

THE UNIFORMITY OF NATURAL LAWS IN VICTORIAN BRITAIN: NATURALISM, THEISM, AND SCIENTIFIC PRACTICE

by Matthew Stanley

Abstract. A historical perspective allows for a different view on the compatibility of theistic views with a crucial foundation of modern scientific practice: the uniformity of nature, which states that the laws of nature are unbroken through time and space. Uniformity is generally understood to be part of a worldview called “scientific naturalism,” in which there is no room for divine forces or a spiritual realm. This association comes from the Victorian era, but a historical examination of scientists from that period shows that uniformity was an important part of both theistic and naturalistic worldviews. Victorian efforts to maintain the viability of miracles and divine action within a universe ruled by natural laws receives special attention. The methodological practices of theistic and naturalistic scientists in the nineteenth century were effectively indistinguishable despite each group’s argument that uniformity was closely dependent on their worldview. This similarity is used to reexamine both the reasons for the decline of the role of religion within the scientific community and claims made by the intelligent design movement about the relationship of science and religion.

Keywords: history; intelligent design; laws of nature; methodological naturalism; miracles; naturalism; theism; worldview

It is no secret that the intelligent design (ID) movement sets its sights on overthrowing the current structures of science. Their stated goal is to replace modern science with “theistic science,” and their strategy is to do so through attacking methodological naturalism—the foundational principle that science should only invoke natural laws and events (Johnson 1993, 2001; Plantinga 2001; Tammy Kitzmiller v. Dover 2005). This naturalistic approach, they assert, is wholly incompatible with a theistic view of the universe. Many vocal scientists agree (Dawkins 1987).¹

I argue here that the history of science shows this alleged incompatibility to be far from obvious. Even during the throes of the Darwinian controversies, when the myth of eternal warfare between science and

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religion was being developed, there was broad agreement among scientists (theistic or otherwise) about the methodological foundations of science. Here, I will examine the historical use of one such principle that still sits at the center of arguments between ID and its critics: the uniformity of nature. This principle is often invoked by ID as explicitly prohibiting a religious worldview, but a historical perspective shows that its relationship with religion is much more complex than one might expect. Uniformity has been justified and embraced in both purely naturalistic and theistic contexts, and in both, allowed for virtually identical scientific methodologies—that is, the actual practice of science—regardless of whether God was part of the equation.

UNIFORMITY

Uniformity is the claim that the laws of nature are the same everywhere and everywhen in the universe—that those laws do not break down or lapse anywhere in time or space. For example, uniformity demands that scientists conceive of the Earth’s surface being formed in distant ages by the same processes of matter and energy at work today. This idea emerged from complex historical processes and comes in several different varieties, but by the mid nineteenth century, there was a core version of uniformity that is recognizable to modern scientists and philosophers (Hooykaas 1963; Rudwick 1971).²

The importance of this uniformity of nature is well described by the philosopher of biology Michael Ruse: “I believe the key distinguishing factor about science to be its appeal to and reliance on *law*: blind, natural regularity. Everything else follows from an unpacking of this notion: explanation, prediction, testing, confirmation, falsifiability, tentativeness” (Ruse 1988, 21). This regularity of natural law, he says, is “that which makes science possible” (Ruse 1995, 2). Robert Pennock, a key witness against ID in the 2005 *Dover* trial, credits uniformity with making even basic empiricism possible (Pennock 1996, 552). The idea that the regularities of the world enshrined as natural laws will always happen, and never change, seems to be essential. Modern scientists have a hard time imagining how one could do science, if this assumption of uniformity was not invoked. How can you conduct an experiment on gravity if objects will fall differently tomorrow from today, or differently in Kenya or in Kansas? Indeed, many scientists would say that the mere fact that science is feasible and the universe is comprehensible shows that this assumption must be true.

