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Damning Criticism

Historical Perspectives on the Evolution/Intelligent Design Conflict

Richard M. Simon, Pennsylvania State University

Abstract

Evolutionary theory and Intelligent Design are often portrayed as being diametrically opposed. However, events in the history of science demonstrate that theological criticisms of science have at times served to put science onto a productive path. Drawing on historical accounts of the 1277 Parisian condemnations of Aristotelian physics and Paracelsian chemical and medical philosophy, it is argued that theological criticism of science may be beneficial for science if such criticisms can be incorporated within a naturalistic framework. This insight is used to interpret the relationship between intelligent design and evolutionary theory. It is argued that intelligent design has made a positive contribution to evolutionary theory, and that it is possible, and indeed likely, that it may make such a contribution again in the future.

Introduction

[1] The relationship between science and Christianity is long and complex (Lindberg and Numbers). Throughout that history theological and natural philosophic accounts of nature have been in tension, and yet have often interacted to produce amalgamated concepts. However, since the triumph of Darwinian naturalism in biology, theological claims to nature have been thoroughly expelled from the scientific corpus. Nevertheless, creationists continue to lurk around the margins of legitimate science, prodding and feeling for any opening that might undermine scientific naturalism. Not surprisingly, the relationship between science and creationism has often been framed in terms of a zero-sum game, in which any successes for creationists necessarily imply setbacks for science. One current manifestation of

creationism is "intelligent design" (ID), which claims that the naturalist metaphysic requires scientists to ignore evidence that suggests organisms have been created by a supernatural "intelligence." Both popular and scholarly treatments of the conflict between ID and evolutionary theory assume their relationship to be necessarily adversarial, with ID advocates pushing to dislodge evolution as the hegemonic account of biological transformation, and evolutionary scientists struggling to keep what they consider a pseudoscience out of the scientific discussion. Moreover, scientists and their sympathizers without exception view the conflict as an egregious waste of time, serving only to distract scientists from engaging in productive work (Attie et al.).

[2] Yet history suggests that theological challenges to science have not always been fetters on scientific advance. In the thirteenth century, condemnations of Aristotelian physics by theologians who believed the Aristotelian system threatened the Christian faith encouraged natural philosophers to consider nature outside of the Aristotelian paradigm. Aristotelian physics was, of course, an inadequate system for representing nature, and the thirteenth century condemnations contributed to its eventual demise by requiring natural philosophers to reject certain claims. Similarly, Paracelsus, the Renaissance-era medical and chemical philosopher and iconoclast, found Galenic medicine to be incompatible with Scripture, and so devised a new philosophical system in which fresh observations of nature would be used to interpret Christian dogma. As with Aristotelian physics, Galenic medicine was incapable of supporting an observation-based science, and Paracelsus's challenge to Galen was instrumental in bringing about a revolution in medicine and chemistry. These examples show that it is possible for theologically oriented critiques to be productive for science. Focusing on two cases from the history of science – the thirteenth century condemnations of Aristotlian physics and the development of Bible-based Paracelsian chemical theory during the Renaissance – I hope to shed new light on the conflict between intelligent design and evolutionary theory by demonstrating that theological challenges to prevailing scientific paradigms may function to expose weaknesses in those paradigms, even if the specifically theological counterclaims are not viable. While Aristotelian physics and Paracelsian medicine differ from ID in many respects, I will work from the assumption that considering them may still contribute to understanding the ID/evolution conflict in important ways, in that they share with ID theologically-oriented critiques of scientific theories. I will argue that ID has indirectly contributed to developments in evolutionary theory, and, because theological criticisms of science in general may be stripped of their supernatural components and incorporated within naturalistic interpretations of nature, it is possible and even likely that ID will again in the future make positive contributions to evolutionary biology.

Intelligent Design

[3] The term "intelligent design," one of the most recent manifestations of creationism,[1] is meant to denote aspects of nature that seem to serve some function beyond their own limited makeup, and these functions are interpreted as being evidence of a supernatural force

[1] One may argue that it is more accurate to conceptualize ID as "anti-evolutionist" rather than "creationist." Nevertheless, ID has its roots in creationism, and many creationists became ID advocates after *Edwards v. Aguillard* mandated a (ostensibly) non-religious approach to biology in public school classrooms. Hence, it is appropriate to discuss ID with reference to creationism more generally.

(Sarkar: 41). For instance, the bee's pollination of the flower would be seen by ID advocates as evidence for design because the bee contributes to a system far more complex and vital than it could possibly comprehend, and thus would be one part among many in a sophisticated, natural "machine" that assures the reproduction of the flower. Moreover, ID advocates would argue that the existence of natural "machines" that serve some purpose imply a designer, and in fact "are God's handiwork, fashioned to help organisms" (Ruse: 6). This argument is often traced to William Paley's watchmaker analogy. Paley argues that when one comes across a stone, it is not absurd to imagine that it may have lain in that spot for eternity. When one comes across a watch however, Paley continues, it is absurd to think that it had always been – the existence of a watch implies a watchmaker. Paley's analogy seeks to portray that anything as complex and purposeful as life implies the existence of a designer (for earlier creationist and design arguments, see Sedley).

