Forum for Philosophical Studies 2025, 3(1), 2817.
https://doi.org/10.59400/fps2817

Article

Kant and biological evolution, contra Ralph Cudworth's *deus ex machina*

Ryan Vilbig

Independent Researcher, St. Louis, MO 63021, USA; ryan.vilbig@gmail.com

CITATION

Vilbig R. Kant and biological evolution, contra Ralph Cudworth's *deus ex machina*. Forum for Philosophical Studies. 2025; 3(1): 2817.
https://doi.org/10.59400/fps2817

ARTICLE INFO

Received: 19 February 2025
Accepted: 29 April 2025
Available online: 21 May 2025

Abstract: The relationship between Immanuel Kant's philosophy and the modern theory of biological evolution has been a topic of much scholarly debate with little consensus. It has been generally contended that the amassed confusions about Kant's views are due to ambiguities in his own thinking, and, as such, perplexed interpretations subsequent to his writings were broadly articulated even in 19th-century Germany. More recent philosophers have sought to emphasize how Kant changed his mind from 1785 when he found evolutionary theories "so monstrous that reason recoils before them" to a reconsideration that "one species would have arisen from the other" as a mere "daring adventure of reason" in 1790. Alternatively, this paper will argue that Kant's philosophical commitments to biological evolution can be traced to an earlier point, specifically, in his encounter with the *deus ex machina* concept of Ralph Cudworth (1617–1688) in his *True Intellectual System*, translated at Jena in 1733. Kant had read Cudworth's text sometime before writing his *Universal Natural History* in 1755, influencing his professed adherence to universal physical laws and metaphysical teleology, as well as his opposition to the *deus ex machina* fallacy of divine interference in the natural biological order. Similar arguments against the *deus ex machina* concept are also frequently found among evolutionary biologists throughout the 19th–20th centuries, thus placing the pre-critical Kant even among their philosophical ranks. This paper will evaluate these important sources and demonstrate Kant's continuing relevance to the philosophy of evolutionary biology, including his perspective on teleological judgments.

Keywords: Immanuel Kant; Ralph Cudworth; evolution; *deus ex machina*; teleology; anthropic principle; epistemology; metaphysics

1. Introduction

Immanuel Kant's (1724–1804) supposed identification as an evolutionist began as early the late 18th-century as one of a number of German Enlightenment thinkers who expounded the philosophical basis for scientific theories and naturalistic metaphysics. The year 1790 saw both the publication of Kant's third critique, *Critique of Judgment*, and the famous polymath Johann Wolfgang von Goethe's (1749–1832) *Metamorphosis of Plants*. Both texts were widely read, and the coincidences regarding their statements about biological development of species did not go unnoticed by the German public. The *Critique of Judgment* nearly sold out at its debut at the Leipzig book fair in 1790; a second publishing was needed in 1792; and a third edition followed in 1799. "This renown soon spread beyond German-speaking lands, and translations of Kant's work into English were published even before 1800" [1] (pp. xiii–xlvi). According to research, there is circumstantial evidence that when Goethe published his *Essay on a General Theory of Comparison* in 1794, "by that time, he had absorbed the message of Kant's third *Critique*" [2] (p. 6), and several years later in 1797, when he wrote to Kant's student Johann Herder (1744–1803), he would collate his views with those of Kant: "nature goes on forever inventing plants," and

"the same law will be applicable to all other living organisms" [3] (p. 104). These and other popular associations took root in the German public's collective memory at this time in the last decade of Kant's life, and his earlier writings relevant to biological evolution became largely overlooked. Of particular interest would be Kant's 1755 *Universal Natural History and Theory of the Heavens*, wherein Kant had attempted to explain with Newtonian physics the formation and evolution of the planetary solar system, additionally outlining the physical and chemical processes at the basis of the emergence of life. This text will form the main study contributed by this paper due to the influence found therein of the English philosopher and theologian Ralph Cudworth (1617–1688) and Kant's responses to his ideas. It was in this text that he made note of his opposition to the *deus ex machina* concept that Cudworth had introduced into his lexicon and which Cudworth had upheld as a meritorious philosophical solution. It also perhaps requires some preparatory explanation: the *deus ex machina* was a theatrical device by which an insoluble plot was brought to its conclusion by entering a god onto the stage "out of a machine" to resolve the conflict. In philosophy, it represents divine interference in the natural order.

Because of Kant's naturalistic metaphysics in this 1755 text, the *Universal Natural History* would fail to gain acceptance among the German public, and its radical evolutionary ideas, according to a more recent biographer, Manfred Kuehn, were generally "recognized as belonging to the tradition of 'Lucretius or his predecessors Epicurus, Leucippus, and Democritus'" [4] (p. 99). Furthermore, the king as the government's censor was "the one who ultimately was going to make or break his career. It was hardly an accident that the book was dedicated to him." Finally, at its printing, "the publisher of the book went bankrupt, and the court impounded his entire stock. The *Universal Natural History* did not cause so much as a murmur among the zealots—only a review" [4] (p. 99). Hence, to understand the subsequent generation's philosophical assessment of Kant's view of biological evolution, it is actually more informative for us to begin with his statements in *Critique of Judgment*.

2. Biological evolution in *Critique of Judgment,* or earlier texts

The *Critique of Judgment* (1790) has been subjected to significant scholarly analysis, though less than the earlier, more famous first *Critique* (1781/87); its general reception among readers can be highlighted with several common themes. First, this text has been recognized to be a difficult subject by many contemporary philosophers; Hannah Ginsborg, for example, in *Philosophical Review*, considered it an "important and difficult work […] with all its unclarities and ambiguities" [5] (p. 429). Writing in the journal *Evolution and Cognition,* Thomas Mehrs has advanced the view that studies are required for a "reconstruction of Kant's philosophy" to compare it with "the equivalent evolutionary thesis" and "investigate the question whether these approaches in principle are compatible" [6] (p. 24). Catherine Wilson has described it as "a long, worried, ambivalent book about evolution, beauty, and living forms" [7] (p. 98). This comment and other similar reviews have been cited by Nabeel Hamid to underscore its "piecemeal character" which "led to a suitably fragmentary body of secondary literature" [8] (p. 157). Nonetheless, such reconstructions have taken place, and numerous writers have elicited the appropriate passages that align Kant's view

with evolutionary theory. As in all such quests to paint a picture of any philosopher or other intellectual in the beau ideal, concerns of legitimacy have arisen; Carol Hay, along these lines, has asked "whether we're justified in cherry-picking the parts of Kant we like best" [9] (p. 110). Even in the recent and thoroughly academic compilation *Kant and Animals*, this tendency to selectively read Kant is evident in the charted chronology that Cohen provided for the variations in Kant's views on evolution [10] (p. 132); to this chart (modified with additions in **Table 1**), we can footnote to several other general sources that speculatively attribute or deny to Kant statements of evolution in his various earlier texts:

Table 1. Chart of Immanuel Kant's important texts evaluated for evolutionary concepts.

Year	Text	General assessment
1755	*Universal Natural History*	Nebular theory of cosmic development [11] "Origin of organisms [...] In mechanistic terms [...] At no time affirmed" [12] (p. 540) "Detailed evolutionary cosmology" [13] (p. 1)
1771	*Review* of *Moscati's Anatomy*	"Anthropological evolution" but not "biological evolution" [14] (p. 36) "Germs" of "animality" in human life [15] (p. 114)
1770s–80s	*Lectures on Anthropology*	"Epigenetic evolution" [16] (p. 36) "Deliberately refused [...] General biological evolutionism." [12] (p. 553) "Darwinian-like thesis" [17] (p. 15)
1785	*Letter to Herder*	Non-evolutionary [14] Non-evolutionary [10]
1790	*Critique of Judgment*	"Expresses, more or less distinctly, the fundamental idea of the theory of descent" [18] (p. 103) "Evolutionary theory" [16] (p. 39) "Epigenetic theory" of "generic preformation" [19] (p. 26)

Because many subsequent scholarly commentaries (though not all) address the last of these publications by Kant, it is important to focus on it to understand the current consensus. The primary topic of his 1790 book, the mental faculty of "judgment (urteil)" is best understood in its German context. Robert Hanna has written a very thorough article for this topic in the *Stanford Encyclopedia of Philosophy* (2017), outlining the essential points of Kant's definition and citing the numerous instances in his texts referencing it. These publications in which Kant had discussed "judgment (urteil)" included *False Subtlety* and *Negative Magnitudes* from the 1760s, *Inaugural Dissertation* from the 1770s, the three *Critiques* from the 1780s and 1790s, and even *Lectures on Logic* from the 1800s. As Hanna's article chronicles, the connotations emerged in different contexts and are suggestive of multiple aspects essential to Kant's definition, including (but not limited to) the following: (1) its ability to subsume the particular under the universal by the aesthetic sense; and (2) evaluations of certain inferences as true or false [20]. Similarly, Andrew Cooper has recently noted in a review at the 13th International Kant Congress that "the principle of reflecting judgment guides observation in empirical research" [21] (p. 949). These epistemological topics are undoubtedly a thematic part of *Critique of Judgment*. Additionally, however, the text also contains specific examples of case studies in which this faculty is relevant. In fact, the thread of references to evolutionary theory throughout *Critique of Judgment*, for those who had read the *Universal Natural History*, should be recognized as an enduring speculative idea being proposed by Kant with other content to be found elsewhere in his oeuvre; it should suggest to attentive scholars that this scientific theory was still at the forefront of Kant's mind from that

poorly received, previous publication. Since, as noted above, his 1755 text had been dedicated to Frederick II of Prussia (1712–1786) and its publisher's stock had been impounded by the court, it is an arguably tenable and meaningful hypothesis that Kant's third *Critique* was still seeking to avenge his earlier ideas. Perhaps stretching the translation, this 1790 work might be rendered better under the title "~Critique of the Power to Subsume Particular Data under General Laws, and Judge it True or False; with Reference to the Theory of Evolution." While this revisionist title digresses us somewhat from the topic, it might be a major oversight among Kantian scholars to not recognize that he was critiquing at length the faculty of "judgment (urteil)," perhaps including judgments against speculations within his own writings and earlier publications.

Kant wrote two introductions to this important work, the first one in 1790 which went unpublished, and then another at the second printing in 1792. The second introduction opened with an outline of several noted aspects of judgment:

> "There are such diverse forms of nature, so many modifications as it were of the universal transcendental concepts of nature, which are left undetermined by these laws, that surely there must be laws for these forms too […]. Hence reflective judgment, which is obliged to ascend from the particular in nature to the universal, requires a principle, which it cannot borrow from experience, precisely because it is to be the basis for the unity of all empirical principles under higher though still empirical principles, and hence is to be the basis that makes it possible to subordinate empirical principles to one another in a systematic way" [22] (p. 19).

Kant had set before his readers, by way of introduction, the course for his definition of judgment that availed it of his forthcoming discussion of the important example later in his text, i.e., evolutionary theory. The essential methodology for evaluating this, however, which perhaps he considered lacking in his earlier 1755 text, was now clearly articulated: the "reflective judgment." As Joan Steigerwald has written: "That Kant provided reflective rather than determinate judgments about such processes [i.e., evolution] opened up rather than shut down possibilities for thinking further about the capacities of organisms" [23] (p. 312).

Arguably as a clarification of his earlier text, but perhaps more likely, as a deeper reflection upon the ideas of *Universal Natural History*, Kant midway through this text included a discussion of artificial selection: "Consider flowers, blossoms, even the shapes of plants, or consider the grace we see in the structure of various types of animals, which is unnecessary for their own use, but is selected, as it were, for our taste" [22] (p. 221). He also noted that "it is quite conceivable, and involves no infringement on the teleological principle by which we judge organization, that the beauty in both the shape and the color of flowers, plumage, and seashells can similarly be attributed to nature […] freely, without following specific purposes, but merely in accordance with chemical laws." [22] (p. 224). These passages just anticipate a more clearly articulated theory of evolution by natural selection and follow a line of logic that Darwin argued in *Origin of Species* with regard to artificial selection. Moreover, they are demonstrative of Kant's meticulous focus on the epistemological basis for a theory of evolution, something founded upon the "reflective judgment" that he introduced to develop this hypothesis, perhaps as a corrective to his logical exposition

found in his earlier text.