ID’s hostility to uniformity comes from an important corollary, that uniformity gives no room for supernatural or spiritual forces. One way to describe this is that the “natural world is the whole of reality that we know of and interact with; no supernatural or spiritual realm distinct from the natural world shows up *within* our natural world, not even in the mental

life of humans” (Drees 1997, 531).³ Uniformity is said to allow for no hidden corners in nature. The world is a unitary whole, with only one set of laws that are never suspended or restricted. There are no gaps for God to hide in, nothing is shielded from explanation in terms of natural laws, and there are no eras of history concealed from investigation. There can be no believers in Nebuchadnezzar’s furnace if the laws of thermodynamics apply; the Mosaic chronology cannot be literally correct unless the laws of radioactivity have been suspended. Is it not obvious, then, that uniformity allows no space for religion or the divine? Despite these concerns, it was not at all clear to historical scientists that a uniform universe must be *truly* naturalistic; that is, that uniformity necessarily excluded religion, theology, and supernatural considerations.

A HISTORICAL PERSPECTIVE

To explore these issues, I will focus on the time and place where scientific naturalism in the modern sense emerged: Victorian Britain. The term “scientific naturalism” was first coined by T. H. Huxley in 1892, but the ideas, methods, and attitude of naturalism became widespread decades before (Numbers 2003). In the middle decades of the nineteenth century, a group of scientists preaching the strict exclusion of religion from scientific matters (for which the uniformity of nature was an important weapon) became influential and rose to prominence in the scientific community (Jacyna 1980; Lightman 1987, 2001; Moore 1979; Numbers 2010; Ruse 1975; Turner 1974, 2010; Young 1985).⁴ Led by Huxley, John Tyndall, and their allies, these strongly naturalistic scientists portrayed themselves as the vanguard of a truly modern and enlightened science and eventually succeeded in making their visions of a completely naturalistic and areligious science seem obvious and inevitable—precisely how naturalism is presented by scientists today. However, a historical perspective allows us to see naturalism and its associations with fresh eyes in its “native” context, and reminds us that uniformity was *not* an obvious ally for those hostile to religion. The uniformity of nature did indeed become an increasingly critical assumption of science over the course of the century, but its role as an antireligious category was far from clear. By examining historically how uniformity actually worked in science, and how it was justified, we can better understand the complicated relationships among uniformity, religion, and naturalism.

Other scholars have already contributed important work to our understanding of the history of scientific naturalism. Bernard Lightman (1987) has shown us how agnostics embraced uniformity as an axiomatic statement about the world, and I will here examine the other side of the coin—how theists also embraced uniformity, but for almost completely opposite reasons. This is to be distinguished from the figures discussed

in Frank Turner's classic work (1974), who criticized naturalism from a variety of perspectives, but who were not orthodox Christians. The theists discussed in this paper are those who, strangely, agreed with the naturalistic scientists on important points. My argument builds most strongly on Ronald Numbers's discussion (2003) of the intersection of Christian belief and natural law. I am particularly interested in the overlap of theistic and naturalistic thinking in the area of scientific methodology, and the implications that has for our understanding of the transition from theistic to naturalistic science, as well as current controversies regarding ID.

I do not have space here to engage in a detailed and thorough examination of Victorian naturalism and religion, so I will instead discuss representatives of two groups within the Victorian scientific community: naturalistic scientists and theistic scientists. These two groups are, of course, locations on a continuum rather than incommensurable poles, but in this essay, I treat them as deeply separated for the purposes of clearer argument. The uniformity of nature remains my primary focus, and I will first show its function and significance for the naturalistic scientists, and then for the theistic scientists.

We are often told that Darwin, by extending the uniformity of nature to the biological world, pushed religion from science and, therefore, turned science truly naturalistic and modern. But many leading scientists in the Victorian period continued to work productively in a theistic context even as naturalistic scientists flourished. These two groups were bitterly opposed, with both sides deploying rhetoric accusing the other of corrupting the true nature of science. Strangely, though, there was no such split in matters of scientific *practice*. The basic methodological assumptions that made science possible, such as the uniformity of natural laws, were agreed upon by both sides of the theistic/naturalistic divide.