[4] Confronted with the overwhelming triumph of naturalism in science, creationists continue to challenge evolution in the social and political spheres. A 2005 Harris Poll revealed that only 22% of Americans believe that humans evolved from an earlier species and only 12% of Americans believe that evolution should be taught in schools to the exclusion of religious interpretations of biology. Despite recent legal setbacks for creationists pushing to teach ID in public school classrooms (see Attie et al.), strong public dissatisfaction with naturalistic biology ensures that the political clashes will not soon decrease. Creationism will not likely leave the *political* arena any time in the near future, and so its relationship to science continues to be salient, even if the vast majority of the scientific community considers it less than worthy of their professional attention.

[5] Recent developments in creationism labeled as ID are essentially extensions of Paley's watchmaker analogy, although they have become slightly more sophisticated. Like Paley, ID essentially claims that complexity and purpose (what Dembski: 47 calls "specified complexity") in biological structure are evidence of an intelligent agent. However, the biggest reform in creationism since the 1990s has been the explicit rejection of the biblical account of Genesis, which suggests a young earth of roughly 10,000 years of age, and biological variation that sprung exclusively from the creator's touch. ID creationists have begun to realize that a cosmogonical struggle with science cannot be fought outside the realm of established scientific facts, and so have accepted many claims once thought to be heretical so that ID might enter the field of scientific activity and critique evolution on its own terms. Thus Michael Behe, a leading proponent of ID, admits:

> I have no reason to doubt that the universe is the billions of years old that physicists say it is. Further, I find the idea of common descent (that all organisms share a common ancestor) fairly convincing, and have no particular reason to doubt it. I greatly respect the work of my colleagues who study the development and behavior of organisms within an evolutionary framework, and I think that evolutionary biologists have contributed enormously to our understanding of the world (5).

In this statement Behe is representative of his fellow ID advocates in that, unlike previous incarnations of creationism, he recognizes the power of evolutionary theory, yet seeks to find in its limits a place for divine intervention.

[6] In one respect, however, ID bears a close resemblance to its creationist predecessors. Naturalism is a relatively recent, though thoroughly hegemonic metaphysical basis for biology, and creationist accounts by definition have always sought to attribute natural phenomena to supernatural causes. Hence, since the establishment of evolution as the scientific basis of biological variation, the task of creationism has been to oust naturalism's hegemonic position within biology, and ID has taken up this challenge. William Dembski, another of ID's intellectual leaders, defines scientific naturalism as the disregard of divine forces, and thus suggests that a more honest scientific metaphysic would be open to supernatural forces if evidence presented itself in support of them.

> Scientific naturalism locates the self-sufficiency of nature in the natural laws of science. Accordingly, scientific naturalism would have us to understand the universe entirely in terms of those laws. . . To be sure, there is no logical contradiction for the scientific naturalist to affirm God's existence, but this can be done only by making God a superfluous rider on top of a self-contained account of the world. What evidence is there of God interacting with the world? . . . To answer this question we must look to science. The science we look to, however, needs to be unencumbered by naturalistic philosophy (Dembski: 103-5).

The attack on naturalism is an important component of intelligent design because it represents the greatest metaphysical barrier to the re-admittance of theology into science.

[7] In tandem with Dembski's philosophical pleas to reconsider naturalistic biology, Michael Behe has led the critique of evolution's scientific basis. Indeed, Behe seems to be the only ID advocate to have taken seriously the biochemical implications of evolutionary theory. In *Darwin's Black Box*, Behe questions evolution's efficacy in explaining life at its most basic level: the molecule and its behaviors and functions. He argues that evolutionary theory was developed as an explanation of morphological changes at the macro level of the organism and that natural selection cannot explain complex molecular processes. Behe believes that at the molecular level he has found a key weakness in evolutionary theory, and he quotes Darwin to demonstrate the implications of biological complexity at the molecular level: "If it could be demonstrated that any complex organ existed which could not possibly have been formed by numerous, successive, slight modifications, my theory would absolutely break down" (154). Behe claims to have identified many such biological systems which "could not possibly have been formed by numerous, successive, slight modifications" and thus Darwin himself seems to concede the inadequacy of his theory. Behe notes that at the molecular level biological processes often consist of a system of highly interdependent parts and functions, and if even one element were to be absent, the entire system would cease to function. Behe refers to such systems as "irreducible complexity" and gives them the following definition:

> By *irreducibly complex* I mean a single system composed of several well-matched, interacting parts that contribute to the basic function, wherein the removal of any one of the parts causes the system to effectively cease functioning. An irreducibly complex system cannot be produced directly (that is, by continuously improving the initial function, which continues to

> work by the same mechanism) by slight, successive modifications to a precursor system, because any precursor to an irreducibly complex system that is missing a part is by definition nonfunctional (39).

Behe gives detailed descriptions of what he claims are irreducibly complex systems, including vision, the blood clotting cascade, and most famously, the bacterial flagellum, a feature resembling a motorized paddle which some kinds of bacteria use for motion. Because in all of these examples the removal of one element makes the entire system nonfunctional, Behe claims, they could not have evolved by slight and successive modifications to precursor systems, as those nonfunctional systems would give the organism no advantage in natural selection. Importantly, Behe does not stop at his critique of evolution, but offers ID as an alternative interpretation of irreducible complexity. "Clearly," Behe writes, "if something was not put together gradually, then it must have been put together quickly or even suddenly" (187). He maintains that the sudden appearance of a complex system is compelling evidence for a supernatural power.

