove teleology from the foundation of the world (rejection of cosmic teleology) but even to remove teleology and related concepts from the language of science. This is a strategy pursued by philosophers of science with a positivist orientation. The second strategy is to acknowledge the lack of success and the impossibility of removing the teleological concepts from the language of biology and accepting these concepts in the language of science while at the same time emphasizing that these concepts exist only at the level of the apparent surface of life and can, "in principle," be reduced to entirely material mechanisms and physico-chemical causes (Mayr, 1992, p. 134). The term teleonomy was coined to refer to such a strategy. In other words, teleonomy represents the total naturalization of teleology. Despite the existence of purposeful characteristics and processes at the surface level of life, they are ultimately the consequence of purposeless, blind, and mechanical processes that have been shaped over a lengthy time by the totally-nonteleological Darwinian processes. The critical point is that the Darwinian (Neo-Darwinian) process does not include any purposeful mechanism in its foundation, and purposefulness has only appeared on the surface level of life. As Dawkins, in *The Blind Watchmaker,* aims to show, all the wondrous complexities of life that we see on the surface are the result of the blind process of cumulative selection, and there is no need or indication of the existence of intelligent or teleological processes in evolution (Dawkins, 1996). In this way, both strategies are in agreement that there is no purpose at the basic level of nature and that all purposeful manifestations in life, even if in practice, they cannot be reduced to mechanical explanations, are, *in principle,* reducible to entirely mechanical and physicochemical explanations, both at the level of *proximate* causation and at the level of *ultimate* causation.

However, the critical question is if, first, it is not possible to reduce biological explanations to mechanical and physico-chemical explanations at the proximate level, and, second, it is not possible to explain adapted features solely based on the Darwinian mechanism (i.e., the combination of mutation, natural selection, and genetic drift) at the ultimate level, how can it be claimed that this possibility exists in principle? Accepting the metaphysical-in-principle claim depends on the complete or almost complete success of Neo-Darwinian explanations in practice. If Neo-Darwinism is not successful in practice, or worse, if it faces serious problems, then the metaphysical claim that these explanations are successful in principle will no longer be valid. Accordingly, if the negation of teleology based on Neo-Darwinism is not a

metaphysical or dogmatic claim, it is dependent upon the efficacy of Neo-Darwinian explanations in practice; if these explanations prove ineffective or the evidence indicates a contrary position, namely fundamental teleology in nature, then our stance on teleology should be evidence-based.

However, it seems that, sometimes, the Neo-Darwinist view has already decided about teleology. As Mayer says: "I was determined not to accept any principles or causes that were in conflict with the Newtonian natural laws. The biology for which I wanted to find a philosophy had to qualify as a genuine, bona fide science" (Mayr, 2007, p. 2). He goes on to say that "Biology could not be accepted as a bona fide science until it eliminated cosmic teleology from its framework of theories" (Mayr, 2007, p. 5).

21st-century Biology and the Revival of Teleology

Before embarking upon this article's final and pivotal section, it is prudent to undertake a more comprehensive examination of why Neo-Darwinism precludes the possibility of teleology. Several fundamental tenets of the Neo-Darwinian perspective seem responsible for this outcome.

Firstly, the Darwinian perspective is gene-centric and reductionist in nature. Indeed, within this perspective, the genome is the sole agent exhibiting a bottom-up featural and behavioral pattern. Indeed, higher-level features and behaviors, particularly those with an evolutionary function, result from a bottom-up causal process originating from the genome. In this manner, the characteristics and behaviors of an organism are wholly determined by its genome, and the organism is unable to act in a meaningful manner that extends beyond the parameters of its genetic program.

Secondly, the existing genetic information is isolated. This is exemplified by the Central Dogma of Molecular Biology, which states that information is transferred from the genotype to the phenotype and that there is no way to influence and purposefully change the genetic information. Any variation in genetic information results from errors in the replication process or other random disturbances that affect the organism. In this manner, all the traits and behaviors of organisms are the consequence of a bottom-up and reductionist mechanism designated as the genetic program. This program is also incapable of purposefully altering its course following existing needs.