The importance of natural laws and their uniformity in nineteenth-century science can be seen in one of the most influential documents of the period: John Herschel's *Preliminary Discourse* (1830), a formative text for a generation or two of scientists. It helped articulate scientific orthodoxy before the scientific community split into theistic and naturalistic camps and remained important for both. Herschel stressed that the regularity of natural phenomena was an essential part of the universe: it is "impressed on us from our earliest infancy . . . that events do not succeed one another at random, but with a certain degree of order, regularity, and connection. . ." (Herschel 1830, 35). Those phenomena that "happen uniformly and invariably" can then become laws of nature, which were both the goal and proper focus of attention for the natural philosopher (Herschel 1830, 119).

Herschel addressed directly the uniformity of these laws. Was it possible that laws were "subject to mutation" over time, or that they were restricted in their application? The clear answer was no: a natural law

functions “uninterruptedly, for ages beyond all memory, [and gives] a strong expectation that it will continue to do so in the same manner; and thus our notion of an *order of nature* is originated and confirmed” (Herschel 1830, 35, 39–40). Herschel’s position that the essence of science was the search for and study of universal, uniform laws was accepted by every scientist I will discuss here, whether theist or naturalist. Precisely what uniformity meant, and how one should think about it, was more complicated.

NATURALISTS

Scientific naturalism had its most important locus in a group known as the X-Club (Barton 1990; Jensen 1970/1; MacLeod 1969). This informal network (essentially, a dining club) of young, ambitious scientists sought to professionalize their discipline and increase its social and cultural standing. A critical part of this effort was the exclusion of religion, the supernatural, and the clergy from science: “They opposed all suggestions that there were supernatural interventions in the natural order and any attempts to constrain scientific investigation within theologically-determined boundaries” (Barton 1990, 56). A major driving force for the X-Club was to eliminate the lingering aristocratic and clerical control over science professorships and institutions.

The triumphalist story of scientific naturalism—that science only became modern once it cast off the albatross of religion—is precisely the story promoted by the X-Club. While they were far from representative of scientists of the time, its leaders spent a great deal of time and energy discussing the foundations of science and explaining how those foundations excluded the supernatural. And the most important idea supporting that exclusion was uniformity.

Here, I will consider two of the most eloquent and aggressive spokesmen for this position—T. H. Huxley and John Tyndall. Huxley, as “Darwin’s bulldog,” was perhaps the better known (Desmond 1997; Lightman 1997). For him, the purpose of science was to uncover the orderly system of the universe: “The fundamental axiom of scientific thought is that there is not, never has been, never will be, any disorder in nature.” It would be impossible for science to admit “the occurrence of any event which was not the logical consequence of the immediately antecedent events, according to these definite, ascertained, or unascertained rules which we call the ‘laws of nature. . .’” (Huxley 1887c, 70). Any one of these rules “by which the relation of phenomena is truly defined, is true for all time” (Huxley 1887b, 61). The laws of nature admitted no exceptions or interruptions.

This uniformity then allowed scientists to discuss the distant past scientifically, because one could extrapolate the past based on forces visible today (e.g., erosion) (Huxley 1859a, 90). Huxley argued that even violent,

apparently nonuniform events such as volcanoes and earthquakes should be thought of as uniform phenomena:

The working of a clock is a model of uniform action; good time-keeping means uniformity of action. But the striking of the clock is essentially a catastrophe; the hammer might be made to blow up a barrel of gunpowder, or turn on a deluge of water; and, by proper arrangement, the clock, instead of marking the hours, might strike at all sorts of irregular periods, never twice alike, in the intervals, force, or number of its blows. Nevertheless, all these irregular, and apparently lawless, catastrophes would be the result of an absolutely uniformitarian action. . . (Huxley 1869, 324–25)

A natural law was universal and could not, by definition, be interrupted: “To speak of the violation, or the suspension, of a law of nature is an absurdity. All that the phrase can really mean is that, under certain circumstances the assertion contained in the law is not true; and the just conclusion is, not that the order of nature is interrupted, but that we have made a mistake in stating that order” (Huxley 1887a, 14). Any apparent disruption to the orderliness of nature was an indication of a human error, and nothing more.