[8] This brief introduction to some of the central claims of ID reveal why it has been in tension with science at least in the public sphere, if not among many practicing scientists. In short, ID advocates claim that biology can be better understood when scientists are permitted to consider divine causes. From the ID perspective, allowing supernatural causes to be incorporated into scientific theories actually counts as good *science* (and is not just a theological critique of science) because such forces are better equipped to explain natural phenomena than evolutionary theory. However, wrestling nature from theologians was a long and arduous process for scientific naturalists and the renewed calls to put God back into nature understandably unnerves most scientists. While the biology community has rejected ID's claims to being a science, the issue continues to foment conflict within popular culture and the popular press.

[9] But is this conflict really a categorical opposition? The fact that many battles about the place of creationism in culture have been fought in the courtroom fosters the image that the opposing camps are necessarily adversarial and scientists need to "defend" (Attie et al.: 1134) their house from the ID barbarian invaders. However, the cases of the thirteenth century condemnations and the Paracelsian challenge to Galenic medicine demonstrate the complexity of the theology-science relationship, showing that theologically-based criticisms of science have at times set science onto a productive path.

Thirteenth Century Condemnations

Historical Circumstances Surrounding the Condemnations

[10] Around the beginning of the thirteenth century the university as we now know it began to take shape. Originating out of the guild system of the Middle Ages, the knowledge guilds organized and formed centers of learning in what would become the first universities (Grant 1996: 34). In the early universities there were only four recognized "faculty," or departments, as we would now label them: theology, medicine, law, and the arts. The central principle of cultural organization and the institution with the greatest power in medieval European society was the Church, and so the theology faculty enjoyed preeminent status in the university system. The arts faculty included all strains of philosophy that fell outside of the

bounds of traditional Christian theologizing, and so scholars concerned primarily with the philosophy of nature would have been located there.[2] Following the reintroduction of Aristotle to the West by new translations in the previous century (Grant 1996: 27), the arts curriculum was heavily dominated by Aristotelianism. This hegemony of Aristotelian thought was a source of frustration for religious authorities who were sensitive to many of his ideas that contradicted Christian dogma. The integration of Aristotelianism and Christian doctrine would become a preoccupation of scholars in the thirteenth and fourteenth centuries.

[11] Sensing the threat of Aristotelianism, many actions were taken against natural philosophers who used Aristotle without proper respect for Christian dogma. In the first half of the thirteenth century several theology faculties banned Aristotle's heretical works from the curriculum. However, as Aristotle's physical works were nearly coextensive with natural philosophy at the time, theologians found these bans difficult to enforce, and by 1255 all bans on Aristotle had been lifted (Grant 1996: 70). Theologians would need a more effective weapon in their struggle against Aristotle's heresies.

[12] The year 1210 would mark the beginning of a string of sixteen condemnations of Aristotle at the University of Paris that would stretch into and across the fourteenth century (Thijssen: 85). Most of these condemnations were arranged by theology faculty who took up the task of outlining specific Aristotelian arguments or philosophical orientations, which they viewed as threatening to the faith. After a string of unsuccessful bans on Aristotle, the condemnations possessed the benefit of specificity, outlining in detail the "errors" of the philosophers. While the University of Paris was not unique in issuing condemnations, it seems to have been the most fervent seat of theological censorship.

[13] The 1277 Parisian condemnations stand out as one of the more historically relevant among those of the thirteenth and fourteenth centuries both in the extent of their censorship and in their influence on medieval scholarship. The 1277 condemnations identified a total of 219 propositions to be offensive to Christian theology, and those propositions were forbidden in both teaching and writing (Grant 1996: 71). In January of 1277, Pope John XXI inquired to the Bishop of Paris, Etienne Tempier, concerning heretical ideas that were circulating at the University of Paris. By the end of March, Tempier, with the help of the theology faculty, had drawn up the 219 articles of condemnation (Thijssen: 91). Their disorganization and repetition reflects the haste in which they were assembled, though Thijssen argues that Tempier may have been preparing the articles at the time of the papal inquiry. Because Aristotelianism, the target of the condemnations, thoroughly dominated natural philosophy in the thirteenth century, their impact was immense.

[2] I use the phrase "primarily concerned" because in practice many theologians addressed problems in natural philosophy and many natural philosophers were compelled to come to terms with the theological implications of their work. Indeed, Grant argues that one of the reasons why natural philosophy flourished in an era so completely dominated by Christian dogma was that the theologians themselves were heavily involved in natural philosophy (1996: 183).