Thirdly, the generation of genetic material that determines everything occurs as a consequence of the interaction between spontaneous mutations and natural selection, in addition to other random occurrences such as genetic drift,

which not only negates the existence of any primary purposeful mechanism but also, it introduces the concept of macroscale evolution as a random and divergent phenomenon, which has significant implications in the broader context of evolutionary theory.

However, the evolution of biology in the latter decades of the 20th century and the 21st century indicates a divergence from the prevailing perspective. This is not an occasion to provide a comprehensive account of these significant developments and their outcomes. Nevertheless, a concise overview of some pertinent related findings and works may prove valuable.

Convergent evolution

Simon Conway Morris, against this Neo-Darwinian idea that 'If one was able to re-play the whole evolution of animals, there is no guarantee – indeed no likelihood – that the result would be the same,' argues that, according to plenty of recent paleontological findings, evidence points to repeated evolutionary responses at very distant points in the tree of life. This means that evolution, beyond Neo-Darwinian mechanisms, has an internal capacity to create mechanisms needed by organisms in similar situations, even when these mechanisms, despite their great complexity, do not share inheritance. "It is the otherwise uncontroversial observation that from very different starting points in the Tree of Life, very much the same solution has evolved multiple times." Morris believes that these new findings show the inadequacy of Darwin's formulation and that most of the Tree of Life has a pre-determined shape (Conway Morris, 2009) and "something very like a human is an evolutionary inevitability, a view that hardly sits comfortably with Neo-Darwinian orthodoxy (Conway Morris, 2007, p. 140).

Whatever mechanism Morris has in mind for the fact that evolution at separate and distant points on the tree of life leads to the same answers, that is, complex biological structures with similar functions, the idea of convergent evolution indicates that contrary to Neo-Darwinian views, evolution at the macro level is not a random process. In this way, even if the internal mechanism of evolution does not have clear teleological aspects, the process of evolution cannot be considered random in the macro view but can be considered direct. A direction that leads to surprising results (such as human intelligence). Thus, based on convergent evolution, if we were to repeat the evolutionary process, we would arrive at almost the same results as we have now, and this shows that evolution is a process directed towards excellent results, such as human intelligence.

Self-organization

Self-organization means that life structures can organize themselves and create balanced complexity without needing external and environmental selection. In his numerous works based on complex systems, Stuart Kaufman proposed the idea of self-organization in the sense that complex biosystems can be created and organized even without external and environmental selection. He states: "Self-organization may require that we rethink all of the evolutionary theory, for the order seen in evolution may not be the sole result of natural selection but of some new marriage of contingency, selection, and self-organization." (Kauffman, 2008, p. 60) Elsewhere, he said that it seems important to stress that the new realization that "the biosphere, without natural selection "acting" to achieve it, creates its future possibilities of becoming, was not seen by Darwin, nor by contemporary evolutionary theory, including the Neo-Darwinian synthesis...and with the enchantment of the fact that the evolving biosphere creates, beyond selection, its own future possibilities, we are beyond Darwin. We have entered an entirely new worldview" (Kauffman, 2013, p. 180).

Although there are different approaches to understanding self-organization, the point that is particularly noteworthy in Kauffman's treatment is that nature in general, and life in particular, has a directional dynamic. Based on this view, and in contrast to the previous Neo-Darwinian view, nature and life at its very heart are not passive and completely blind but active and directed. In this way, even without natural selection, nature tends to create complex structures, which shows that the previous reductionist and mechanistic picture of nature and life is not correct.

Systems biology

Denis Noble criticizes various elements of the Neo-Darwinian view in his works based on new biological findings, especially in Systems Biology. He posits that systems biology represents a novel approach to understanding life that has yet to be fully realized within the context of the prevailing reductionist perspective. Consequently, it engenders a transformation in scientific discourse and promises to reshape our philosophical understanding (Noble, 2006, p. xi). One of his fundamental criticisms of Neo-Darwinism is the incorrectness of the gene-centered view and causal reductionism. This means that the causal path is not only from the gene to the top but also from life, and in addition to the bottom-up causation, it has top-down causalities. He states, "This leads to concepts like downward causation, circular causation, and multi-level

interactions. Surprising as it may seem, the lowest molecular levels are controlled by the higher levels. Even DNA is controlled by the organism as a whole"(Noble, 2017, p. 72). On this basis, Noble states that since the purpose cannot be understood at the level of the genes, Neo-Darwinism reaches the denial of the purpose in life, while if it is viewed from the perspective of the organism as a whole, then the teleological causality exists and can be recognized (Noble, 2017, pp. 45, 178, 190).