But, of course, humans had throughout history claimed to see such disruptions and attributed them to the intervention of a higher power. Huxley’s position was that the progress of all of the sciences could be measured by the rejection of divine intervention in favor of natural causes (Huxley 1859b). He said, what made a discipline scientific was its insistence on unbroken law, particularly in rejection of the supernatural. Huxley referred to the order of nature in almost every essay or lecture, and explicitly opposed it to theology (Barton 1983). He celebrated the “complete emancipation of the modern geologist from the controlling and perverting influence of theology” (Huxley 1887b, 127). His famously vicious review of *Vestiges of the Natural History of Creation* attacked the book as unscientific on this very point of God’s activity. It made no sense, he said, to speak of natural laws at the same time as divine action. So long as there was “‘creative fiat,’ an ‘interference,’ an ‘interposition of creative energy,’” there could be no science (Huxley 1854, 6). Any violations of the uniformity of nature, whatever the source, were “out of the domain of science altogether” (Huxley 1859b, 10). Religion, as the culprit of such violations, was something wholly other.

Huxley’s friend and ally John Tyndall also spoke vigorously of the power of uniformity to banish God, particularly in his famous Belfast address. A valid natural law, he said, “asserts itself everywhere in nature” (Tyndall 1875a, lxxxviii). The mutability of nature demanded by religious believers was being steadily crushed by the advance of science. The effect of this was predicted to be dramatic:

Now, as science demands the radical extirpation of caprice and the absolute reliance upon law in nature, there grew with the growth of scientific notions a desire and determination to sweep from the field of theory this mob of gods and demons, and to place natural phenomena on a basis more congruent with themselves. (Tyndall 1875a, lxvii)

Tyndall could hardly be clearer. The uniformity of natural laws left no room for religion in science. A sterling example of the military metaphor of science and religion is seen in the martial language used:

The impregnable position of science may be described in a few words. We claim, and we shall wrest, from theology the entire domain of cosmological theory. All schemes and systems which thus infringe upon the domain of science must, *in so far as they do this*, submit to its control, and relinquish all thought of controlling it. Acting otherwise proved disastrous in the past, and is simply fatuous to-day. (Tyndall 1875a, xcvi)

According to him, science, as a complete scheme of the universe, could have no interaction with religion other than accepting its surrender. Before the advent of science, Tyndall said the unlearned masses had no option other than filling the world with “witchcraft, and magic, and miracles, and special providences.” This appeal to the unseen was a natural human behavior, but foolish and dangerous nonetheless. The power of natural laws would simply squeeze the world until nothing else remained: “the law of gravitation crushes the simple worshippers of Ottery St. Mary, while singing their hymns, just as surely as if they were engaged in a midnight brawl” (Tyndall 1875b, 67, 49).

The subtext of these claims was that uniformity not only restricts religion from entering science, but that uniformity can only be justified in a world without divine intervention. How can scientists plan and conduct an experiment if they must worry that Jehovah will change the constants of nature? Uniformity can only be justified, then, if everyone agrees *a priori* that there can be no divine interventions.

So far, this is not surprising. Naturalism in the Victorian period sounds much like the complaints raised by ID—crusading scientists removing the possibility of the divine by fiat. But there is more to the story.

THEISTS

While scientific naturalism made serious inroads into Victorian science, it did not seem to have much impact on theistic scientists themselves. The claims of Huxley and Tyndall that uniformity demanded a completely a-religious science did not drive the theists to secularism. And yet, these theistic scientists (in Britain, almost all Protestants of various flavors) were in total agreement with the naturalists that uniformity was critical to the advance of science. How could they embrace the naturalistic methods but not the naturalistic conclusions (Numbers 2003, 81)?