Relevance of the Condemnations to Science

[14] Within the verbosity of 219 articles, the 1277 Parisian condemnations made three general objections to Aristotelian theory: the postulation that the world is eternal (and thus not created by God), the doctrine of double truth (in which natural philosophers seemed to insist on the truth of revelation while also making arguments that challenged the faith), and limitations placed on God's absolute power (Grant 1996: 74-80). Of these, objections to the limits placed on God's absolute power had the greatest effect on natural philosophy. Aristotle's physical theories delineated inviolable laws of the universe, and this offended theologians who insisted that God must be permitted to enact anything he wished. The result was an unprecedented level of detailed criticism aimed at Aristotle's theories. And this criticism constituted more than a mere rejection on theological grounds – it reformulated physical properties of the universe outside the boundaries of Aristotelian thought. Grant has called the doctrine of God's absolute power "a powerful analytic tool" (1979: 217) in breaking free from the limits of Aristotelian physics.

[15] Grant identifies articles 34 and 49 as being particularly influential on thinking about Aristotelian physics in the context of God's absolute power. Article 34 permits God to create other worlds. In the Aristotelian system all earth was naturally drawn to the center of the world (i.e., the entire cosmos), and thus if other worlds existed they would draw earth from our world to their centers. Because Aristotle's physics allowed matter to have only one natural motion, he concluded that no such worlds could exist (1979: 220). However, when the 1277 condemnations created the possibility of other worlds, it inspired philosophers to contemplate how Aristotle's physics – predicated on the existence of only one world – might be comprehensible within a multi-world cosmos. "Thus it was the absolute power of God to make as many worlds as he pleased," remarks Grant, "which raised physical problems that evoked interesting solutions most of which conflicted with, or were alien to, the principles of Aristotelian physics and cosmology" (1979: 226). No less relevant to Aristotle's physics was article 49, which compelled philosophers to concede that God may move the world in a rectilinear motion. Central to Aristotle's theory of motion was that motion could only occur from one place to another, and that places were located in a plenum. Further, it was held that beyond the final sphere in which the heavens were located there was no other place. Therefore, prior to 1277 it was generally understood by natural philosophers that the world could not move, as there existed no place beyond it in which it could be moved. Moreover, its movement would leave behind a vacuum, an absurd impossibility in the Aristotelian system. But if motion required a plenum according to Aristotle, how could the world move in vacuum space? How could ordinary motion and acceleration be conceived in a vacuum? "It was almost inevitable," Grant claims, "that an idea such as the one that God could move the world rectilinearly should have posed difficult, and even unanswerable, questions about motion and place in the context of Aristotelian natural philosophy" (1979: 231). As with the problem of multiple worlds, the denial of the possibility that the world could be moved in a rectilinear fashion offended theologians who granted God the power to do anything, and so to deny him the power to move the world in such a way was an unacceptable conclusion. This religiously motivated act of censorship compelled philosophers to begin to question Aristotle's ideas about motion, place, and vacuum, and these questions began a long tradition of modification to the inadequacies of those ideas.

[16] The works of Aristotle were enormously influential on the university curricula, and even today his presence is felt in the subjects of logic and rhetoric. His physical theories, however, would eventually prove to be inadequate, but only after a very long and difficult process of modification. The 1277 Parisian condemnations were significant because they forced scholars to challenge Aristotle's views on the nature of matter and motion. This is a clear case in which theologically oriented critiques of science eventually proved to be leading science in the right direction, even if God's absolute power would not be the ultimate alternative to Aristotelian physics.

Implications of the Condemnations for Science

[17] The 1277 Parisian condemnations seem to have been influential for the reception of Aristotle's thought in the late Middle Ages (Grant 1996: 72). The condemnations stayed effective throughout the fourteenth century (Grant 1979: 213), and their influence spread to other medieval universities such as Oxford, where a similar set of condemnations was issued later in 1277 (Wilshire). Both Thijssen (87) and Grant (1979: 239) observe that many subsequent medieval texts explicitly referred to the Parisian condemnations of 1277, and many more implicitly affirmed their connection by taking up the arguments associated with them. Throughout the history of Christianity, there has hardly been a religious injunction which has had such a profound and enduring influence on scientific thought. Grant insists, "frequent citation of, and implicit allusions to, numerous articles of the condemnation of 1277 should convince us that it was taken seriously throughout the fourteenth century and that it encouraged innumerable invocations of God's absolute power . . . it is no exaggeration to view them as an integral feature of late medieval thought" (1979: 239).

[18] However, the relevance of the 1277 condemnations has been projected beyond the immediate effects of the late thirteenth and fourteenth centuries. Because the condemnations began the slow process of freeing scientific thought from the fetters of Aristotelianism, Duhem (1913) has famously argued that 1277 marked the beginning of modern science. Duhem notes of the contradictions to the faith addressed in the 1277 Parisian condemnations:

> Among these errors considered dangerous to the faith were several which might have impeded the progress of physical science . . . These condemnations destroyed certain essential foundations of peripatetic physics because although in Aristotle's system such propositions were ridiculously untenable, belief in Divine Omnipotence sanctioned them as possible while waiting for science to confirm them as true (1996: 173).

Grant seconds Duhem's thesis, pointing to discussions of the possibility of a vacuum and motion within it well into the seventeenth century in thinkers such as John Locke and Pierre Gassendi. Also, and perhaps most importantly for the history and development of science, Grant cites the 1277 condemnations as a *methodological* development that initiated the practice of using counterfactuals in scientific reasoning (1996: 196-97). Even Newton, Grant points out, made use of the counterfactual method, which he claims was inherited from the 1277 condemnations.