Kant continued with this example for evaluating the faculty of judgment, assessing the merits of the evolutionary theory as due to the "technic of nature":

> "So many genera of animals share a certain common schema on which not only their bone structure but also the arrangement of their other parts seems to be based; the basic outline is admirably simple but yet was able to produce this great diversity of species, by shortening some parts and lengthening others, by the involution of some and the evolution of others. Despite all the variety among these forms, they seem to have been produced according to a common archetype, and this analogy among them reinforces our suspicions that they are actually akin, produced by a common original mother. For the different animal genera approach one another gradually: from the genus where the principle of purposes seems to be bourne out most, namely, man, all the way to the polyp, and from it even to mosses and lichens and finally to the lowest stage of matter discernable to us, crude matter. From this matter, and its forces governed by mechanical laws (like those it follows in crystal formation), seems to stem all the technic that nature displays in organized beings" [22] (p. 304).

Darwin would also consider this possibility, viz., "If we suppose that the ancient progenitor, the archetype as it may be called, of all mammals, had its limbs constructed on the existing general pattern, for whatever purpose they served, we can at once perceive the plain signification of the homologous construction of the limbs throughout the whole class" [24] (p. 435). By making such statements that explicitly avoided the Lucretian/Empodoclean ideas of 'spontaneous generation' (generatio aequivoca) and by introducing the idea of the "technic" of nature, Kant had outlined his own thoughts within what should be considered a theory of gradual evolutionary descent from common ancestors. It is perhaps surprising that later 19th-century German writers would fail to notice some of these parallels in *Critique of Judgment*, let alone the related ideas of the earlier *Universal Natural History* which had led him to such considerations.

Kant continued in his 1790 text as follows:

> "When the archaeologist of nature considers these points, he is free to have that large family of creatures (for that is how we must conceive of them if that thoroughly coherent kinship among them is to have a basis) arise from the traces that remain of nature's most ancient revolutions, and to have it do so according to all the natural mechanisms he knows or suspects. He can make mother earth (like a large animal, as it were) emerge from her state of chaos, and make her lap promptly give birth initially to creatures of a less purposive form, with these then giving birth to others that became better adapted to their place of origin and to their relations to one another" [22] (p. 305).

Again, similarities are evident with the theory of Darwin, who wrote that, "Natural selection, during a long-continued course of modification, should have seized on a certain number of the primordially similar elements, many times repeated, and have adapted them to the most diverse purposes" [24] (p. 437).

Amid these such descriptions of evolutionary descent and natural selection, however, Kant was still most concerned with the epistemological and metaphysical reasoning that provided a basis for developing this scientific theory: "The

archaeologist of nature will have to attribute to this universal mother an organization that purposively aimed at all these creatures, since otherwise it is quite inconceivable how the purposive form is possible that we find in the products of the animal and plant kingdoms" [22] (p. 305). In other words, for Kant, if nature were not metaphysically endowed with inherent ends that oriented organic matter toward evolutionary fecundity, we could not continue to find—by means of empirical epistemology—this purpose, or perhaps others, at work in the later clades of the evolutionary branches.

Kant then concluded this section by turning to the question of the evolution of organic life from inorganic matter. Such ideas had been known as "spontaneous generation" to speculative philosophers for centuries, but Kant here sought to reconsider them in terms of the teleological power of judgment, perhaps as if to return to and reevaluate his earlier ideas in *Universal Natural History* where the *deus ex machina* was opted against in favor of metaphysical teleology. Thus, Kant was investigating whether certain conclusions which would distinguish between these several alternative views—viz., organic life from inorganic matter; organic life only from organic matter; organic life only from other life—could ever have a sound epistemological basis to make determinate conclusions:

> "This kind of generation is not absurd, as in generatio aequivoca, which is the production of an organized being by the mechanics of crude, unorganized matter. Rather, this generation would still be a generatio univoca in the most general sense of the world, because anything organic would be produced only from something else that is also organic, even though different in kind from it among beings of that type, as when, e.g., certain aquatic animals developed gradually into marsh animals and from these, after several generations, into land animals. This is not inconsistent a priori, in the judgment of mere reason. Experience however does not show an example of it […]. As far as our empirical knowledge of nature goes, we do not find anywhere a generatio heteronyma" [22] (p. 305).

It is again evident from these statements that Kant was particularly concerned with the philosophical reasoning that allowed natural scientists to reach such conclusions about biological evolution. He reiterated this evaluation in the remainder of this paragraph:

> "Even some of the changes that certain individuals of the organized genera undergo accidentally have to be judged in this way. If we find that the altered character of these individuals becomes hereditary and is taken up into their generative force, then the only proper way to judge it is as the occasional development of a purposive predisposition that was originally present in the species" [22] (p. 306).

His conclusion, derived by means of the "reflective judgment," was that variations in heredity must also be considered from the teleological point of view. Based on Kant's logical analysis, he was thus able to distinguish inorganic "mechanism" from organic "teleology" and argue that these metaphysical aspects are essential to the production of a science and philosophy of biology. Michael McNulty has recently further contended that this teleological property evident in the evolution of species enables the possibility of a philosophical understanding for establishing both a "science for humans" and a "science for gods," in that our empirically conditioned perception of teleology leads us to questions about the ultimate, perhaps

"divinely" created, origin of species in matter itself [25].

It is essential to note, however, that the distinctive organic teleology Kant had proposed—i.e., that an evolving species should be considered to be endowed with intrinsic purposes—must not be read as a teleological influx of divine influence on the species' material structure, but rather by which it is both the reciprocal "cause and effect of itself." As Lucas Mix has argued, this is a perspective that "opened the door for the recursive process of natural selection as environments and genes shape one another through intermediary phenotypes and populations" [26] (p. 62). Similarly, Rama Singh has noted that "since organisms drive their evolution through organism-environment interactions and are not passive participants, any laws of biology must be the result of 'self-causation'" [27] (p. 263). In support of this reading, Kant had also noted in paragraph §LXXX.420 that the archaeologist of biology must research these evolutionary processes "according to all the natural mechanisms he knows or suspects," and thus it is obliquely evident that Kant had never placed mechanism and teleology into a strict opposition, but rather as two related methodologies in scientific investigation. This important perspective both aligned his statements with Darwin's evolutionary theory and also led to many further questions for subsequent readers of the Kantian corpus in the 19th-century. As this paper will show, their debates might have been better clarified by integrating these later ideas from his 1790 text with the earlier 1755 *Universal Natural History*.

3. Nineteenth-century perspectives on Kant's theory of evolution

In an article published in 1820 entitled "Einwerkung der neuoen Philosophie" ("Incorporation of the New Philosophy"), Goethe recounted that when the *Critique of Pure Reason* was being disseminated throughout Germany, he had been "present at many a conversation on the subject" [28] (p. 1) and that as he made "serious inquiries into the formation and transformation of organic natures, again he returned to the Kantian doctrine" [28] (p. 1) to frame his theory of transformation and evaluate his methodology. Furthermore, around this time of his life, as he recalled: "the *Critique of Judgment* came to my attention, and to it I owe[ed] a most joyful epoch of life. Here I saw my most disparate occupations juxtaposed, works of art and natural products treated one like the other; aesthetic and teleological powers of judgment illuminated each other alternately" [28] (p. 1). Such statements by Goethe in his 1820 article have led to it being characterized as "a virtual hymn of praise to the *Critique of Judgment*" [29] (p. 36). As other reviewers have further noted, "both men agreed that the enterprise of reading God's intentions off of the systematic structure of nature […] was worthy of criticism" [30], (§3.2), and as such, Kant's and Goethe's naturalistic, evolutionary ideas were generally evident to their readers. Thus, there certainly are multiple suggestive ideas shared between the two philosophers. Yet Goethe, despite his formation under Kantian philosophy, appears nonetheless to have never specifically recognized the metaphysical concepts from *Universal Natural History*.

Arthur Schopenhauer (1788–1860) came to know of Kant's philosophy through Johann Fichte (1762–1814) and, unlike Goethe, placed the *Critiques* themselves in opposition to evolutionary theory. When he published *World as Will and Representation* (Die Welt als Wille und Vorstellung) in 1844, he emphasized his

reading that "the quality of the universal forms of intuition, which was discovered by Kant [...] is certainly very important" [31] (p. 8). Initiating his evaluation of evolutionary theory in terms of the transcendental categories of the first *Critique*, Schopenhauer wrote further that the philosophy of "simple materialism […] in order that it may evolve organic nature and finally the knowing subject from it […] entirely disappears if we think the subject away" [31] (pp. 34–35). Focusing on the subjective aspects of the Kantian transcendental theory of knowledge thus led him to dissociate Kant's evolutionary philosophy from the scientific method he employed to justify it. As Marco Segala has noted, Schopenhauer was unable to resolve "the friction between a metaphysical account that would easily describe unity and continuity in nature and scientific theories that, on the contrary, underlined discontinuities between inorganic and organic nature and even between human and non-human animals" [32] (p. 111). While Goethe had at least found the *Critiques* amenable to his theory of epigenetic and morphological evolution, Schopenhauer did not find Kantian philosophy at all compatible with evolutionism; perhaps his analysis might have been different had he studied *Universal Natural History*.

Hans Christian Ørsted's (1777–1851) *Soul in Nature* (Der Geist in der Natur), published in 1852, presented an extended narrative of cosmic evolution, which he based on the geological and fossil records. He began noting that "the planets were in a state of vapor before they became liquid" and that "many thousands indeed perhaps millions of years […] preceded the formation of the first organic bodies on the earth," represented in "the oldest strata" [33] (p. 170). Ørsted then theorized about the emergence of life: "More organic forms were continually developed, sunlight so favorable to the life of plants increased, and the atmosphere became better adapted to the life of animals," which was evident from "the remains preserved in the earth, a series of forms more and more developed which succeed one another till at length that condition was prepared in which man and the animal and vegetable world […] could prosper" [33] (p. 171). Of course, Kant, as one of the most well-known, celebrated philosophers of Germany at this time, made his way into the text too; however, Ørsted recognized only Kant's methodology from a 1786 publication: "It is evident that we must often take refuge in those experimental ideas that hitherto we have too much overlooked. Kant has given us, in his *Metaphysical Rudiments of Natural Science*, the most beautiful examples of this representation, yet without bringing forward the view introduced here" [33] (p. 460). No references, however, were made by Ørsted to Kant as an evolutionist, either from *Universal Natural History* or the third *Critique*.

On 10 August 1864, Ernst Haeckel (1834–1919), having read *Origin of Species* (1859), wrote to Charles Darwin (1809–1882), with the following note: "Our greatest philosopher, Kant, also spoke in favor of the 'theory of epigenesis,' as he expressly calls it. In fact, all possible organic natural phenomena, both in animal and plant life, are explained so simply and harmoniously by it that I cannot understand how so many knowledgeable naturalists can still be your opponents" [34] (p. 299). Haeckel followed up years later, in a response to a letter he received from Darwin, with a second note on 9 November 1868, here quoting an extended passage from Kant's *Critique of Judgment* as evidence of his support for evolutionary theory [35]. Darwin and Haeckel would continue to exchange letters for a number of years (over 100 letters addressed and received), while Haeckel devotedly promoted the reading of Darwin in Germany.

John Stowell has noted that, "Darwin had his fair share of German converts, but none so important, and none so vociferous, as Ernst Haeckel," whose campaign was in no small part motivated by his having found "Darwin's thought located within a German intellectual genealogy" [36] (p. 519). Nonetheless, Haeckel did not make any acknowledgement to Darwin about the ideas of Kant's *Universal Natural History*.

Around this same time, Friedrich Lange (1828–1875) published in 1866 an influential treatise entitled *History of Materialism and Critique of its Significance in the Present* (Geschichte des Materialismus und Kritik seiner Bedeutung in der Gegenwart). Here, a marked shift in the academic mood appears to have taken place. Lange introduced Kant's 18th century school of philosophy as having "made the enormous mistake of assuming that the original forms of the judgment were known or proven, while we are faced with one of the most difficult problems of the future" [37] (p. 270). Lange believed that while "the great man was as completely wrong as any metaphysician has ever been, the illumination of his errors can only serve to put the value of his basic idea in an even brighter light" [37] (p. 248). As Lange argued, "The dogmatic materialist will ask: what the purpose of transcendental categories is if they are not allowed to have any influence on the course of the positive sciences; he will suspect that they will slip back into the area of research, through some back door, and oppose the progress of the sciences" [37] (p. 271). Having presented an extended criticism of Kantian philosophy, he praised Darwin as having "taken a mighty step towards the completion of a natural philosophical world view" and that with his writings, "we now have the actual core questions of materialism before us" [37] (p. 399–400). This text by Lange, although largely forgotten now, was broadly influential in Germany in the late 19th century [38]—but was again based primarily on the first and third *Critiques*—without analysis of the *Universal Natural History*.