Noble is one of the most influential biologists of our time who has tried to show the incompleteness of the Neo-Darwinian view of life with various evidence. In several works (Noble, 2006, 2013, 2015, 2017, 2021), he has tried to show these flaws and open the way for a new perspective on life. A view that is fundamentally at odds with the Neo-Darwinian view, especially in two aspects. Firstly, there is the problem of reductionism, which Noble believes, even though the reductionist method has led to significant scientific advances and discoveries. However, this view is profoundly inadequate, and insisting on it, which exists in the dominant scientific atmosphere, hinders the progress of science towards a correct understanding of reality (Noble, 2017, pp. 73, 160). The second, proposed as a continuation of the first theme, is the problem of teleology. Suppose the unjustified insistence on the reductionist point of view is abandoned. In that case, it becomes clear that the behavior of the components of life is purposeful concerning the whole (organism). In contrast, this purposefulness cannot be understood and recognized from the reductionist and gene-centered point of view (Noble, 2017, pp. 45, 190).

Natural genetic engineering

Perhaps of greater significance and interest than the others is the concept put forth by James Shapiro, based on years of experimentation and evidence collection. Firstly, he posits that the accidental view of the process of mutations has been the dominant view since the formation of modern synthesis until the present day. However, the Darwinian view that evolution occurs through the gradual accumulation of "numerous, successive, slight modifications" is currently supported by little evidence (Shapiro, 2011, p. 128). In contrast, there is "convincing (perhaps overwhelming)" evidence for purposeful mechanisms influencing genetic alterations (Shapiro, 2011, p. 134). Shapiro hypothesizes that these mechanisms constitute "natural genetic engineering," whereby organisms can modify their genomes in response to specific needs. The intricacies of these mechanisms lie beyond the scope of this article and the author's expertise. However, readers interested in

pursuing this topic further may wish to consult Shapiro's seminal works in this field (Shapiro, 2013, 2017, 2019, 2023).

The significance of Shapiro's findings, particularly the concept of natural genetic engineering, is that when considered in the context of recent biological discoveries, it can transform our understanding of life and evolution. Indeed, Natural genetic engineering can be considered an extreme version of Lamarck's ideas, which posit that not only can the characteristics acquired by an organism in response to its needs and the environment be inherited, but that the organism can even cause changes based on its specific needs, targeted at its genome. As Shapiro has noted, this idea seemed impossible before, particularly within the Darwinian theory (Shapiro, 2011, pp. 5, 89-90).

Concluding remarks

The recent discoveries in the field of biology appear to challenge the Neo-Darwinian anti-teleological perspective in several ways. The phenomenon of convergent evolution demonstrates that the macro-evolutionary process is not as random as previously assumed, and the fossil evidence obtained thus far indicates that evolution can create complex structures independently on numerous occasions. Conversely, self-organization demonstrates that life is not a passive phenomenon; instead, it is capable of advancing creatively and influencing the potential outcomes before it. In this way, life itself can be considered to possess a certain degree of agency. Furthermore, integrating systems biology into evolutionary biology has revealed the limitations of the previous reductionist and gene-centric approach, elucidating the causal mechanisms that extend beyond the one-way pathway of gene transmission to the organism's features. Instead, as Noble stated, genes are organs for the organism, and it is the organism that behaves actively and purposefully. However, the most significant challenge to the Neo-Darwinian anti-teleological perspective arises from the advent of natural genetic engineering. This concept can potentially replace the fundamental anti-teleological assumption in evolutionary biology, namely the blind and random nature of genetic changes, with a more purposeful and intentional explanation.