[19] Because late medieval philosophers were compelled to theorize physics outside of the now defunct Aristotelian system, the 1277 condemnations clearly represent a case in which science benefited from theological criticism. But as we shall see, the 1277 condemnations are not the only case in which this occurred. Paracelsianism, as well, challenged the ancient pagan natural philosophy by appealing to Christian dogma.

The Paracelsian Challenge to Medieval Natural Philosophy

Historical Circumstances Surrounding Paracelsus and his Philosophy

[20] Paracelsus, born Philip Theophrastus Bombast von Hohenheim, is one of the more controversial figures in the history of science. Affiliated with magic and other occult practices of the Renaissance, he is often dismissed as a pre-modern fool quite far removed from the practices and metaphysical bases of modern science. Yet the influence of his ideas on natural philosophy were felt a century after his death, at a time when science was just beginning to coalesce into its modern recognizable form.

[21] Born in 1493 to a learned physician in the Swiss town of Einsiedeln, his first contact with institutionalized education left Paracelsus disillusioned with the chasm between pedantic learning and practical experience at the medieval university, leading him to comment, "At all the German Schools, you cannot learn as much as at the Frankfurt fair" (quoted in Ball: 41). This early negative attitude toward the academic status quo adumbrates what would become a lifelong unabashed critique of the ancient paradigms. In 1512, after Paracelsus attained his bachelor's of science in Germany, he traveled to Ferrara, Italy to pursue a degree in medicine. As in Germany, at the University of Ferrara Paracelsus was disappointed by the uncritical veneration of the ancient authorities, and it is unclear whether Paracelsus lingered long enough to complete his degree in medicine (see Ball: 70-71).

[22] Paracelsus considered himself to be as much a theologian as a physician. Indeed, he saw no separation between the two pursuits. As Ambrose has observed, it is impossible to comprehend his medical theses without incorporating them with his views on God and God's relationship to man. While modern science views natural theories that are intertwined with Christian cosmologies with suspicion, Paracelsus's ideas were apt to be in accord with the prevailing cultural ideology in the period following the Reformation.

Relevance of Paracelsianism to Science

[23] One of the central criticisms Paracelsus leveled at the ancients was their paganism (Debus: 21). Galen and Aristotle were rejected on theological grounds, as they had not taken into account the truths revealed in the Bible. Paracelsus therefore sought to construct a natural philosophy that was not only consistent with Christian doctrine, but also emanated directly from it. By rejecting the pagan thinkers of antiquity, Paracelsus sought to "make chemistry and medicine truly Christian by freeing them from their pagan roots" (Walton: 4). His vitriolic attacks on Galen were legitimated through an appeal to religious authority and also by the quite impotent state of medical theory at the time.[3] Consequently, Paracelsus

[3] Ball notes, "in sixteenth-century Europe . . . there were doctors and there was medicine, but there does not seem to have been a great deal of healing" (48). Paracelsus's charge that contemporary physicians were little more than confidence men could hardly have been refuted with evidence of their successes.

constituted the first serious challenge to the medical theory of Galen and Hippocrates (Hammond: 7). He recognized that uncritical adherence to the ancients was preventing medicine from progressing any further, and "his aim was to break the bonds of ancient authority and accepted dogma which had for centuries held medical science enchained" (Stillman: 25).

[24] So that medicine and chemistry would unerringly embody the Christian truth, Paracelsus grounded his science in literal (if idiosyncratic) biblical exegesis (Daniel: 3-4). Many of his most notable scientific claims were reflections on specific biblical passages. For example, Paracelsus took Matthew 7:17 ("[E]very good tree bears good fruit, but a bad tree bears bad fruit") as a literal explanation for reproduction, in which the father contributed the "seed," the mother functioned as the "earth" in which it was nourished, and the child was the "fruit" that was produced. While it had long been obvious that both male and female were required for reproduction, Paracelsus was the first to give equal emphasis to male and female (Hammond: 15-16). The same biblical passage led Paracelsus to conclude that different diseases were the results of different "seeds" of disease being lodged in the body. This was a significant advance over Galenic theory, which postulated only one "disease"; to Galenists all maladies were a consequence of an imbalance of the four humors. Also, one principle occupation of Paracelsus and his followers was the use of chemistry in the interpretation of Genesis. To Paracelsus, creation was literally the "chemical unfolding of nature" (Debus: 23), and later Paracelsians would rely heavily on his Creation account as a means of "campaigning against the Galenic and Aristotelian establishment" (Daniel: 109). As many Paracelsus scholars have observed, there is little use in attempting to consider Paracelsus's scientific claims apart from his theological orientations.

[25] But Paracelsus's challenge to the prevailing scientific authority was more than just theological. Paracelsus believed that observation and experiment were necessary to interpret God's word in the Bible. Indeed, Paracelsus insisted that "fastidious research in the light of nature" (Daniel: 10) was a necessary requirement of all true Christians, and one of the characteristic features of Paracelsus's philosophy was to get doctors out of books and into the field (Stillman; Ball). Part of Paracelsus's remedy for the slavish adherence to ancient authority was to demolish it through an appeal to observation. And where observation contradicted the Galenists, Aristotelians, and Hippocratesians, Paracelsus reminded his colleagues that theory should not deny established facts, but should conform to them (Ambrose: 4). Through his integration of Christian doctrine and observational evidence, one major feature of Paracelsus's legacy was to give religious sanction to experimentation (Daniel: 41).