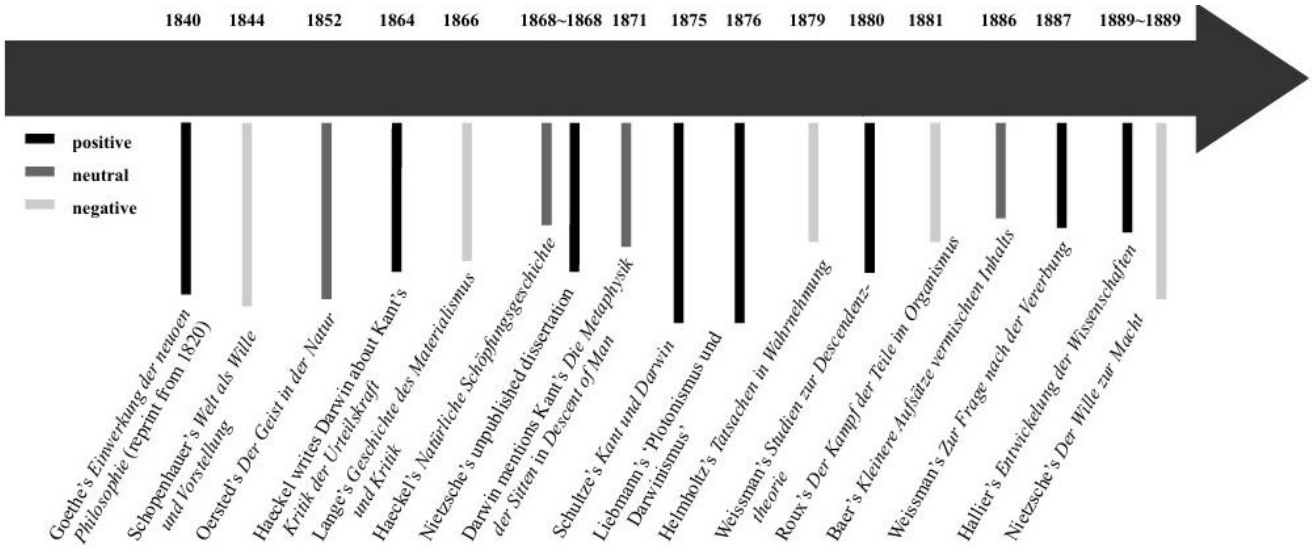

Figure 1. Timeline relating Kantian philosophy to Darwin's theory of evolution.

As can be clearly seen in this chronology of the associations studied between Kant and Darwin (**Figure 1**), the German academic public had begun to closely follow these topics in comparative philosophy. In 1868, Ernst Haeckel's two volume *History of Creation* (Natürliche Schöpfungsgeschichte), subtitled: *Scientific Lectures for the*

general public on the Theory of Evolution in general and that of Darwin, Goethe and Lamarck in particular, appeared in Germany. Having written to Darwin about Kant previously, Haeckel now opted to leave out from the subtitle Kant, whom he had so proudly championed previously. It seems that Haeckel had developed a few misgivings about Kant's views about teleology at this point, but nonetheless would defend Kant as a proponent of the Darwinian worldview in the main text. He again considered Kant's *Critique of Judgment* §80 to be "his most important biological work," but characterized it as having a "dualistic point of view" [18] (p. 102), in that inorganic matter could be explained entirely mechanistically, while organic matter, for Kant, required the recognition of teleological properties. Nonetheless, Haeckel emphasized that for Kant "the right of human reason to explain all phenomena mechanically is unlimited, he says, but its power is limited by the fact that organic nature can be conceived only from a teleological point of view" [18] (p. 102). Further, Haeckel was keen to cull a passage from Kant wherein he "expressly asserted that, without it (i.e., the principle of mechanism), there can be no natural science at all; this principle is quite inseparable from our non-miraculous history of creation" [18] (p. 37). He concluded the book's discussion of Kant by predicting that "Kant would have been delighted and indeed in the domain of organic nature" [18] (p. 131). Again, for Haeckel, Kant's philosophical commitments presented no insurmountable obstacles and arguably predisposed it toward Darwinism, even if his analysis was overlooking key passages from *Universal Natural History*.

Another important student of these debated ideas was the young Friedrich Nietzsche (1844–1900). In the spring of 1868, he began drafting a dissertation "The Concept of the Organic According to Kant" ("Der Begriff des Organischen sest Kant"), a project which he later abandoned, though he left about thirty pages of notes for posterity to read. His acquaintanceship with Darwin's theory, Pieter Mostert asserts, was only through Lange's 1866 text on materialism, and moreover, based on his studies of Kant, "he was not resigned to the general opinion that Darwin's theory was the new creed" [39] (p. 239). Even later in life, Nietszche only read an 1877 essay by Darwin and continued to rely on Lange's 1866 text as "his manual of philosophy" [39] (p. 239). Other works influential on the young Nietzsche for his philosophical appropriation of Darwinism—which became more important in his later writings—included those by Kuno Fischer (1824–1907) and Friedrich Ueberweg (1826–1871), as well as the ancient Greek philosophers Empedocles (5th cent. BCE) and Democritus (5th–4th century BCE). In a detailed assessment of Nietzsche's notes for this unpublished dissertation, Sebastian Gardner noted that Kant's "Critique of Teleological Judgment" was "referred to more frequently than any other text" and led him to make several conclusions: (1) Nietzsche agreed with Kant that the concept of an organism is not simply an empirical concept; (2) Nietzsche followed Kant's argument that teleological features cannot be discovered from material or mechanical processes; (3) both contended teleology is based on the subject's dispositions; and (4) both considered teleology to be bound up with broader philosophical issues [29] (pp. 29–31). The unpublished dissertation as such represents an important document in the 19th-century German attempt to integrate Darwinian evolution with the tenets of Kantian philosophy. However, key ideas from Kant's earlier writings were still being overlooked.

In 1870, Darwin himself received encouragement from a correspondent, Frances Cobbe (1822–1904), to read Kant's *Metaphysics of Morals* (Die Metaphysik der Sitten, 1797). Responding to Cobbe's letter, Darwin contrasted "the great philosopher looking exclusively into his own mind," and his own view, "a degraded wretch looking from the outside thro[ugh] apes & savages at the moral sense of mankind" (23 March 1870) [40] (p. 81). The next year, in the publication of *The Descent of Man* (1871), Darwin noted that "a struggle may often be observed in animals between different instincts, or between an instinct and some habitual disposition" [41] (p. 83), but that as "the power of self-command becomes strengthened by habit, and as the power of reasoning becomes clearer so that man can appreciate the justice of the judgments of his fellow-men, he will feel himself impelled, independently of any pleasure or pain felt at the moment, to […] say, 'I am the supreme judge of my own conduct,' and in the words of Kant, 'I will not in my own person violate the dignity of humanity'" [40] (p. 86). Contemporary writers are inclined to also find a possible complementarity between Darwinian and Kantian approaches to ethics [42], even though the one begins naturalistically and the other transcendentally. Anecdotally, Kant had elsewhere (in a 1798 text) outlined views similar to Darwin's view of the struggle between habits: "The education of the human race is wholesome, but harsh and severe; it requires many efforts and transformations of nature, which extend almost to the destruction of the whole race, to produce from the disunited and self-contradictory evil a good that man did not intend, but which, once being present, preserves and maintains itself" [43] (p. 241). Unfortunately, however, Darwin's *Descent of Man*, though acknowledging the transcendental German philosopher, did not make any specific reference to Kant's evolutionary theories from *Universal Natural History*, the *Critique of Judgment*, or other publications.

The book *Kant and Darwin* (Kant und Darwin) written by a philosopher named Fritz Schultze (1846–1908) was published at Jena in 1875. Schultze had read Haeckel's defense of Kantian philosophy as a precursor to Darwinism and even contended that his own treatise would show that Haeckel "did not even remotely exhaust the supply of weapons forged by Kant that can be used for the theory of evolution [...] in the large, multi-faceted structure of Kant's works" [16] (p. 2). First considering the philosophical aspects of Kant's texts relevant to Darwin, Schultze noted that "Kant's train of thought is clear: […]. A truly philosophical science in the explanation of nature and its individual phenomena should never appeal directly to God as a creator who intervenes directly in the course of the world, nor should it apply physico-theological, i.e., teleological, explanations, rather it becomes more philosophical to the extent that it tries to derive everything from purely mechanical causes, and indeed from as few generally valid natural laws as possible" [16] (p. 32). Schultze argued that Kant had established this philosophical requirement from the *Regulae philosophandi* of Isaac Newton (1642–1726), though other sources might have also influenced him as well [44]. Schultze also addressed the growing scholarly disputes in the German public related to this subject: "If today's so-called Darwinists claim more than Kant does here, they are just as transcendent and dogmatic as any of the philosophers and theologians they characterize as dogmatic; the critical Kant is entirely on the side of those who, according to the principle of affinity, accept the continuous ladder of creatures in a regulatory hypothetical manner as a heuristic

principle, as a maxim of reason, in a word, critically" [16] (p. 83). Among the publications that this text had championed on Kant's behalf were his "Essays on Race" (1775), which because of Shultze's influence were taken up by Johannes Unold (1860–1935) in his sociological theories of evolution [45] (pp. 69–70). However, even in Schultze's protracted and influential text, the earlier *Universal Natural History* and its core ideas had perhaps still not received their due contextualization and analyses.

The next year, another contributor to this discussion of Kantian and Darwinian philosophy appeared in the person of Otto Liebmann (1840–1912), who published in 1876 an extended essay "Plotonismus and Darwinismus" for his *Zur Analysis der Wirklichkeit*. A recent review by Baedke et al. has noted that Liebmann had seen how "a materialist worldview helps in understanding the mechanistic basis of species transformation, but [that] it is a poor philosophy to address deeper questions, like the difference between living and non-living" [46] (p. 345), thus leading him to revisit Kantian philosophy. In his 1876 essay, he had written that "The idea of a gradual humanization of the ape can also be found clearly expressed by Kant […] One is amazed at Immanuel Kant, the serious idealist, as the forerunner of the notorious monkey theory" [47] (p. 341). In a later section of the text, Liebmann proceeded on this line of thought: "But how should the controversial question of Plato versus Darwin be brought to a decision?" He continued: "I believe that the controversy between Plato and Darwin is incorrectly posed […]. Here, the eternity of generic forms; there, the causal origin and genetic development of the same; they should be able to exist side by side" [47] (p. 347). According to Frederick Beiser, "Liebmann's aims were not counter-revolutionary," and his given task was only "to reconcile these warring parties, so that [they] could live in harmony" a project that also would cite neo-Kantian ideas of "dualism between the natural and normative, the phenomenal and noumena" [48] (p. 441). Again, however, Liebmann, like so many others, had failed to connect the concepts of *Critique of Judgment* to Kant's earlier ideas in *Universal Natural History*.

Perhaps among the most important German "scientist-philosophers" of the 19th-century, Hermann von Helmholtz (1821–1894) was notable for his Kantian studies early in his career, having made a commemorative address at the University of Königsberg on the 50th anniversary of the philosopher's death, in which he presented Kant's theory of planetary evolution from *Universal Natural History* as a significant forerunner to a similar theory by Pierre-Simon Laplace (1749–1827) [11]. However, this changed later in his career and is evident from such statements as "Kant was not critical enough in his critique; but of course, it was a matter of mathematical theorems, and this piece of critical work had to be done by mathematicians" [49] (p. 152). While Helmholtz had originally begun his famous investigations into the neuroanatomy of perception because of Kant's philosophy of the inaccessibility of the 'ding-an-sich,' or 'thing-in-itself,' he later reasoned that the evolution of the mental faculties (e.g., "reflective judgment") needed for empirical research was also inaccessible in Kant's philosophy [50]. As such, the empirical basis needed to substantiate Kant's theory of evolution in *Universal Natural History* was actually undermined by his later transcendental epistemology. Such criticisms—perhaps like those of Schopenhauer and Lange—made Helmholtz a critic of even Kant's *Critiques*. Thus, Kant's later texts intended to salvage the evolutionary ideas of *Universal Natural History* left his original ideas even more obscure.