The answer is that the theists saw uniformity as *their* impregnable position, not Tyndall's. The consistency of natural laws over time and space was a sign pointing toward God, not warding him off. John Herschel, the great authority of Victorian science, wrote that natural laws had their origin in the "Divine Author of the universe" and that the uniformity of those laws came from "the constant exercise of his direct power in maintaining the system of nature, or the ultimate emanation of every energy which material agents exert from his immediate will, acting in conformity with his own laws" (Herschel 1830, 37). The laws of nature were only stable because of God's constant and ubiquitous action. If matter and energy were left to their own devices, the universe would be a place of chaos. The orderliness of natural phenomena could only be explained, the theists argued, if God ensured that it was so. This attribution of uniformity to divine action extends back to the scientific revolution and the emergence of the concept of natural laws in the modern sense. Victorian theists were following in a long tradition of allying God and the laws of nature that was widespread and productive. This was explicit in natural theology in the style of William Paley, as well as implicit in the work of the scientists themselves. Natural laws were seen as instances of divine fiat, and they were constant because God is consistent in his actions (Harrison 2008).

Despite the expectations of scientific naturalism, this link between uniformity and divine action remained widespread throughout the nineteenth century and can be seen in the work of some of the most important scientists of the period. Consider William Thomson, better known as Lord Kelvin. Kelvin argued that the vast age of the earth claimed by geologists and biologists was unfeasible due to the laws of thermodynamics. This attack on cutting-edge science, including Darwinian evolution, earned him a reputation as a defender of the old guard unwilling to adapt to modern scientific methods and perspectives. But Kelvin's position in these debates was actually built on precisely the same methodology as his opponents: uniformity.

We are used to thinking of attacks on geological estimates of the earth's age as relying on attacks on uniformity: radioactive dating is unreliable or uniformitarian processes were disrupted by directly creative acts such as Noah's flood. It is easy to interpret Kelvin's arguments in this light, particularly with his statements such as "There cannot be uniformity" (Smith & Wise 1989, 585). However, this is misleading. He was actually attacking a particular kind of geological uniformitarianism that allowed for an extremely old earth, not uniformity in general, and his position was essentially that geologists were not being uniform *enough*. Huxley, and others, he said, assumed that geological forces should be thought of as being constant deep into the past, virtually forever. But this constancy of geology was made impossible by the constancy of physics: the second law of

thermodynamics demanded that deep in the past, the surface of the earth would appear and behave quite differently from how it does today. Kelvin said that if there was a dispute about the uniformity of different processes, one must assume that the more fundamental process (i.e., physics rather than geology) holds to the principle most closely.

Far from attacking uniformity, Kelvin was vigorously defending uniformity. He believed strongly that natural laws were permanent and universal (Burchfield 1975, 3, 28). Indeed, he was actually attacked for this assumption (Smith & Wise 1989, 544–48). Kelvin thought the whole scientific enterprise relied on the idea that currently observed natural laws could be extended throughout time: “the essence of science, as is well illustrated by astronomy and cosmical physics, consists in inferring antecedent conditions, and anticipating future evolutions, from phenomena which have actually come under observation” (Smith & Wise 1989, 638). He completely rejected the possibility of violations of natural laws, particularly supernatural intervention. Since natural laws were uniform, scientists must restrict themselves to explanations in terms of those laws: “If a probable solution [to any scientific problem], consistent with the ordinary course of nature can be found, we must not invoke an abnormal act of creative power” (Burchfield 1975, 48).

Kelvin was a Christian with a Latitudinarian perspective, and he was adamant that a uniform universe was still perfectly consonant with a religious worldview. Writing with his collaborator P. G. Tait, he declared that

we have the sober scientific certainty that heavens and earth shall “wax old as doth a garment” [Psalm 102:26]; and that this slow progress must gradually, by natural agencies which we see going on under fixed laws, bring about circumstances in which “the elements shall melt with fervent heat” [2 Peter 3:10]. (Smith & Wise 1989, 535)

They made the case that a world running by “natural agencies” was an idea with strong scriptural support. The reason for this, of course, was that Kelvin saw natural laws as coming from God. They were clearly the result of a creative, consistent intelligence, and it was this intelligence that allowed for uniformity in the first place (Burchfield 1975, 49; Smith & Wise 1989, 555).