[26] This brief overview of the relevance of the Paracelsian philosophy to science has revealed that an appeal to Christian doctrine played a major role in challenging the prevailing scientific theories. While Galen would hardly depart from the intellectual scene so easily, Paracelsus's ideas can be considered as the beginning of the end for Galenic medicine.

The Implications of Paracelsianism for Science

[27] The ideas of Aristotle and Galen had dominated natural philosophy since antiquity, and by the sixteenth century the only serious challenge to Aristotle had resulted from the Parisian condemnations. Galenic medicine had received even less criticism, and scholars within the

university system were often reprimanded for suggesting that Galen had erred in some way. Paracelsus, however, worked outside the university system and thus possessed more freedom than his university-employed contemporaries to challenge the status quo. In the second half of the sixteenth century, shortly after the posthumous publication of his works, the Paracelsian movement appeared and it rivaled the Galenic establishment for hegemony (Debus). Bolstered by the newly available printing press, the Paracelsians battled the Galenists for the allegiance of the public in a "pamphlet war" (Debus: 6). At stake was nothing less than the future course of natural philosophy and medicine.

[28] The Paracelsians were an integral element in the slow and painful extrication of the ancients from the corpus of natural philosophy. Paracelsus's insistence upon the incorporation of Christian doctrine into natural thought appealed to the children of the Reformation who sought to escape the seemingly unnecessary authority of the Catholic Church and to develop an intimate relationship with Scripture (Daniel: 103). Ball has even claimed that there is "no sharp distinction" (103) between the reformation of the Church and that of natural philosophy. If Luther and Calvin were the leaders on the religious front of the Reformation, Paracelsus was endeavoring to unseat the ancient authorities at the natural-philosophical end. A century after Paracelsus's death in 1541, Paracelsian reformers were still working to this effect (Hammond: 7). Eventually, the Paracelsians and the mechanists emerged as the paradigms competing to replace the philosophies of Aristotle and Galen (Ball: 368). While the mechanists would eventually abolish from science all theologically oriented explanations of natural phenomena, their success would follow only after a long struggle with the Paracelsians. Although Paracelsus's philosophy was bound up in religious dogma, his emphasis on observation and his contribution to the ultimate expulsion of the ancients from the scientific corpus has led Koyre to call Paracelsus the founder of modern science. Paracelsus's contribution serves as a clear example of a religiously oriented critique of science that eventually proved to be productive for science. Of course, the specific religious contents of Paracelsus's critiques and ideas would never be incorporated into any modern scientific explanation of nature. However, that Pararacelsus's specific claims would ultimately be ignored does not preclude his role in overturning Galenic medicine and thus advancing the science beyond its ancient beginnings in which it stagnated for more than a thousand years.

The Function of Religiously Oriented Criticisms of Science

Examples from History

[29] In the previous sections on the thirteenth century condemnations and Paracelsianism, it has been shown that in both cases religiously oriented criticisms of the scientific establishment can function to reveal inadequacies in scientific theories, and suggest alternative pathways of understanding by rejecting the limits set by the reigning scientific paradigm. In the case of the 1277 Parisian condemnations, the demand that God commands absolute power over the physical properties of the world compelled natural philosophers to reconsider physics that were absurd in the Aristotelian paradigm. In this instance, the religiously motivated condemnations of Aristotelianism began the long process of exposing the inadequacies of Aristotle's physics, and therefore the condemnations served a positive function for science in the long run. A similar process can be observed in the Paracelsian

challenge to Galenic medicine. Paracelsus's primary complaint concerning Galen and the ancient medical philosophers was that they were pagans and therefore did not incorporate the truths of the Bible into their philosophies. Paracelsus's strategy for overturning the ancient philosophy was to show how observations of nature could be compatible with Scripture. As a consequence, Paracelsus was one of the first medical philosophers to stress the necessity of accounting for observation of the natural world in constructing theory. In the world of medieval scholarship, contradicting Galen was nearly blasphemous, and medical faculty who dared to stray from Galenic theory were often forced to recant their "errors" (Debus). Paracelsus, however, maintained no dogmatic allegiance to any but Christian doctrine, and so felt no hesitation at deriding the Galenic establishment at every turn, although the price he paid was complete marginalization by the medical community during his lifetime. Moreover, like the 1277 Parisian condemnations, the Paracelsian challenge to ancient medical theory began the long process of developing a modern alternative to ancient medicine and chemistry. By the beginning of the seventeenth century, the inadequacies of ancient natural philosophy had given rise to two camps eager to replace it: the iatrochemists (descendents of Paracelsian philosophy) – those who sought a mystical-religious foundation for the study of nature – and the mechanists – those who sought to abandon religious explanations for natural phenomena and reduce natural philosophy to the formulation of rules which could be reproduced in experiment (Debus). While the Paracelsians eventually lost this struggle, their positive contribution to science was to assist in dislodging the ancient philosophy from its hegemonic position.