Two public lectures delivered in the 1860s and 1870s by the Russian-German biologist Karl Von Baer (1792–1876), and published posthumously in 1886, directly addressed Darwin's theory in light of Kantian philosophy. While advocating for mechanistic explanations, Von Baer "directed his attention toward identifying the irreducible organizational forms postulated by Kant […] to identify concretely the associated predispositions (anlagen)" [51] (p. 18). These forms, Von Baer demonstrated, had been clearly seen among the common patterns of embryology found among diverse animal species. Making an analogy to music, he argued that harmony can only result from set intervals but that random frequencies would only sound jumbled; this Von Baer contended was in a qualified sense opposed to Darwin's theory of chance. Yet in a second lecture, Von Baer clarified that while "Kant taught that all parts of an organism are both purpose [zweck] and means," his own views were different; instead, his analysis had demonstrated that all parts of an organism are "goals [ziele] and means" and that "purposes [zwecke] do not exist in nature; there are only necessities in it; and does not want to recognize that these very necessities are means to ends." [52] (p. 14). Interestingly, the French biologist Claude Bernard (1813–1878) would cite Von Baer's ideas as part of his alternative protoplasmic hereditary process in opposition to Darwin's theory of blind chance [53]. Yet Von Baer had written on "ziele" and "zwecke" to align his ideas with Darwin and distinguish a certain aspect of his teleology from Kant's. This example demonstrates just how important these nuances are for such philosophical studies and also why continued research on Kant's own ideas (including those from *Universal Natural History*) is essential.

The influential biologist August Weismann's (1834–1914) interactions with Kantian philosophy were less pronounced than those of Haeckel, but he still found it appropriate to include references in at least two texts, first in *Studies in the Theory of Descent* (Studien zur Descendenztheorie; 1875–1880). Here Weismann noted that considering the mechanistic explanations of life, "a chain of necessities is undoubtedly connected with a teleological force […]. If we apply this argument to the development of the organic world, those who defend mechanical development will not be compelled to deny a teleological power, only they would have, with Kant, to think of the latter in the only way in which it can be conceived, viz., as a final cause" [54] (p. 709). Later, in an 1888 essay "On the Question of the Inheritance of Acquired Characteristics" ("Zur Frage nach der Vererbung erworbener Eigenschaften"), Weismann wrote: "Concerning a certain class of acquired characters, viz. mutilations, the great German philosopher Kant has distinctly denied that transmission can take place." He continued: "If the transmission of acquired characters is truly impossible, we must completely abandon the Lamarckian principle, while the principle of Darwin and Wallace, viz., natural selection, will gain an immensely increased importance" [55] (pp. 434–435). Thus, Weismann's texts defended not only the Kantian versions of mechanism and teleology from *Critique of Judgment* but also aspects of his scientific theory of evolution of hereditary (versus acquired) characteristics from his *Lectures on Anthropology*. However, Weismann did not consider the evolutionary ideas of *Universal Natural History*. Nonetheless, through his students John Scott Haldane (1860–1936) and colleague D'Arcy Wentworth Thompson (1860–1948), Weismann influenced a later generation of bio-philosophers to study these questions of teleology and reflective judgment posed by Kant and arguably led to an "approach [that] was

more accurate to the overall stance taken by Kant himself" [56] (p. 52).

In 1889, biologist Ernst Hallier (1831–1904) published his *Cultural History of the Nineteenth Century: The Development of the Natural Sciences* (Kulturgeschichte des Neunzehnten Jahrhunderts [...]). Early in his career, Hallier had attempted to reconcile the Kantian transcendental categories with natural selection, but this later work presented his ideas to a more general audience. Here he introduced Kant's philosophy as that "through which Newton's world view is reconciled with the Platonic one" and which distinguished "the appearance of things from their true essence in themselves" as a corrective to Leibniz's philosophy [57] (p. 78). Dualism, according to Hallier, was antithetical to science, and the "Kantian doctrine [was] the only one that can claim to be called monism" [57] (p. 793). Unfortunately, he wrote, "why then do natural scientists not generally profess this Kantian view? […] Because the natural scientist of our day rarely has the time, even more rarely the talent, to study and understand the discovery of transcendental idealism which led the great philosopher to that worldview" [57] (p. 793). Turning to the application of the scientific method in biology, Hallier listed Goethe, Erasmus Darwin (1731–1802), Geoffroy de Saint Hilaire (1772–1844), and Pattrick Matthew (1790–1874) to show that "the theory of evolution was already in the air during the first half of our century and that it only took a genius like Darwin to trace the new theory all the way to its most distant roots" [57] (p. 324). Moreover, in another passage, Hallier considered Kant to be among this number of forerunners of Darwin, since he "saw the formation of species as an undeniable fact, and therefore, called this law, a law of empirical origin, but of metaphysical significance" and had also demonstrated "the reasons for species formation in nature" and "that the law of specification can be justified just as firmly and securely as any other law of nature" [57] (p. 319). The zeitgeist behind the current project's energetic discussions, he still attributed to Darwin, whose "teachings had a tremendous impact on science" [57] (p. 336), but Hallier also noted that "centuries of work will have to be done on the complete induction series" [57] (p. 405). All such research would require Kant's metaphysical, monistic (as opposed to dualistic) methodology for this scientific undertaking, primarily referencing the *Metaphysical Foundations* and Critiques. Nonetheless, despite such detailed analysis, Hallier had still largely overlooked the importance of *Universal Natural History*.

Nietzsche's early encounter with Kant and Darwin became drastically shaded later in life through his well-documented reading of Wilhelm Roux's (1850–1924) book *The Struggle of Parts in the Organism* (Der Kampf der Teile im Organismus; 1881), a response to the Darwinian theory of evolution, proposing an alternative mechanism in which the struggle to survive occurred at the cellular level. Suggestions of Roux's supposed anti-Darwinian influence can be found in Nietzsche's works throughout the 1880s, including *Die fröhliche Wissenschaft* (1882) and *Also sprach Zarathustra* (1883–1885) [58], but the question was presented more boldly in his work *Will to Power* (Der Wille zur Macht) compiled circa. 1890: "I always see before me the opposite of that which Darwin and his school see or want to see today: selection in favor of the stronger, better-constituted, and the progress of the species." He continued to note that "precisely the opposite is palpable: the elimination of the lucky strokes, the uselessness of the more highly developed types, the inevitable dominion of the average, even the sub-average types" [59] (p. 8). Moreover, it is evident that at

this time Nietzsche had taken a turn against Kant too, whom he called the "elusive, pale, Nordic, Königsbergian" [59] (p. 6). Published in this veiled language of *Twilight of the Idols* (Götzen-Dämmerung) in 1888–1889, here he regarded Kant's *Critique of Judgment* as perhaps both a proponent of unscientific teleological progress, and as philosophizing the inaccessibility of the 'ding-an-sich" (things-in-themselves), which would limit research in Roux's hypothesis of the cellular struggle for survival.

Similar reviews of Kant and Darwin have continued after these chronologically listed here, in the following decades and up until the present, both in German and English sources, and with the increasing literature, many of the earlier discussions have now been largely lost in contemporary scholarship. Notable detractors of Kantian philosophy have emerged in an increasing preponderance in the English-speaking world, a turn perhaps initially exemplified by David Ritchie (1853–1903) in *Proceedings of the Aristotelian Society*: "In Kant as a philosopher, the idea of evolution, and indeed the whole conception of historical growth, is conspicuously absent […]" [60] (p. 57). Weighing all of these citations to 19th-century reviewers of Kantian and Darwinian philosophy in sum, this paper would count that: 7 would support Kant as a precursor to Darwin's natural philosophy (Goethe, Haeckel, young-Nietzsche, Schultze, Liebmann, Weismann, Hallier); 4 have negative conclusions about their compatibility (Schopenhauer, Lange, Helmholtz, old-Nietzsche); and 3 are neutral on any similarities (Ørsted, Darwin, Von Baer). Such considerations at this juncture having been drawn out, it might provide valuable insight to take a closer look at Kant's earlier text *Universal Natural History* and the additional sources associated with it.

4. The influences of Ralph Cudworth on *Universal Natural History*

Numerous texts had influenced Kant's 1755 publication *Universal Natural History*, including works by René Descartes (1596–1659), Gottfried Wilhelm Leibniz (1646–1716), Comte de Buffon (1707–1788), and perhaps others that Kant either owned or had access to: Thomas Burnet (1638–1704), Edmund Halley (1656–1741), William Derham (1657–1735), John Woodward (1665–1728), William Whiston (1667–1752), Emanuel Swedenborg (1688–1772), Pierre Maupertuis (1698–1759), Thomas Wright (1711–1786), etc. [61]. However, and importantly for this paper, none of these commonly listed influences contained a key philosophical concept that was an integral part of the *Universal Natural History*, specifically, the Greek idea of the *deus ex machina*, used to explain unnatural origins for processes in the physical world. Another philosopher—Ralph Cudworth (1617–1688), whose book Kant personally owned (see **Figure 2** below) and whose clear influence other contemporary scholars have previously noted—might have been the source.

Cudworth held the position of the Regius Progressor of Hebrew at Cambridge, but he became notable as a Platonist philosopher and an opponent of Thomas Hobbes' (1588–1679) philosophy. His magnum opus was entitled *True Intellectual System of the Universe* (1678) with the plan of three parts; however, he died before completing it. Kant's version in his personal library was its 1733 Latin translation by Johann Lorenz Mosheim (1693–1755), with several discrepancies between it and the original text and appended notes by Mosheim. However, this Latin translation was later

rendered back into English by John Harrison in 1845, so this paper will quote from Harrison's translation as it contains the exact text in Kant's library. The *Stanford Encyclopdia of Philosophy* has noted on this book's possible influence that the "link to Kant through the Jena connection remains to be explored" [62] (p. 1). Besides (1) the *deus ex machina* references which Kant appears to have taken from Cudworth's text, there were two other sections of *True Intellectual System* that conceivably influenced Kant: (2) the philosophical basis behind the necessity of any species' existence in the natural order (both authors refer to the questionable necessity of fleas in their texts); and (3) the concept of 'plastick nature' as a mediating influence between God and the world to explain the origin of biological life.

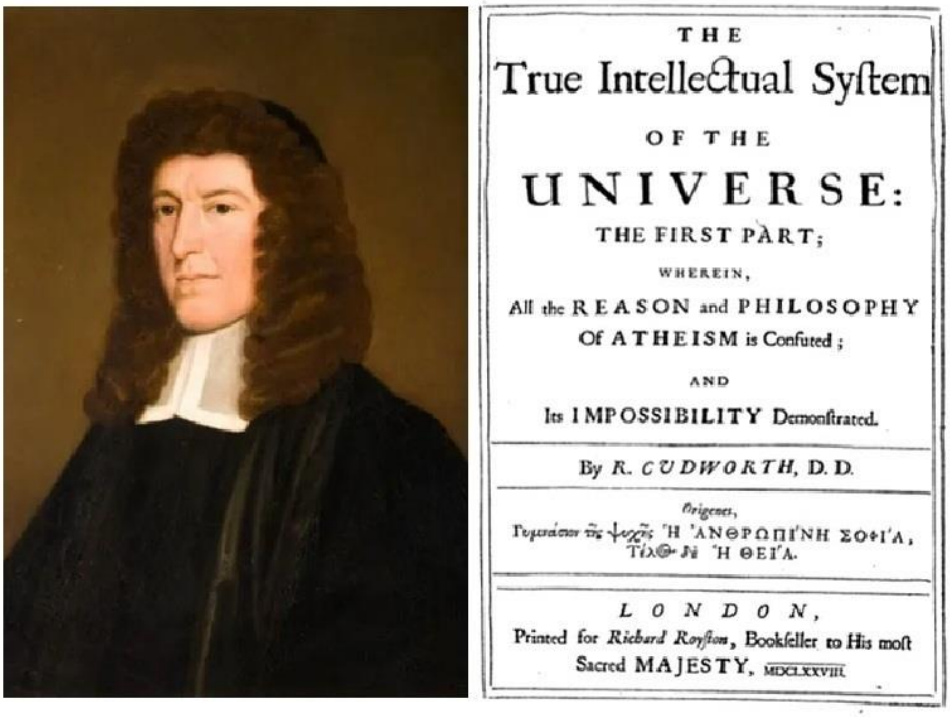
THE
True Intellectual System
OF THE
UNIVERSE:
THE FIRST PART;
WHEREIN,
All the REASON and PHILOSOPHY
Of ATHEISM is Confuted;
AND
Its IMPOSSIBILITY Demonſtrated.
By R. CUDWORTH, D.D.
Origenes,
LONDON,
Printed for Richard Royſton, Bookſeller to His moſt
Sacred MAJESTY, MDCLXXVIII.

Figure 2. Cudworth's *True Intellectual System* of 1678 was published posthumously with additions in 1733.