Kelvin’s fellow pillar of Victorian physics, James Clerk Maxwell, had similar feelings. He clearly worked with the assumption of uniformity of natural laws in both time and space. Spatially, his award-winning investigation of Saturn’s rings began with a statement that it was inconceivable that terrestrial mechanics might not apply to distant planets (Brush, Garber, and Everitt 1983, 73). Temporally, he explained to his students that once a natural law was grasped, one could ponder its effects on events that have not yet occurred—assuming, of course, that

that law will hold good in the future (Maxwell 1857, 543). A basic principle of science was that “place and time are not among the conditions which determine natural processes” (Maxwell 1890c, 418). Maxwell did not welcome violations of uniformity. He rejected otherwise impressive hypotheses for the cause of gravity because they suggested interruptions of conservation of energy (Maxwell 1890a, 491).

Maxwell was a fairly conservative Victorian evangelical Christian, who took scripture quite seriously. And as with Kelvin, Maxwell thought that the uniformity of the cosmic order had greater significance:

I think that each individual man should do all he can to impress his own mind with the extent, the order, and the unity of the universe, and should carry these ideas with him as he reads such passages as the 1st Chap. of the Ep. to Colossians. . . , just as enlarged conceptions of the extent and unity of the world of life may be of service to us in reading Psalm viii.; Heb. ii. 6, etc. (Maxwell 1876, 418)

The unity of nature was a theological concept as well as a scientific one (Stanley 2011). The scriptural passages Maxwell referred to here emphasized God’s role as creator of the natural world (Colossians 1:16: “For in him all things in heaven and on earth were created, things visible and invisible”) and the awe that God designed his creation for humanity (Hebrews 2:6: “What are human beings that you are mindful of them, or mortals, that you care for them?”) (New Revised Standard Version). Thus, Maxwell was powerfully linking the unity and order of nature not just with divine creation itself but also with the role of humans in that creation. In the same letter he argued that we can see “wisdom and power” in the uniformity of natural laws just as effectively as in the beneficial adaptations of living creatures: “uniformity, accuracy, symmetry, consistency, and continuity of plan are as important attributes as the contrivance of the special utility of each individual thing” (Maxwell 1876, 417).

In addition to uniformity being another premise in the argument from design, it was a tool given to man by God to fulfill the commandment to subdue nature. Maxwell, writing to his students, instructed that once they understood the constancy and universality of natural laws, they would

begin to understand the position of man as the appointed lord over the works of Creation and to comprehend the fundamental principles on which his dominion depends which are these—To know, to submit to, and to fulfil, the laws which the Author of the Universe has appointed. Attend to these laws and keep them, you succeed, break them, you fail and can do nothing. (Maxwell 1857, 543)

Natural laws were a manifestation of the divine will, just like Biblical commandments. The principles that ran the steam engine and created the wealth of industrial Britain were gifts from God. Conscientious people

had an obligation to be mindful of the immutability of both natural and moral law.

Maxwell's best known statements on the uniformity of nature appeared in his famous lecture on molecules at the British Association for the Advancement of Science. He argued that new techniques of spectroscopy showed that in the Sun "there are molecules vibrating in as exact unison with the molecules of terrestrial hydrogen as two tuning-forks tuned to concert pitch, or two watches regulated to solar time . . . Now this absolute equality in the magnitude of quantities, occurring in all parts of the universe, is worth our consideration." Hydrogen in distant stars, or liberated from rocks buried since time immemorial, was identical to that in the Cavendish lab. This incredible uniformity among matter scattered through space and time indicated the hand of a divine manufacturer: again, uniformity could only be explained through God (Maxwell 1870, 224).

Maxwell and Kelvin were both members of what Crosbie Smith has called the "North British" group of scientists that were critical in the spread of energy physics and forging particular links between physics and industry (Smith 1998). This grouping helps bring out some of the common characteristics of the prominent theistic scientists working in the second half of the nineteenth century: they were often located in the industrial regions of north England and Scotland; had connections in the rising industrial classes; and typically held Dissenting (i.e., non-Anglican) religious views. Those theistic scientists that were Anglicans often had evangelical leanings as well (e.g., Maxwell, George Gabriel Stokes), giving them connections outside the established church. It is difficult to generalize about such a broad group, but it is interesting to note that productive theistic scientists were usually non-Anglican and often worked in the physical sciences.