[30] These examples illustrate that the ID-evolution conflict has precursors that predate Darwinism. Indeed, Christian challenges to scientific interpretations of nature are as old as Christianity. However, the past four centuries have witnessed astonishing successes of naturalistic science. In the thirteenth century, and even in Paracelsus's time, the Christian faith and its official dogma completely dominated all aspects of cultural life, constituting the institution by which all other institutions would be measured. During this era all knowledge claims were inevitably considered in their consistency with religious dogma, and natural philosophers who opted to operate outside of the conceptual framework provided by Christianity risked rebuke or worse. Today the hierarchy of institutions has shifted. Christianity is no longer the default doctrine against which naturalistic interpretations must struggle. Instead naturalistic science has secured epistemic hegemony, and it is creationists who find themselves at the margins of mainstream thought. Clearly then, the historical examples utilized in this essay deviate from the contemporary account of ID's critique of evolution in this key respect. The present world is one in which science has finally rose to the dominant position, and its unequivocal successes have severely narrowed the window in which religious critiques appear plausible. So in the present context, can ID possibly offer anything productive for science in the manner that the 1277 condemnations and Paracelsianism have?

The Small Picture: Complexity in the Biological Sciences

[31] There is evidence which suggests that Behe's notion of irreducible complexity may have indirectly contributed to developments in evolutionary theory. It should be emphasized that the biology community has uniformly rejected Behe's claim that irreducibly complex

biological systems could not have evolved,[4] and there is some doubt whether irreducible complexity even exists in biology (Sarkar). Moreover, Behe's insistence that irreducibly complex systems imply a designer has not been taken seriously by his colleagues. However, in the early 1990s, as Behe was writing *Darwin's Black Box*, his primary critique of evolution – that it failed to account for complex molecular processes – was entirely justified. Sarkar, in a volume dedicated to demolishing ID arguments, admits:

> *Darwin's Black Box* generated widespread interest within the biological community when it first appeared in 1996. It was widely reviewed and though, without exception, scientists dismissed Behe's claim of having found evidence for design, they largely agreed with his assessment that biochemistry presented several as yet unresolved puzzles for the theory of evolution by natural selection (96).

For example, Vella, in his review of *Darwin's Black Box* appearing in *Biochemical Education*, applauds Behe for his "discussion of the challenge that advances in biochemistry and molecular biology now pose to Darwin's ideas as currently formulated" (60), and in Coyne's review of Behe's work in *Nature*, he acknowledges, "There is no doubt that the pathways described by Behe are dauntingly complex, and their evolution will be hard to unravel" (227). It seems that, despite the shortcomings of Behe's ideas, he succeeded in alerting the scientific community to the challenges biochemistry presented to evolutionary theory. Indeed, as a still fledgling science, molecular biology had not been considered in the modern formulation of the evolutionary paradigm (Behe: 24-25). Despite unrelenting criticism of ID, Sarkar observes, "To the extent that Behe may have been responsible for focusing attention on genuinely interesting puzzles, *Darwin's Black Box* may be viewed as a positive philosophical contribution to science: evolutionary theory, like any other scientific theory, should be confronted with recalcitrant facts" (96). The stir caused by Behe's criticisms has contributed to a recent push to understand "biocomplexity," or the evolution of complex biological systems such as the ones described by Behe. Research in biocomplexity has even graced the pages of *Nature* (Lenski et al.) and *Science* (Bridgham, Carroll, and Thornton). Lenski et al., in their computer simulations of the evolution of complex features, take as their point of departure the dearth of scientific evidence on the evolution of complex biological systems, admitting that biological complexity has constituted "a long-standing challenge to evolutionary theory" (139). And in Bridgham's et al. study of the functional molecular relationship between the steroid hormone aldosterone and its mineralocorticoid receptor (what the authors consider a complex biological system), the justification they give for conducting their research could have come straight from *Darwin's Black Box*:

> The ability of mutation, selection, and drift to generate elaborate, well-adapted phenotypes has been demonstrated . . . How evolutionary processes

[4] There are two broad evolutionary interpretations of complex biological systems: 1) adaptations may initially occur long before their integration into a complex system and are not indispensable, but merely advantageous. However, later developments in the system render the initial trait indispensable. 2) Traits are selected for one function, but are co-opted to serve a different function later on (what biologists call "exaptation") thus dismissing the claim that irreducibly complex systems require parts to be simultaneously generated (see Thornhill and Ussery; Gishlick).

> assemble complex systems that depend on specific interactions among the parts is less clear, however. Simultaneous emergence of more than one element by mutational processes is unlikely, so it is not apparent how selection can drive the evolution of any part or the system as a whole. Most molecular processes are regulated by specific interactions, so the lack of exemplars for the emergence of such systems represents an important gap in evolutionary knowledge (97).

Bridgham et al., like Behe, are concerned that evolutionary theory has yet to account for "complex systems that depend on specific interactions among the parts." Moreover, Bridgham et al. go on to cite precisely the *same passage* from Darwin's *Origin of Species* that Behe cited (see above) to justify their own work on aldosterone. In the same issue of *Science* in which Bridgham's et al. article appeared, Christoph Adami makes an explicit link between their work and ID, stating that it is of "particular scientific interest, given the political attention given to intelligent design lately" (63). Clearly, while Behe has remained a marginal, even blacklisted member of the biology community, his criticisms of evolutionary theory have served as a basis of subsequent research on complex biological systems. Biochemistry has now been incorporated into the evolutionary fold, but only after Behe's critique of evolutionary theory in terms of ID spurred scientists to consider evolution at the molecular level.