Cudworth had focused his outline on refuting several different types of atheism (hylopathian, atomistic, cosmo-plastic and hylozoist), but the details of these specific refutations were all determined with some reference to the *deus ex machina* concept of classical Greek philosophy:

> "It is altogether unreasonable to suppose there should be no cause in nature for the phenomena, especially for those things that are daily generated, as the bodies of animals; but (as by the tragic poets) a god should be introduced, as it were from a machine, forcibly to solve them. And indeed though there were a God, yet atheists think He ought not to be so detruded to such mean offices as this, viz. to make the body of every the most contemptible animal, as it were, with His own hands miraculously; nor ought nature or the world to be supposed so imperfect, as if it must be bungled and botched up everywhere after this manner. It is nature therefore, that is the cause […]. To all of which we briefly reply; that there are indeed two extremes here to be avoided" [63] (p. 605).

This ancient philosophical concept referenced by Cudworth can be traced to the Greek playwrights Aeschylus (6th–5th cent. BCE) and Aristophanes (5th–4th cent. BCE); it was later critically evaluated by the philosopher Aristotle (4th cent. BCE) and the poet Horace (1st cent. BCE) as an obstacle to causal explanations. Cudworth's via media (middle ground) solution to the conflict posed by it will be discussed further along in this section.

It is important to read that later in this same text Cudworth referenced the *deus ex machina* concept again, a passage making more apparent his commitment to its metaphysical reality, and demonstrating that he intended it to be a part of his solution to the conflict about the atheistic/theistic perspectives on the origin of species:

> "Thus do we see, that there is nothing in the world so monstrous nor prodigiously absurd that men, atheistically inclined, will not rather imagine and swallow down, than entertain the notion of a God. Wherefore, here is 'dignus vindice nodus,' and this phenomenon of the first beginning of mankind, and other greater animals, cannot be solved otherwise, *than* according to the Mosaic history, by admitting of θεός ἀπὸ μηχανῆς [*deus ex machina*], 'a god out of a machine,' that is, an extraordinary manifestation of the Deity, 'in forming man and other animals, male and female, once out of the earth; and that not in a rude, tender, and infant-like state, but mature and adult, that so they might be able immediately to shift for themselves, multiply and propagate their kind by generation; and this being once done […] then putting a stop immediately thereunto" [63] (p. 624).

This second reference to the *deus ex machina* was included after Cudworth made a line of argumentation in which he considered that the initially equal numbers of male and female sexes formed in the natural order could not have occurred by chance alone; it required God's intervention. Thus, any ambiguity of the *deus ex machina* in the first reference appears here as an authorial determination to make certain his solution between the disputing atheists and theists. Both references should also be underscored by historians to note it as a significant textual source for the re-appropriation of an ancient (and often overlooked) Greek philosophical concept. When taken with Cudworth's references to the "plastic nature" molded by God, his philosophical and theological bias is immediately understood by the reader.

Published in the midst of this emerging flourish of academic interest in the formation of planets and their chemical and biological evolution, Kant's preface to his 1755 work (**Figure 3** below) made clear his intention and whose views he aligned his own with. His stated goal, "to derive the formation of the celestial bodies themselves and the origin of their motion out of the first state of nature through mechanical laws," was one that he knew would lead to "religion threatening us with the solemn accusation of the audacity" [64] (p. 194). This being the case, Kant was "concerned to find protection for the atheist in the forwardness of such observations;" he declared that he perceived "all these difficulties clearly," and yet was "not faint of heart" because he "dared to undertake a dangerous journey on the basis of a slight supposition and already [could] see the foothills of new lands" [64] (p. 194). It is interesting to note at this juncture that Kant was philosophically open to challenging his own thoughts and making daring suppositions, even at this early point in his writing career. While most of this text is concerned with solar planetary formation, Kant also appended a chapter about the possibility of inhabitants of other planets. This section of

the text is highly suggestive of evolutionary mechanisms for the emergence of such extraterrestrial life, although Lovejoy has contended that at this time, "the manner of the original formation of plants and animals […] had never been accounted for by any philosopher with any tolerable success," and that "this was substantially the attitude Kant adopted" [12] (p. 552). Fisher in the recent compilation *Kant's Theory of Biology* has noted the background debate of preformation versus epigenesis at the time in which Kant was writing, and perhaps some of the text's ambiguities about evolution represent Kant's hesitancy to directly engage these competing theories until a later publication [19]. In this same collection, McLaughlin has read this text as outlining the evolutionary "processes as completely natural, and Kant had no qualms about propagating something like spontaneous generation of the first inhabitants of countless planets as soon as the physical conditions were right" [65] (p. 157). More recently, Vereb has argued that *Universal Natural History* is best characterized as presenting a theory of "emergent materialism […] in a dynamically changing, fundamentally active cosmic context" [66] (p.20).

Figure 3. Kant's 1755 *Universal Natural History* was re-published in 1791 (abridgement), 1798 and 1808.

It is important, nonetheless, to consider the specific language employed by Kant in *Universal Natural History* with regard to the emergence of life:

> "Although it may seem that in this type of subject the freedom to invent has no real barriers and that in judging the nature of the inhabitants of distant worlds we can give free rein to our fantasy with far greater liberty than a painter in the depiction of plants or animals of undiscovered lands, and that thoughts of this type could be neither properly proved nor disproved; we nonetheless have to admit that the distances of the heavenly bodies from the Sun include certain relations that contain an essential of the various properties [that are] tied to and

> dependent on the number of impressions that the world awakens in them according to the properties of the relation of their abode to the centre point of attraction and of heat. I am of the opinion that it is just not necessary to assert that all planets must be inhabited. Even though it would be nonsense to deny this in regard to all or even only most of them" [64] (p. 295).

This dynamic, but still under-determined, process described above, as Kant proceeded to state in the next section, appeared to him to have taken place in "deep time," a theory for which natural scientists of that era, such as Leibniz, Buffon, and others, were just then beginning to find indirect evidence [67]. *Universal Natural History* states:

> "Perhaps our Earth existed for a thousand or more years before it was constituted so as to support people, animals, and plants […]. The infinity of creation encompasses in itself, with equal necessity, all natures that its overwhelming wealth produces. From the most sublime class among thinking beings to the most despised insect, not one link is indifferent to it; and not one can be absent without the beauty of the whole, which exists in their interrelationship, being interrupted by it. Meanwhile, everything is determined by universal laws which nature effects by the connection of its originally implanted forces […]. If the constitution of a heavenly body puts obstacles in the way of the population, it will be uninhabited, although in and of itself it would be better if it were inhabited. The excellence of creation loses nothing thereby […]." [64] (pp. 296–297).

Moreover, regarding the existence of deep time and this process of emergence or re-emergence of biological life on other planets, Kant considered such properties to have been intrinsic to matter itself: "One way or another, the perfection of all world-orders is threatened by inevitable destruction, we shall find no difficulty in the aforementioned law of their demise by means of the tendency of the mechanical arrangement, which, however, becomes acceptable, principally because it bears within itself the seed of renewal even in being conjoined with chaos" [64] (p. 277).

From these considerations, it is apparent that Kant did not exclude some type of biological evolution in deep time from being under the purview of his naturalistic philosophy. However, he recognized that the logic of this theory presupposed first solar and planetary evolution before biological evolution could occur: "It should therefore not be thought strange if I dare to say that we will understand the formation of all the heavenly bodies, the cause of their motion, in short, the origin of the whole present constitution of the universe sooner than the creation of a single plant or caterpillar becomes clearly and completely known on mechanical grounds" [64] (p. 201). His book followed this organization for its contents, not to deny the possibility of biological evolution, but arguably, it was rather to provide a more sure scientific foundation for the latter theory. Thus, Kant's protracted discussion of cosmic evolution presented in *Universal Natural History* was certainly intended to apply also to his appended discussion of biological evolution later in the text. In other words, reading the text as a whole, Kant's opposition to Cudworth's *deus ex machina*, quoted here, would have been intended to apply equally to cosmic and biological evolution:

> "If one considers that nature and the eternal laws that are prescribed to substances for their interaction […] shows so much correspondence and order in what it produces through universal laws […] then nature will appear to us more dignified

> […]. If, by contrast, one gives credit to an unfounded prejudice, that the universal laws of nature in and of themselves create nothing but disorder and any useful correspondences that shine forth in the constitution of nature points to the direct hand of God, then one is required to turn the whole of nature into miracles […]. Indeed, there will then no longer be any nature; there will be only a *god in the machine* [*Gott in der Maschine*] bringing about the changes of the world […]. On the contrary, let us conclude with greater propriety and correctness as follows: Nature, left to its own universal properties, is fertile [früchtbar] in many beautiful and perfect fruits [früchten] which not only show correspondence and excellence in themselves but also harmonize with the entire realm of their beings, with the usefulness to mankind and the glorification of the divine properties" [64] (p. 281).

It is also interesting that this passage, which appears in Ch.VIII before the text's sections on extra-terrestrial life forms, included terminology more specific to biological life, viz., fertile (früchtbar) and fruits (früchten). Arguably, Kant understood where the logic of cosmic evolution led and the dangerous stance he assumed when articulating a theory of evolution. As such, *Universal Natural History* had positioned itself as a text that aimed to ultimately explain biological evolution without the *deus ex machina* argument; his success has been judged by those who followed, and it continues to find a small number of devoted and supportive readers to this day.

These references to Cudworth's text and Kant's re-evaluations of his theological conclusions are not the only parallels that scholars have uncovered in *Universal Natural History*. Interestingly, both authors had discussed an example of the survival of flea populations to consider the philosophical arguments that motivate theories about the necessity of any particular species in the natural order. An insightful article by Ulrich Lehner in *Brill's Studies in Intellectual History*, Vol. 149 "Kant's Vorsehungskonzept" (2007), has previously noted that these shared references make evident to historians that Kant had Cudworth's text in front of him as he wrote in 1754–1755. However, Lehrer also notes their conclusions are quite disparate. Cudworth's original text had stated:

> "And so fleas and lice, had they understanding, might conclude the bodies of greater animals, and men also, to have been made only for them. But the whole was not properly made for any part, but the parts for the whole, the whole for the maker thereof. And yet may the things of this world be well said to have been made principally, (though not only) for man. For we ought not to monopolize the divine goodness to ourselves, there being other animals superior to us, that are not altogether unconcerned either in this visible creation; and it being reasonable to think, that even the lower animals likewise, and whatsoever has conscious life, was made partly also to enjoy themselves. But atheists can be no fit judges of worlds being made well or ill […]. [R]ailing upon nature (that is, Providence) and calling her a stepmother only to mankind, while she was a fond, partial, and indulgent mother to other animals [...], yet is there nothing but poetic flourish in it all, without any philosophical truth, the advantages of mankind being so notoriously above those of brutes" [63] (pp. 466–468).
>
> Kant's parallel reference is the following:
>
> "After reporting the general news from the realm of the sciences, [Bernard de Fontenelle (1657–1757)] was able to present in a ridiculous way the notion of the

> necessary population of all the celestial bodies […]. '[Lice] on the head of a beggar had long regarded their abode as an immeasurable sphere and themselves as the masterpiece of creation […] suddenly became aware of the head of a nobleman […]. He immediately said: we are not the only living beings in all of nature; behold here a new country, more lice live here.' If this conclusion arouses laughter then it is not because it departs so far from the way humans make judgments, but rather because precisely the same error that is based on the same cause in the case of human beings seems to deserve more of an excuse in their case. Let us judge without prejudice. This insect, which expresses the disposition of most people very well both in the way it lives and in its insignificance, can be used as a comparison with good reason. Because *in its imagination its existence matters infinitely to nature, it considers the whole of the rest of creation as in vain* as far as it does not have its species as a precise goal, as the center point of its purposes. The human being, so infinitely removed from the highest stage of beings is so bold as to allow himself, in a similar delusion, to be flattered by the necessity of its existence" [64] (pp. 296–297, emphasis added).