However, religious defenses of uniformity were found in the life sciences as well. William Carpenter, the pioneering physiologist and liberal Unitarian, argued that "orderly uniformity" was the distinguishing feature of a law of nature, and that this uniformity revealed the law's divine origins:

It is thus that when we pass from the sphere of human government to that of the Divine, and speak of the universe as "governed" by the "laws" of a supreme Ruler, we mean that his power is exerted, not like that of an arbitrary potentate who changes his course of action as his own caprice or passion may direct, but like that of a benevolent sovereign whose rule is in uniform and orderly conformity with certain fixed principles, originally determined as conducive to the welfare and happiness of his people. (Carpenter 1888a, 367–68, 382)

In addition to being dependent on the Creator, uniformity revealed his nature as well. God's benevolence and consistency could be seen in all realms: "we see that the hypothesis [of uniformity] coincides with all which Science and Religion alike teach, respecting the invariability of His mode of working" (Carpenter 1888b, 36–37).

Even the great weapon of the scientific naturalists, evolution, was fit comfortably into such schemes. Belief in theistic evolution—that is, evolution guided or supported in some way by God—was widespread, and many commented on how Darwin’s ideas had extended uniformity throughout the world of life. Frederick Temple, the future Archbishop of Canterbury stated: “Once more, the doctrine of Evolution restores to the science of Nature the unity which we should expect in the creation of God” (Temple 1884, 121). The Duke of Argyll, who did important work in both science and politics, argued that God’s choice to create species via natural laws instead of direct fiat was no slight of His power: creation by process “is Creation still” (Argyll [1867] 1870, 29).

In sum, far from uniformity being antithetical to religious thinking, many scientists and philosophers concluded that uniformity only made sense in a theistic world. Without an ordering force (i.e., God) one would expect the universe to be a mishmash of chaotic events. The only guarantee for constancy of the laws of nature was the intent of the lawgiver. Temple and Argyll acknowledged that the uniformity assumption was critical for science (“on no other assumption can Science proceed at all”), that it was justified both by the results of science (“This idea is a product of that immense development of the physical sciences which is characteristic of our time”) and simple experience (“Millions on millions of observations concur in exhibiting this uniformity”) (Argyll [1867] 1870, 3; Temple 1884, 8, 27). The theists did not reject empiricism, reasoning, testing, or theorizing. Rather, they said all of those things were dependent on God, and pointed to his role in the universe.⁵ Baden Powell chose a quote from the scientist Hans Christian Oersted to describe elegantly this framework:

The progress of discovery continually produces fresh evidence that Nature acts according to eternal laws, and that these laws are constituted as the mandates of an infinite perfect reason; so that the friend of Nature lives in a constant rational contemplation of the Omnipresent Divinity. . . . The laws of Nature are the thoughts of Nature; and these are the thoughts of God. (Powell 1855, 113)

THE PROBLEM OF MIRACLES AND CREATION

Within the general rubric of uniformity, there are two specific topics that are thought commonly to be exemplars of how uniformity allows no room for religion: miracles, and the origin of the universe. These are shibboleths, if you will, which put someone into either the theistic or naturalistic camp. It seems that a miracle must be a violation of a natural law, and therefore, a violation of uniformity, and therefore, has nothing to do with science (Ruse 2001, 95; 2005, 44).

This was certainly the vulnerable point emphasized by Victorian scientific naturalists, many of whom were directly inspired by David Hume.

Huxley's battles with Gladstone turned on precisely this issue, and in the infamous "prayer gauge" debate, Tyndall was merciless in drawing this line (Mullin 2003). He said that once science had demonstrated the uniformity of nature, "the age of miracles is past" (Tyndall 1875b, 36). There was no indication that natural law was ever suspended, and therefore, there was no possibility of miracles. The only way out, he said, was to retort: "How do you know that a uniform experience will continue uniform? You tell me that the sun has risen for six thousand years: that is no proof that it will rise tomorrow; within the next twelve hours it may be puffed out by the Almighty" (Tyndall 1875b, 409). He said someone attacking uniformity in this way, however, could barely function in the normal world, and had no reason to believe that Jack and the beanstalk was not a true story, since perhaps the natural laws governing bean growth had been suspended at some time. The rhetorical move here was a clear one: someone who believes in the miracles of the Bible or that God will answer a prayer for their sick child was no different than someone who believed in fairy tales.