It is, therefore, evident that the recent discoveries in the field of biology have the potential to alter our understanding of the relationship between evolution and teleology. Each case above can rectify one of the fundamental tenets of the Neo-Darwinian view that marginalizes and even finally eliminates teleology. This, in turn, paves the way for a deeper understanding of the mechanisms underlying purposefulness in nature. However, the new

findings of biology also suggest other important axes, which, in addition to those already mentioned, can bring about a fundamental transformation in our understanding of teleology. Topics such as **coevolution**, **symbiogenesis**, **niche construction**, **evo-devo**, and **agency in life** are worthy of further scientific and philosophical investigation (Corning et al., 2023), as they may ultimately lead to a significant shift in our perception of teleology.

Conflict of Interests

The author has no competing interests.

References

Ariew, A. (2007). Teleology. In D. L. Hull & M. Ruse (Eds.), *The Cambridge companion to the philosophy of biology*. Cambridge University Press.

Ayala, F. (2004). Design without designer: Darwin's greatest discovery. In W. Dembski & M. Ruse (Eds.), *Debating design: From Darwin to DNA*. Cambridge University Press.

Beatty, J. (2013). Chance and design. In M. Ruse (Ed.), *The Cambridge encyclopedia of Darwin and evolutionary thought*. Cambridge University Press.

Conway Morris, S. (2007). *Life's solution: Inevitable humans in a lonely universe* (4th print). Cambridge University Press.

Conway Morris, S. (2009). The predictability of evolution: Glimpses into a post-Darwinian world. *Naturwissenschaften*, 96(11), 1313-1337. https://doi.org/10.1007/s00114-009-0607-9

Dawkins, R. (1996). *The blind watchmaker*. W. W Norton and Company.

Dresow, M., & Love, A. C. (2023). Teleonomy: Revisiting a proposed conceptual replacement for teleology. *Biological Theory*, 18(2). https://doi.org/10.1007/s13752-022-00424-y

Forber, P. (2020). Contemporary teleology. In J. K. McDonough (Ed.), *Teleology: A history*. Oxford University Press.

Futuyma, D. J., & Kirkpatrick, M. (2017). *Evolution* (4th ed.). Sinauer Associates, Inc., Publishers.

Ghiselin, M. T. (1994). Darwin's language may seem teleological, but his thinking is another matter. *Biology & Philosophy*, 9(4). https://doi.org/10.1007/BF00850377

Harrison, P. (2019). Laws of God or laws of nature? Natural order in the Early Modern Period. In P. Harrison & J. H. Roberts (Eds.), *Science without God? Rethinking the history of scientific naturalism* (1st ed.). Oxford University Press.

Johnson, M. R. (2017). Aristotelian mechanistic explanation. In J. Rocca (Ed.), *Teleology in the Ancient World: Philosophical and medical approaches* (1st ed.). Cambridge University Press. https://doi.org/10.1017/9781139567855

Kampourakis, K. (Ed.). (2013). *The philosophy of biology: A companion for educators* (vol. 1). Springer Netherlands. https://doi.org/10.1007/978-94-007-6537-5

Kauffman, S. (2008). *Reinventing the sacred: A new view of science, reason and religion*. Basic Books.

Kauffman, S. (2013). Evolution beyond Newton, Darwin, and entailing law: The origin of complexity in the evolving biosphere. In C. H. Lineweaver, P. C. W. Davies, & M. Ruse (Eds.), *Complexity and the arrow of time* (pp. 162-190). Cambridge University Press. https://doi.org/10.1017/CBO9781139225700.011

Kojonen, E. V. R. (2021). *The compatibility of evolution and design*. Springer International Publishing. https://doi.org/10.1007/978-3-030-69683-2

Leidenhag, M. (2021). Purpose for and within creation: A theological appraisal of organismic teleology. *Modern Theology*, 37(2). https://doi.org/10.1111/moth.12689

Lennox, J. G. (2013). Darwin and teleology. In M. Ruse (Ed.), *The Cambridge encyclopedia of Darwin and evolutionary thought*. Cambridge University Press.

Lennox, J. G., & Kampourakis, K. (2013). Biological teleology: The need for history. In K. Kampourakis (Ed.), *The philosophy of biology: A companion for educators* (vol. 1). Springer Netherlands. https://doi.org/10.1007/978-94-007-6537-5

Mayr, E. (1992). The Idea of teleology. *Journal of the History of Ideas*, 53(1). https://doi.org/10.2307/2709913

Mayr, E. (1998). The multiple meanings of "teleological." *History and Philosophy of the Life Sciences*, 20(1).