[32] The parallels between Behe's critique of evolution and the historical examples expounded above should be obvious: in all of the cases considered here a religiously orientated critique of a scientific theory functioned to improve the state of the science by compelling researchers to advance in directions which would have otherwise been (at least at the time) largely ignored. Of course, the fates of Aristotelian physics and Galenic medicine have already been decided, and the thirteenth century condemnations and Paracelsians have been vindicated in their rejections of the ancient natural philosophy. Behe's contribution to biology's new focus on complex systems has shown that, like the thirteenth century condemnations and Paracelsus, appeals to supernatural forces have at times indirectly contributed to science, even if no such forces are found to affect natural processes.

The Big Picture: On the Origin of Criticism

[33] Criticisms of scientific theories cannot be categorically rejected because they appeal to supernatural forces. It must be emphasized that in all three cases considered here, the specific religious claims of those challenging the scientific establishment were not taken up as legitimate explanations of natural processes. When Aristotelianism finally fell, it was not because God's absolute power was found to be a demonstrable fact. Modern medicine, like Paracelsus, has no need for Galen. However, unlike Paracelsus, neither does it require biblical interpretation. While Behe's complaints about evolutionary theory may have been justified, the biological sciences did not require a supernatural agent to address them. Yet, in all three cases it can be observed that science ultimately benefited from these criticisms. This is because *the motivations underlying criticisms are irrelevant to the content of those criticisms*. Indeed, the history of science is full of ideas which in themselves were eventually abandoned but nevertheless directed research onto a productive path. In the early history of evolutionary theory, many biologists supported the recapitulation hypothesis, which postulated that in its

embryonic stage an organism relived its evolutionary heritage through successive morphological changes to the undifferentiated state at conception. The recapitulation hypothesis turned out to be incorrect. However, those who expected it to bear fruit began to pay close attention to embryonic forms of life, and "these embryological investigations served enormously to expand biologists' knowledge of the varied developmental patterns of plants and animals" (Coleman: 82). The case of the recapitulation hypothesis bears a resemblance to the religiously oriented criticisms that have been considered, in that it served to put science onto a productive path despite its ultimate falsification. What makes the recapitulation hypothesis stand out compared to the cases of religious criticisms of scientific theories is that it is philosophically uncontroversial: Whereas the three cases of religiously orientated criticisms of science transgressed the modern scientific metaphysic (i.e., naturalism), recapitulation was simply an incorrect hypothesis located squarely within the bounds of legitimate science. However, to the extent that all of the examples produced similar consequences, the metaphysical bases of their premises are irrelevant.

[34] All of this begs for a more general statement about the role of theology in naturalistic science. Naturalism, by definition, disallows supernatural forces from intervening in natural phenomena, and so any religious claim to divine intervention cannot be included in a naturalistic system. However, *theology can serve naturalistic science if its claims can be interpreted within a naturalistic framework*. Brooke notes, "Debates which have so often been interpreted in terms of the 'conflict between science and religion' turn out, on closer inspection, to be debates in which rival claims are made for the 'correct' meaning to be attached to scientific theories" (275). Indeed, in the case of the ID-evolution conflict ID advocates do not deny the findings of biological science, but merely insist that religious interpretations of those findings be readmitted into the scientific corpus. This point is crucial because it highlights the fact that ID concerns itself with many of the same concepts and processes as naturalistic biological science and as a consequence it may contribute to science's understanding of those concepts and processes, even if those contributions are inadvertent, indirect, or undermine the original intent of the criticism.

Conclusion

[35] Despite the fact that theological claims on nature may in certain respects be helpful for naturalistic science, the uneasy relationship science and religion share is healthy and probably unavoidable. Even if Behe, operating within an ID framework, contributed indirectly to evolutionary understandings of biological complexity, this does not mean that biologists would have done well to consider ID as a serious scientific pursuit. And more generally, even if naturalistic theories may benefit indirectly from religious challenges, this does not mean that naturalism is an untenable principle. The only conclusion that may be drawn is that some religiously oriented challenges to science may be stripped of their supernatural overtones and incorporated as a positive contribution to naturalistic systems. This essay has attempted to show that religious challenges have in the past proven productive for science, not because they were ultimately correct in their claims, but by suggesting new directions in research and thought that had previously been occluded or neglected. An implication of this argument is that it is possible in the future for *ID to make a positive contribution to evolutionary theory*; indeed, it would hardly be surprising given that exposing the weaknesses of

evolutionary theory is a preoccupation of ID. Because ID expends so much energy attacking evolutionary theory, it is likely that eventually, similar to Behe's charge that evolution had not sufficiently explained complex molecular systems, it will reveal something of import that evolutionary theory will be forced to address.

[36] A marriage between biological science and ID is neither plausible nor desirable. Still, a complete understanding of the relationship between ID and science requires an acknowledgement that science has and may again in the future benefit from religiously orientated criticism.

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