Elucidating his analysis on Cudworth's evidence, Ulrich Lehner provided the following commentary below, contending that, although it is unmistakably clear evidence that Kant had Cudworth in mind when writing *Universal Natural History*, it is nonetheless demonstrative of the fact that Kant was really outlining a fundamental criticism of Cudworth's system:

> "Since the example of the louse is taken word for word from Cudworth, it seems to indicate that Kant either had his *True Intellectual System of the Universe* in front of him when he wrote the *Universal Natural History*, or at least remembered the passage. Cudworth also criticizes a naive physico-theology that proceeds without considering the whole of creation. Kant criticizes the presumption of man in regarding himself as the goal of creation in his *Critique of Practical Reason*. There, however, he works out that the moral law gives man an infinite value in comparison to the 'infinity of creation' and thus really places him at the center of providence. However, for the critical Kant, this can only be thought of in a practical way. The pre-critical Kant avoids the difficulties of deriving divine intentions from natural phenomena by inferring from physical law as a whole that God is the architect of the world and the supreme principle of form. For Kant believes that *only in physics can a necessary law be abstracted from the complexity of the world*, from which a legitimate physico-theological speculation can be based on the phrase 'before there was a world'" [68] (p. 244, emphasis added).

Cudworth, differing from this, considered the atheistic tendency to make man an un-necessary creature in the divine plan to be a thought "without any philosophical truth." However, Kant's conclusion, as Lehner makes evident, even in this early 1755 text *Universal Natural History*, argued that necessity in creation applies only to physical laws which originated before the world, and man, as a product of the world in time, cannot infer his own necessity from the world around him. These differences between Cudworth and Kant, in contemporary language represent, in a related but slightly modified format, the alternative stances of the "strong anthropic principle," viz., that the created cosmos was made necessarily to produce a world habitable for

man, often represented as the theistic position; and alternatively the "weak anthropic principle," viz., that supposing the world did not evolve to be habitable for rational life, humanity would not even exist to ask why the world is just so for humankind to exist, often a view associated with agnostics [69]. The textual and thematic distinctions between Cudworth and Kant thus shed light on their relationship to modern scientific/philosophical ideas and also can raise further questions about connecting their own concepts to our contemporary ones.

As to Cudworth's middle position between different extreme notions of mechanism of the origin of life, he wrote the following on the concept of 'plastick nature,' which both ancient authors and contemporary writers had considered in various and distinctive ways:

> "Having now declared the Aristotelic doctrine concerning the plastic nature of the universe, with which the Platonic also agrees, that it is, ἢ μέρος ψυχῆς, ἢ μὴ ἄνευ ψυχῆς; 'either part of a mundane intellectual soul,' that is, a lower power and faculty of it, 'or else not without it, but some inferior thing depending on it;' we think it fit to add in this place, that though there were no such mundane soul, as both Plato and Aristotle supposed, distinct from the Supreme Deity, yet there might notwithstanding be a plastick nature, of the universe depending immediately upon the Deity itself. For the plastic nature essentially depends upon mind or intellect, and could not possibly be without it; according to those words before cited: 'Εκ τοιαύτης ἀρχῆς ἤρτηται ἡ φύσις, 'Nature depends upon such an intellectual principle;' and for this cause that philosopher does elsewhere join νοῦς and φύσις, 'mind and nature' both together" [63] (p. 271).

Interestingly, however, Cudworth here proceeded to multiply the number of 'plastick natures' which directly depend upon the will of God, and claimed that these were necessary to explain the order of inorganic and organic matter, thus suggesting multiple openings for divine interaction with the natural world:

> "Besides this general plastick nature of the universe, and those particular plastick powers in the souls of animals, it is not impossible but that there may be other plastick natures also (as certain lower lives, or vegetative souls) in some greater parts of the universe; all of them depending, if not upon some higher, conscious soul, yet at least upon a perfect Intellect presiding over the whole. As for example; though it be not reasonable to think, that every plant, herb, and pile of grass, hath a particular plastick life, or vegetative soul of its own, distinct from the mechanism of the body, nor that the whole earth is an animal endued with a conscious soul; yet there may possibly be, for aught we know, one plastick nature or life belonging to the whole terrestrial (or terraqueous) globe, by which all plants and vegetables, continuous with it, may be differently formed, according to their different seeds, as also minerals and other bodies framed, and whatsoever else is above the power of fortuitous mechanism effected, as by the immediate cause, though always subordinate to other causes; the chief whereof is the Deity. And this perhaps may ease the minds of those, who cannot but think it too much to impose all upon one plastick nature of the universe" [63] (p. 271).

In other words, Cudworth's solution, which opened the first volume of the text and remained thematic throughout, was to posit a number of hierarchical 'plastick principles' that united the various orders of nature (viz., inorganic matter, vegetable

life, animal life) to the ultimate principle of God.

Whether Kant was influenced by or opposed to this 'plastick' concept, as some philosophers have introduced to discussion in contemporary journals, is an important question. Scholarly research by Leonel Ribeiro dos Santos in *Studia Kantiana* (2009) has argued that "The notion of 'plastic nature' by the English Neoplatonists Henry More and Ralph Cudworth […], Kant himself gives the terms 'plastisch,' 'technisch' and 'künstlich' as synonyms" [70] (p. 123). Accounting for the ordered structure of organic nature, Santos contends, might really require an influx of order that is not from mechanical nature. Kant had referenced the term "plastic" once in *Universal Natural History*, but Santos cited passages from *Critique of Judgment* that employed this terminology as evidence of similarities between the two writers and that show "how it becomes possible to appreciate 'nature as art' and 'art as nature' (Natur als Kunst, Kunst als Natur). Both benefit from this reciprocal exchange of predicates between art and nature, since a new understanding has been reached both of nature (no longer merely mechanical) and of human art (no longer merely as something programmed, but as something generated spontaneously […]" [70] (pp. 151–152). Nonetheless, as Santos himself admits, he is not certain whether this reading is a "vicious cycle" or a "virtuous cycle," because Kant had clearly distanced himself from the language of "plastic natures." The following is from *Critique of Judgment*:

> "When we judged aesthetically, no concept of the object was needed, nor was one produced. By the same token, we did not make an objective judgment and declare these objects' natural purposes, but declared them only purposive in relation to the subject […]. In a teleological judgment, on the other hand, we presuppose a concept of the object and judge how the object is possible in terms of a law about the connection of causes and effects. Hence this technic of nature could be called plastic, if that word were not already in vogue in a more general sense, as including not only natural intentions but natural beauty as well. So perhaps we could call it the organic technic of nature, since this expression does stand for the concept of a purposiveness for the possibility of things themselves, not merely a purposiveness for the way we present them" [22] (p. 423).

Again, it seems evident that Kant's metaphysical ordering of the world to explain the emergence of life's sensible features is not in any substantial agreement with Cudworth. However, since the terms 'plastisch,' 'technisch' and 'künstlich' appear throughout works by Kant (including other texts from the 1750s), it might be an interesting journal contribution to more fully explore how these conceptions and terms compare with those of Cudworth. As given here, though, the following are the main features of Cudworth's text which are relevant for a general comparison of it with Kant's *Universal Natural History*—specifically, (1) both discuss the *deus ex machina*, (2) both assess the necessity of any particular biological species in the natural order, and (3) both consider the "plastick nature" theory in alternative ways.

5. *Deus ex machina* and 19th–20th century evolutionary biologists

For Kantian philosophers, it is profoundly interesting to chronicle how the differing views of Kant and Cudworth faired in the generations subsequent to Darwin's publication. Kant has been thoroughly studied for his biological theories in

the *Critique of Judgment*, but this is not the only important point of analysis. Here we will consider the numerous 19th–20th century philosophers and scientists (see **Figure 4** below) who recognized Darwin's rejection of the *deus ex machina* argument as a hallmark of his contributions to scientific thought. As such, Kant's earlier writing in *Universal Natural History*, where he disputed this Greek concept, finds its significant relevance to the philosophy of biological evolution. To begin, let us consider a comparison made between Robert Chamber's (1802–1871) theories and Darwin's which was included in the biography *Charles Darwin* (1885) by Grant Allen (1848–1899), a Canadian science writer and philosopher:

Figure 4. Biologists and philosophers who have recognized opposition to the *deus ex machina* as an essential Darwinian tenet include (first row, L-R): Grant Allen, T. H. Huxley, J. B. Bury, Charles Chamberlain; (second row, L-R): Theodosius Dobzhansky, Ross Ashby, Stuart Shanker, and Daniel Dennett.

> "Chambers himself, in his latest edition [of *Vestiges of Creation* (1844–1860)] before the book was finally killed by the advent of Darwinism, thus briefly describes his main concepts: 'The several series of animated beings, from the simplest and oldest up to the highest and most recent, are, under the providence of God, the results, first, of an impulse which has been imparted to the forms of life advancing them in definite times […]; second, of another impulse connected with the vital forces, tending, in the course of generations, to modify organic structures in accordance with external circumstances […].' Now it is clear at once that these two supposed 'impulses' are really quite miraculous in their essence. They do not help us at all to a distinct physical and realizable conception of any natural agency whereby species became differentiated one from the other. […]

> For many creations, Chambers substitutes one single long creative nisus: where Darwin saw natural selection, his Scotch predecessor saw a *deus ex machina*, helping on the course of organic development by a constant but unseen interference from above" [71] (pp. 70–71).

It is interesting to note that when Chambers' *Vestiges* was translated into Russian, it was highly criticized for these theological aspects, and Russian 'nihilists' as a result notably championed Darwin as the more scientific alternative [72].

Around this same time, Thomas Henry Huxley (1825–1895) wrote in the Obituary Notices of the *Proceedings of the Royal Society* (1888) a similar appraisal:

> "Long occupation with [Darwin's] work has led the present writer to believe that the *Origin of Species* is one of the hardest of books to master; and he is justified in this conviction by observing that although the *Origin* has been close on thirty years before the world, the strangest misconceptions of the essential nature of the theory therein advocated are still put forth by serious writers. […] Strictly speaking, the origin of species in general lies in variation; while the origin of any particular species lies, firstly, in the occurrence, and secondly, in the selection and preservation of a particular variation. Clearness on this head will relieve one from the necessity of attending to the fallacious assertion that natural selection is a *deus ex machina*, or occult agency" [73] (pp. xvii–xviii).

These examples are just two of many scientist-philosophers commenting on this topic regarding Darwin's metaphysical perspective on the *deus ex machina*.

In the beginning of the 20th century, there was a collection entitled *Darwin and Modern Science* (1909), edited by Albert Seward and with contributions from Ernst Haeckel, August Weismann, William Bateson and others, published on the centenary of Darwin's birth and fiftieth anniversary of *Origin of Species*. A historian at Cambridge University named James B. ("J.B.") Bury (1861–1927) also contributed and referenced the *deus ex machina*:

> "The diffusion of the Darwinian theory of the origin of man, by emphasizing the idea of continuity and breaking down the barriers between the human and animal kingdoms, has had an important effect in establishing the position of history among the sciences which deal with telluric development. The perspective of history is merged in a larger perspective of development. As one of the objects of biology is to find the exact steps in the genealogy of man from the lowest organic form, so the scope of history is to determine the stages in the unique causal series from the most rudimentary to the present state of human civilization. […] The success of the evolutional theory helped to discredit the assumption or at least the invocation of transcendent causes. […] Otherwise indeed (as was remarked above) history could not be a science; for, with a *deus ex machina* who can be brought on the stage to solve difficulties, scientific treatment is a farce" [74] (pp. 255–256).

As evolutionary philosophy began to encounter the new political theories that emerged in response to Karl Marx's (1818–1883) writings, it is worthwhile and interesting to note that Abraham Sachs (1877–1931) included a reference to Darwin and the *deus ex machina* in his *Basic Principles of Scientific Socialism* (1927):

> "The philosophical idealists, however widely they may differ in their individual conceptions of the universe, agree on this one general principle—that the Spirit

> existed before external nature. The idealists therefore conclude that the material world did not always exist but was 'created' in accordance with the divine will of the spirit. Their conception is of a *deus ex machina*, a 'divine mind' in which the world exists. The biblical interpretation of the creation of the world is substantially adopted by them […] The evolutionary theory of Darwin, which proves that all living things, plant and animal, have been developed from mere bits of protoplasm, is, in like manner, one of the most forceful arguments against the claims of those who maintain that the spiritual existed before the creation of the material world" [75] (p. 28).

The implications of the *deus ex machina* argument, as these examples demonstrate, were taken up even in the fields of historical and social sciences because of Darwin's theory, and, as such, Kantian philosophy retains its substantial relevance.

Biologist Charles Chamberlain (1863–1943) was notable for having earned the first PhD in botany from the University of Chicago, where he conducted pioneering studies on the microscopic structure of cells and tissues. In his *Gymnosperms: Structure and Evolution* (1935) he also argued that a hallmark of evolutionary theory is its opposition to *deus ex machina* explanations:

> "A few centuries ago people believed that the earth was created suddenly, and that plants and animals were created just as they are today; but no one with any scientific training now believes in such an origin of the earth or its inhabitants. The first living things were simple and, in some way or another, originated from non-living matter. Such simple forms gradually developed into more and more complex organisms. […] A Latin poet, in giving advice to young play writers, once advised them *not to bring a god upon the stage unless the situation demanded it*. In the case of ferns and seed-ferns, it would seem that *genetical relationship*, functioning as it is known to function in living plants, where the relationship is fairly well known, *is a sufficient factor* to account for the observed structures" [76] (pp. vii,33, emphasis added).