Mayr, E. (2007). *What makes biology unique? Considerations on the autonomy of a scientific discipline* (1st paperback ed.). Cambridge University Press.

Mcdonough, J. K. (2011). The heyday of teleology and Early Modern Philosophy: Teleology and Early Modern Philosophy. *Midwest Studies In Philosophy*, 35(1), 179-204. https://doi.org/10.1111/j.1475-4975.2011.00218.x

McDonough, J. K. (2020). Not dead yet: Teleology and the "scientific revolution." In *Teleology: A history*. Oxford University Press.

McGrath, A. E. (2011). *Darwinism and the divine: Evolutionary thought and natural theology*. Wiley-Blackwell.

Noble, D. (2006). *The music of life: Biology beyond the genome*. Oxford University Press.

Noble, D. (2013). Physiology is rocking the foundations of evolutionary biology. *Experimental Physiology*, 98(8). https://doi.org/10.1113/expphysiol.2012.071134

Noble, D. (2015). Evolution beyond Neo-Darwinism: A new conceptual framework. *Journal of Experimental Biology*, 218(1). https://doi.org/10.1242/jeb.106310

Noble, D. (2017). *Dance to the tune of life*. Cambridge University Press.

Noble, D. (2021). The illusions of the modern synthesis. *Biosemiotics*, 14(1). https://doi.org/10.1007/s12304-021-09405-3

Pasnau, R. (2020). Teleology in the Later Middle Ages. In J. K. McDonough (Ed.), *Teleology: A history*. Oxford University Press.

Perlman, M. (2004). The modern philosophical resurrection of teleology. *Monist*, 87(1). https://doi.org/10.5840/monist20048711

Richardson, K. (2020). Avicenna on teleology. In J. K. McDonough (Ed.), *Teleology: A history*. Oxford University Press.

Ridley, M. (2004). *Evolution* (3rd ed.). Blackwell Pub.

Rocca, J. (2017). Introduction. In J. Rocca (Ed.), *Teleology in the Ancient World: Philosophical and medical approaches* (1st ed.). Cambridge University Press. https://doi.org/10.1017/9781139567855

Ruse, M. (2000). Teleology: esterday, today, and tomorrow? *Studies in History and Philosophy of Science Part C: Studies in History and Philosophy of Biological and Biomedical Sciences*, 31(1). https://doi.org/10.1016/S1369-8486(99)00046-1

Scolnicov, S. (2017). Atemporal teleology in Plato. In J. Rocca (Ed.), *Teleology in the Ancient World: Philosophical and medical approaches* (1st ed.). Cambridge University Press. https://doi.org/10.1017/9781139567855

Sedley, D. N. (2007). *Creationism and its critics in antiquity*. University of California press.

Shapiro, J. (2011). *Evolution: A view from the 21st century*. FT Press Science.

Shapiro, J. (2013). Rethinking the (im)possible in evolution. *Progress in Biophysics and Molecular Biology*, 111(2–3), 92–96. https://doi.org/10.1016/j.pbiomolbio.2012.08.016

Shapiro, J. (2017). Biological action in read–write genome evolution. *Interface Focus*, 7(5). https://doi.org/10.1098/rsfs.2016.0115

Shapiro, J. (2019). No genome is an island: Toward a 21st century agenda for evolution. *Annals of the New York Academy of Sciences*, 1447(1), 21-52. https://doi.org/10.1111/nyas.14044

Shapiro, J. (2023). Evolutionary change Is naturally biological and purposeful. In P. A. Corning, S. A. Kauffman, D. Noble, J. A. Shapiro, R. I. Vane-Wright, & A. Pross (Eds.), *Evolution "on purpose": Teleonomy in living systems*. The MIT Press.

Silva, I. (2019). From extrinsic design to intrimsic telelology. *European Journal of Science and Theology*, 15(3), 61-78.

Solinas, M. (2015). *From Aristotle's teleology to Darwin's genealogy: The stamp of inutility*. Palgrave Macmillan.

Wattles, J. (2006). Teleology past and present. *Zygon*®, 41(2), Article 2. https://doi.org/10.1111/j.1467-9744.2005.00749.x