Next consider Theodosius Dobzhansky (1900–1975), who was a geneticist and evolutionary biologist known for the "modern synthesis" of Darwin and Mendel; he held academic positions at Kiev, Leningrad, Columbia, Caltech, Rockefeller and UC-Davis. In an article in *The Antioch Review* (1959), he wrote:

> "Darwin concluded that hereditary variability becomes evolution if and when it is orientated by natural selection. In the language of genetics, mutation and sexual reproduction supply merely the raw materials from which evolutionary changes are shaped by natural selection. Evolution is a response of living matter to environmental opportunity. […] Environment presents challenges of opportunity, to which the organism may or may not respond by evolutionary alterations. Whether it does or does not depends upon the availability at the proper time and place of genetic variants which survive and reproduce in the new environments as well as or better than the ancestral type is capable of doing. […]. Let it not be forgotten that natural selection is not a *deus ex machina* but an automatic consequence of the encounters between a living population and its environment" [77] (pp. 59, 64).

Both of these biologists therefore, quite influential in their fields, might be considered among contemporary philosophers within the Kantian perspective,

including not only their denial of the *deus ex machina*, but also regarding their possible use of the "reflective judgment."

Anthony Manser (1924–1995) was a well-known philosopher of science at Southampton University, UK and also the president of Aristotelian Society (1983–1984). In 1965, he wrote the following:

> "Darwin himself, as the title of his work implied, was concerned with the origin of species; the originality of his book lay in the fact that he proposed a mechanism whereby new species could be formed from existing ones without invoking a *deus ex machina* from outside the process. Most modern adherents would go further than Darwin did to suggest that all living things originated from some primeval form, and, in some cases, to maintain that this form itself arose from nonliving matter. Whether any such event took place on the surface of the earth, or whether this original form was created by some being outside this world, need not make any difference to the rest of the account. (Though it may; in general creationists want also to argue that there was some further direction of the process, either by interference with it, or by the endowment of living matter, or perhaps all matter, with special properties that made development inevitable)" [78] (p. 19).

An article published in *Philosophica* by Stuart Shanker (1952–), references the ideas of Ross Ashby (1903–1972), noted for his theories of cybernetics, dynamic organization and adaptation. Again, they both argue, the *deus ex machina* must be excluded from scientific explanations:

> "Following the tradition of nineteenth-century mechanism the picture had remained thoroughly Darwinian: the 'internal states' regulating the adaptation of an organism were the product of an evolutionary process designed to sustain homeostasis. In Ashby's words, 'learning usually changes in behavior from a less to a more beneficial, i.e., self-promoting form.' Thus, 'when the nervous system learns, its behavior changes for the better,' and 'no use of any "vital" property or tendency will be made, and no *deus ex machina* will be invoked' in computational explanations of 'learning;' the 'sole reason admitted for the behavior of any part will be of the form that its own state and the condition of its immediate surroundings led, in accordance with the usual laws of matter, to the observed behavior'" [79] (p. 115).

Finally, this same concept is found referenced in the writings of Daniel Dennett (1942–2024), an influential philosopher of evolutionary biology and neuroscience at Tufts University. His *Darwin's Dangerous Idea: Evolution and the Meanings of Life* (1995) states the following:

> "Darwin shows us how to climb from 'absolute ignorance' to creative genius without begging any questions, but we must tread very carefully, as we shall see. Among the controversies that swirl around us, most if not all consist of different challenges to Darwin's claim that he can take us all the way here (the wonderful world we inhabit) from there (the world of chaos or utter undesignedness) in the time available without invoking anything beyond the mindless mechanicity of algorithmic processes he had proposed […] We can dramatize the challenge with the aid of another fantasy item drawn from folklore[:] the *deus ex machina* of ancient Greek dramaturgy: when second-rate playwrights found their plots leading their heroes into inescapable difficulties, they were often tempted to

> crank down a god onto the scene, like superman, to save the situation supernaturally" [80] (p. 74).

Such then is the impressive "litany" of evolutionary philosophers, scientists and other theorists who would characterize opposition to the *deus ex machina* concept as a cornerstone feature of Darwin's originality. While all of these above cited writers have in common an essential thread of ideas, their differences might be worth studying too for greater understanding. From the perspective of a core idea of Cudworth which was re-evaluated by Kant in *Universal Natural History*, however, a preponderance of scholars have already weighed in favor of the Königsbergian philosopher, making him an enduring scientific thinker and philosopher of biology.

6. Discussion and conclusion

The robust response among German scientists and philosophers comparing Darwin's theory of evolution to Kant's theory of epigenesis is itself an important chapter in intellectual history. Goethe, Schopenhauer, Ørsted, Haeckel, Lange, Nietzsche, Schultze, Liebmann, Helmholtz, Von Baer, Hallier and perhaps others deserve renewed scholarly studies even now to determine the validity of their analyses from a contemporary perspective. However, for most of these 19th-century writers, the circumstantial occurrences of history, significantly owing to Frederick II of Prussia's not approving of Kant's evolutionary ideas in *Universal Natural History* and the loss of the publisher's printed book stock, made their first-order synthesis of Kantian philosophy with Darwin's theory incomplete. This paper's retrospective study of Kant's *Universal Natural History*, written 270 years ago, and Darwin's *Origin of Species*, written 165 years ago, has provided a comparative study of essential ideas shared by these two texts, especially with respect to both authors' opposition to the *deus ex machina* argument of divine intervention, which Kant had evidently encountered in the writings of Ralph Cudworth. While other influences from Cudworth on Kant have previously been studied with regard to the anthropic principle and the 'plastick' or 'technic' of nature, a new point of comparison between Kant and Darwin has now also been established, enabling a better evaluation of Kant's *Universal Natural History*.

Much has been made of Kant's review of his former student Johann Herder's book *Ideas for a Philosophy of the History of Mankind*, of which Kant had written that any evolutionary theories where "one species would have arisen from the other and all from a single original species, or perhaps from a single procreative maternal womb, would lead to ideas which, however, are so monstrous that reason recoils before" [81] (p. 132). But as Kant's biographer Friedrich Paulsen had pointed out long ago, the monstrous thoughts that Kant so much feared might have really been ones in his own mind [82] (p. 272). In *Immanuel Kant: His Life, His Doctrine* (1902), Paulsen substantiated this claim by quoting from Reicke's *Lose Blätter* (published 1895), found in Kant's office and published posthumously:

> "I also have at times steered into the gulf assuming here blind natural mechanics as the ground of explanation, and believed I could discover a passage to the simple and natural conception. But I constantly made a shipwreck of reason, and I have therefore preferred to venture upon the boundless ocean of Ideas […] The

> incomprehensible persistence of genera and species, with so many causes flowing into them and modifying their development, leads us to this idea. From this I concluded that if diversity arises which is inevitably hereditary, it cannot have been produced by any accidental cause but can only have been developed, and that even for this development, original and purposeful dispositions must be found in nature" [83] (p. 137).

Given this paper's analysis of *Universal Natural History*, with Kant's clear assertion that Cudworth's *deus ex machina* would undermine a true scientific explanation of the origin of life, and given *Universal Natural History'*s poor readership in its first printing, it should now be more clearly elucidated that Kant's ultimate decision to publish again in the *Critique of Judgment* on this topic was actually a demonstration of his academic boldness, not timidity, regarding naturalistic explanations of evolutionary theory. His insightful metaphysical and epistemological considerations of teleology, though certainly important to understand a proper Kantian perspective on evolution (and demonstrably of continuing relevance), often overshadow the philosopher's unequivocal statements in favor of this theory, which can (and should) be traced to even his 1755 text. Additionally, his review of Herder's book might perhaps be better evaluated if we consider that it had also been seen by some of Kant's contemporaries as a review of his own works too.

Darwin for his part had many personal fears and also great misgivings about his theory being published with the uncertain implications it might have. In 1838, he wrote in a notebook that has been preserved, "I fear ‹great evil› from vast opposition in opinion on all subjects of classification; I must work out hypotheses & compare them with results. If I acted otherwise, my premises ‹in di› would be disputed" [84] (p. 79). On another note, Darwin recorded a similar statement characterizing his hesitancy to accept his own theory: "With me the horrid doubt always arises whether the convictions of man's mind, which has been developed from the mind of the lower animals, are of any value or at all trustworthy. Would anyone trust in the convictions of a monkey's mind, if there are any convictions in such a mind?" [85] (p. 64). Nonetheless, despite these fears cited from both of their personal journals, these great philosophical and scientific pioneers of the 18th and 19th centuries were willing to "embark on their journey" and make a "daring adventure of reason." Unlike Cudworth, who fell back on the unscientific explanations of the *deus ex machina* in *True Intellectual System* for his theory of the origin of the world and of its living forms, Kant and Darwin consistently did not, nor did they ultimately succumb to those fears that might have gotten the better of their academic careers. Their profound published contributions remain a beacon of rational philosophical and scientific thought still worthy (as before) of all students' devoted investigation and still (in the generations to follow) providing rich source material for our detailed philosophical analysis.

Conflict of interest: The author declares no conflict of interest.

Notes

[1] Image credits: Ralph Cudworth painting (1781) by Joseph Freeman, Emmanuel College, University of Cambridge; Immanuel Kant painting (1768) by Johann Gottlieb Becker, Schiller-Nationalmuseum in Marbach am Neckar, Germany; Grant Allen portrait (c. 1895) by Walery Ltd., London; Thomas H. Huxley photograph (c. 1880) by Lock & Whitfield Photographers,

London; James B. Bury photograph (c. 1923) by British Library Board; Charles J. Chamberlain photograph (1911) by University of Chicago Archives; Theodosius Dobzhansky photograph (1964) from Science Photo Library/ Alamy; Ross Ashby photograph (1948) by unknown author; Stuart Shanker (2013) photograph from Empathy Symposium, Toronto; Daniel Dennett photography (2008) by Brent Nicastro, Chicago.

References

1. Kant I. Critique of Pure Reason. Cambridge: Cambridge University Press; 1999. doi: 10.1017/CBO9780511804649
2. Richards RJ. The foundations of archetype theory in evolutionary biology: Kant, Goethe, and Carus. Republic of Letters. 2018; 1: 1-15.
3. Goethe JW. The Metamorphosis of Plants. Boston: MIT Press; 2009.
4. Kuehn M. Kant: A Biography. Cambridge: Cambridge University Press; 2001. doi: 10.1017/CBO9781107050433
5. Ginsborg H, Kant I, Guyer P, et al. Critique of the Power of Judgment. The Philosophical Review. 2002; 111(3): 429. doi: 10.2307/3182550
6. Mohrs T. Kant's philosophy of history from an evolutionary point of view. Evolution and Cognition. 1999; 5(1): 24-32.
7. Wilson C. Epicureanism at the Origins of Modernity. Oxford: Oxford University Press; 2008. doi: 10.1093/acprof:oso/9780199238811.001.0001
8. Hamid N. Ido Geiger, Kant and the claims of the empirical world. Kantian Review. 2023; 28(1): 157-161. doi: 10.1017/S1369415422000541
9. Hay C. Radical Kantian rational reconstruction. In: Hänel HC, Müller JM (editors). Routledge Handbook of Non-Ideal Theory, 1st ed. Routledge Press; 2024. pp. 101-112. doi: 10.4324/9781003315032
10. Cohen A. Kant on evolution: a re-evaluation. In: Callanan JJ, Allais L (editors). Kant and Animals, 1st ed. Oxford University Press; 2020. pp. 123-135. doi: 10.1093/oso/9780198859918.003.0007
11. Helmholtz HV. Popular Lectures on Scientific Subjects (1855). New York: D. Appleton; 1897.
12. Lovejoy AO. Kant and evolution I. Popular Science Monthly. 1910; 77: 538-553.
13. Martin S, Thompson M. Kant's philosophical development. In: Zalta E, Nodelman U (editors). Stanford Encyclopedia of Philosophy. Pal Alto: Stanford University Press; 2019.
14. Lovejoy AO. Kant and evolution II. Popular Science Monthly. 1911; 78: 36-51.
15. Baumeister D. Animality in Kant's theory. In: Callanan JJ, Allais L (editors). Kant and Animals, 1st ed. Oxford University Press; 2020. pp. 105-122. doi: 10.1093/oso/9780198859918.003.0006
16. Schultze F. Kant und Darwin. Jena: Hermann Dufft Publishers; 1875.
17. Wilson HL. Kant's Pragmatic Anthropology: Its Origin, Meaning, and Critical Significance. New York: SUNY Press; 2007. doi: 10.1515/9780791481295
18. Haeckel E. History of Creation: Or the Development of the Earth and Its Inhabitants by the Acton of Natural Causes. New York: D. Appleton; 1876.
19. Fisher M. Metaphysics and physiology in Kant's attitude towards theories of preformation. In: Goy I, Watkins E (editors). Kant's Theory of Biology, 1st ed. Berlin: De Gruyter Press; 2014. pp. 25-41. doi: 10.1515/9783110225792.25
20. Hanna R. Kant's theory of judgment. In: Zalta E (editor). Stanford Encyclopedia of Philosophy. Pal Alto: Stanford University Press; 2017.
21. Cooper A. Kant on observation. In: Himmelmann B, Serck-Hanssen C (editors). The Court of Reason: Proceedings of the 13th International Kant Congress. Berlin: De Gruyter; 2021. pp. 941-950. doi: 10.1515/9783110701357
22. Kant I. Critique of the Power of Judgment. Indianapolis: Hackett Press; 1987.
23. Steigerwald J. Kant and organic life. In: Mensch J (editor). Kant and the Feeling of Life: Beauty and Nature in the Critique of Judgment. New York: SUNY Press; 2024. pp. 293-318. doi: 10.1515/9781438498652-016
24. Darwin CR. On the Origin of Species by means of Natural Selection. London: John Murray Press; 1859.
25. McNulty MB. A science for gods, a science for humans: Kant on teleological speculations in natural history. Studies in History and Philosophy of Science. 2022; 94(1): 47-55. doi: 10.1016/j.shpsa.2022.04.008
26. Mix LJ. The End of Final Causes in Biology. London: Palgrave Macmillan; 2022. doi: 10.1007/978-3-031-14017-4
27. Singh RS. A concept of complementarity between complexity and redundancy can account for Kant's biological teleology and unify mechanistic and finalistic biology. Journal of Molecular Evolution. 2024; 92(3): 258-265. doi: 10.1007/s00239-024-10169-w

28. Goethe JW. Influence of modern philosophy (German). Berlin: De Gruyter; 2006. pp. 335-339. doi: 10.1515/9783110922929.335
29. Gardner S. Nietzsche on Kant and teleology in 1868: 'life is something entirely dark…'. Inquiry. 2019; 62(1): 23-48. doi: 10.1080/0020174X.2019.1527541
30. Rupik G. Remapping Biology with Goethe, Schelling, and Herder: Romanticizing Evolution. Abingdon: Taylor & Francis; 2024. doi: 10.4324/9781003441809
31. Schopenhauer A. The World as Will and Idea. Haldane RB, Kemp J, Paul K (translators). London: Trench, Trubner & Company; 1907.
32. Segala M. A Convex Mirror: Schopenhauer's Philosophy and the Sciences. Oxford: Oxford University Press; 2024. doi: 10.1093/oso/9780197599150.001.0001
33. Ørsted HC. The Soul in Nature. Horner L, Horner JB (translators). London: HG Bohn Publishers; 1852.
34. Darwin CR. The Correspondence of Charles Darwin: Vol. 12 (1864). Cambridge, Cambridge University Press; 2001.
35. Darwin CR. The Correspondence of Charles Darwin: Vol. 16 (1868). Cambridge, Cambridge University Press; 1985.
36. Stowell J. On the sages of Königsberg and Down: rethinking Darwin's relationship to Kant. Journal of Victorian Culture. 2024; 29(4): 510-529. doi: 10.1093/jvcult/vcae015
37. Lange FA. History of materialism and critique of its significance in the present (German). Leipzig: F. Brandstetter; 1914.
38. Hussain NJZ, Patton L. Friedrich Albert Lange. In: Zalta E (editor). Stanford Encyclopedia of Philosophy. Pal Alto: Stanford University Press; 2021.
39. Mostert P. Nietzsche's reception of Darwinism. Bijdragen tot de Dierkunde. 1979; 49(2): 235-246.
40. Darwin CR. The Correspondence of Charles Darwin: Vol. 18 (1870). Cambridge: Cambridge University Press; 1985.
41. Darwin CR. The Descent of Man, and Selection in Relation to Sex. London: John Murray Press; 1871.
42. Aram A, Shahraki F. Kant and Dawkins; investigating pre/post evolutionary readings of nature and morality. Western Philosophy. 2022; 1(3): 65-77. doi: 10.30479/wp.2022.17408.1018
43. Buchner EF. The Educational Theory of Immanuel Kant. Philadelphia: J.B. Lippincott Co.; 1904.
44. Biener Z. Newton's regulae philosophandi. In: Smeenk C, Schliesser E (editors). Oxford Handbook of Isaac Newton, 1st ed. Oxford University Press; 2017. pp. 3-22. doi: 10.1093/oxfordhb/9780199930418.013.4
45. Bernasconi R. Critical Philosophy of Race: Essays. Oxford: Oxford University Press; 2023. doi: 10.1093/oso/9780197587966.001.0001
46. Baedke J, Böhm A, Reiners-Selbach S, et al. A synthesis without Darwin: unification attempts in early theoretical biology. In: Delisle RG, Esposito M, Ceccarelli D (editors). Unity and Disunity in Evolutionary Biology Deconstructing Darwinism. Boston: Springer Press; 2024. pp. 333-356. doi: 10.1007/978-3-031-42629-2_12
47. Liebmann O. On the analysis of reality: philosophical investigations (German). London: Trübner; 1876.
48. Beiser FC. The Genesis of Neo-Kantianism, 1796-1880. Oxford: Oxford University Press; 2015. doi: 10.1093/acprof:oso/9780198722205.001.0001
49. Helmholtz HV. The facts in perception (German). In: Hertz P, Schlick M (editor). Schriften zur Erkenntnistheorie. Berlin: Springer Press; 1921. pp. 109-175. doi: 10.1007/978-3-662-36342-3_2
50. Hyder D. Kant's theories of space and time in 19th century physics and physiology. Revue Roumaine de Philosophie. 2022; 66(2): 177-195.
51. Beekman W, Jochemsen H. The Kantian account of mechanical explanation of natural ends in eighteenth and nineteenth century biology. History and Philosophy of the Life Sciences. 2022; 44(1): 1-24. doi: 10.1007/s40656-022-00484-0
52. Rama T. The explanatory role of umwelt in evolutionary theory: introducing von Baer's reflections on teleological development. Biosemiotics. 2024 1(1): 1-26. doi: 10.1007/s12304-024-09569-8
53. Bolduc G, Angleraux C. Claude Bernard's non reception of Darwinism. History and Philosophy of the Life Sciences. 2023; 45 (3):1-26. doi: 10.1007/s40656-023-00588-1
54. Weismann A. Studies in the Theory of Descent. Meldola R (translator). London: Sampson Low Press; 1882.
55. Weismann A. Essays upon Heredity and Kindred Biological Problems. Cambridge: Clarendon Press; 1891.
56. Scarfe AC. D'Arcy Wentworth Thompson's 'physico-mathematical' approach to the investigation of morphogenesis and its pertinence to cognitive-behavioral and/or learning-based explanations of evolution. In: Malassé AD (editor). Self-Organization as a New Paradigm in Evolutionary Biology: From Theory to Applied Cases in the Tree of Life. Cham: Springer Publishing; 2022. pp. 33-89. doi: 10.1007/978-3-031-04783-1_3

57. Hallier E. Cultural history of the nineteenth century in its relationship to the development of the natural sciences (German). Stuttgart: Verlag von F. Enke; 1889.
58. Pearson JS. Nietzsche on the necessity of repression. Inquiry. 2023; 66(1): 1-30. doi: 10.1080/0020174X.2018.1529618
59. Call L. Anti-Darwin, anti-Spencer: Friedrich Nietzsche's critique of Darwin and Darwinism. History of Science. 1998; 36(1): 1-22. doi: 10.1177/007327539803600101
60. Ritchie DG. Darwin and Hegel. Proceedings of the Aristotelian Society. 1890; 1(4): 55-74.
61. Howard S. Kant's Universal Natural History and analogical reasoning in cosmology. In: Lefèvre W (editor). Between Leibniz, Newton, and Kant: Philosophy and Science in the Eighteenth Century. Cham: Springer Publishing; 2023. pp. 247-270. doi: 10.1007/978-3-031-34340-7_11
62. Hutton S. Ralph Cudworth. In: Zalta E, Nodelman U (editors). Stanford Encyclopedia of Philosophy. Pal Alto: Stanford University Press; 2023.
63. Cudworth R. The True Intellectual System of the Universe. Harrison J (translator). London: Tegg; 1845.
64. Kant I. Natural Science. Watkins E (editor). Beck LW, Edwards JB, Reinhardt O, et al. (translators). Cambridge: Cambridge University Press; 2012.
65. McLaughlin P. Mechanical explanation in the 'critique of the teleological power of judgment.' In: Goy I, Watkins E (editors). Kant's Theory of Biology. Berlin: De Gruyter; 2014. pp. 149-166. doi: 10.1515/9783110225792.149
66. Vereb Z. The green Kant and nature: rereading modern philosophy against Vogel. Environmental Ethics. 2024; 46(4): 401-420. doi: 10.5840/enviroethics2024123187
67. Esposito M. Deconstructing and reconstructing the history of evolutionary thought: an agenda for a 'post-Darwinian' Historiography. In: Delisle RG, Esposito M, Ceccarelli D (editors). Unity and Disunity in Evolutionary Biology: Deconstructing Darwinism. Boston: Springer Press; 2024. pp. 443-473. doi: 10.1007/978-3-031-42629-2_15
68. Lehner U. Kant's Concept of Providence Against the Background of the German School of Theology (German). Leiden: Brill; 2007. doi: 10.1163/ej.9789004156074.i-532
69. Parker T, Dunn SM. Anthropic principle. In: Shackelford T (editor). Encyclopedia of Religious Psychology and Behavior. Cham: Springer Nature; 2024. pp. 1-3. doi: 10.1007/978-3-031-38971-9_1269-1
70. Santos LR. Reflections on a Kantian topic (Portuguese). Studia Kantiana. 2009; 7(9): 118-160. doi: 10.5380/sk.v7i9.88589
71. Allen G. Charles Darwin. London: Longmans, Green & Co. Press; 1885.
72. Khramov AV. A forerunner of Darwin in the service of nihilists: the translation and reception of Vestiges in Russia. The British Journal for the History of Science. 2024; 57(1): 65-79. doi: 10.1017/S0007087423000900
73. Huxley TH. Collected Essays: Darwiniana. New York: D. Appleton; 1894. doi: 10.1017/CBO9781139149211
74. Seward AC. Darwin and Modern Science: Essays in Commemoration. Cambridge: Cambridge University Press; 1909.
75. Sachs AS. Basic Principles of Scientific Socialism. New York: Rand School of Social Science; 1925.
76. Chamberlain CJ. Gymnosperms: Structure and Evolution. New York: Johnson Press; 1957.
77. Dobzhansky T. Genetics and the destiny of man. Antioch Review. 1959; 19(1): 57-68. doi: 10.2307/4610128
78. Manser AR. The concept of evolution. Philosophy. 1965; 40(151): 18-34. doi: 10.1017/S0031819100052426
79. Shanker SG. The dawning of (machine) intelligence. Philosophica. 1988; 42(1): 93-144. doi: 10.21825/philosophica.82463
80. Dennett DC. Darwin's Dangerous Idea: Evolution and the Meanings of Life. New York: Simon & Schuster; 1996.
81. Kant I. Anthropology, History, and Education. Zöller G, Louden RB (editors). Gregor M, Guyer P, Louden RB, et al. (translators). Cambridge: Cambridge University Press; 2007.
82. Paulsen F. Immanuel Kant; His Life and Doctrine. Creighton JE, Lefevre A (translators). New York: C. Scribner; 1902.
83. Reicke R. Loose sheets from Kant's estate (German). Darmstadt: F. Beyer; 1895.
84. De Beer G. Darwin's notebooks on transmutation of species part II. HIST. 1960; 2(3): 28.
85. Darwin CR. His Life Told in an Autobiographical Chapter. London: John Murray Press; 1908.