The Victorian naturalists felt they had hemmed the theists into an inescapable dilemma. To do science, the universe needed to be uniform. But uniformity forbade miracles, and without miracles, what was Christianity? Which, then, would the theists sacrifice: science or religion? As we have already seen, the theistic scientists refused to discard either and had robust interpretations of uniformity in a religious framework. So, it should be no surprise that they drew upon religious uniformity as a resource to explain miracles in an orderly world.

There was widespread agreement among theistic scientists that apparent violations of natural law were illusory. Temple declared "There may be instances where this Order is apparently broken, but really maintained, because one physical law is absorbed in a higher. . ." (Temple 1884, 32–33). That is, an event that appeared to be outside the laws of nature actually was lawful, but it simply obeyed a law of which humans were not yet aware. An analogy might be to consider someone who understood the law of gravity, but not that of buoyancy. A hot air balloon would appear to them to be miraculous, but a better informed observer would understand that no laws had been broken.

What, then, of the supernatural? Would not religious believers need violations of natural law to be assured of the existence of supernatural forces? One of the prices of this strategy was that, in an important sense, the category of the supernatural faded away (or was at least redefined). Argyll acknowledged that if something happened in our world, then uniformity demands that it be the result of natural law:

The Reign of Law in Nature is, indeed, so far as we can observe it, universal. But the common idea of the Supernatural is that which is at variance with Natural

Law, above it, or in violation of it. Nothing, however wonderful, which happens according to Natural Law, would be considered by any one as Supernatural. The law in obedience to which a wonderful thing happens may not be known; but this would not give it a supernatural character, so long as we assuredly believe that it did happen according to *some* law. (Argyll [1867] 1870, 4)

If scientists had total knowledge of all natural laws, then nothing would ever appear supernatural. What appears to be inexplicable is actually only temporarily obscured. The Duke of Argyll pointed out that the technological advances of the Victorian period allowed completely normal humans to achieve feats that earlier generations would have called supernatural (such as sending a message instantly across the Atlantic Ocean) (Argyll [1867] 1870, 12–13). Perhaps, then, Jesus’s healings in the Gospels simply relied on laws of medicine not yet understood (Temple 1884, 195).

Baden Powell warned that asserting divine causation for apparent gaps in uniformity would be dangerous for religion, because “enlarged discovery shall disclose the connection and explanation of these appearances by regular laws, [and] their argument for a Deity will fall to the ground!” Reducing God to only a “confession of ignorance,” as in the case of Newton’s arguments for planetary stability, was bad science and bad religion. Why? Because it allowed for violations of uniformity, which was critical for both: “law and order, physical causation and uniformity of action, are the elevated manifestations of Divinity, creation and providence” (Powell 1855, 156). Some critics of this position claimed it restricted God’s action, saying that a God who could not intervene in special circumstances was no God at all. But, again, it was uniformity, not interruptions of it, that truly showed us the nature of things: “To speak of apparent anomalies and interruptions as *special* indications of the Deity, is altogether a mistake. In truth, so far as the *anomalous* character of any phenomenon can affect the inference of presiding Intelligence at all, it would rather tend to *diminish* and detract from that evidence” (Powell 1855, 155).

How, then, does God watch over creation and enact plans, if not through interruptions of the natural order? With natural laws: “There is nothing in Religion incompatible with the belief that all exercises of God’s power, whether ordinary or extraordinary, are effected through the instrumentality of means—that is to say, by the instrumentality of natural laws brought out, as it were, and used for a Divine purpose” (Argyll [1867] 1870, 22; Ruse 1975, 509–10). God created laws as the means to exercise power in the world, like a craftsman that builds his own tools. The deity could manipulate natural laws in a variety of ways without violating their essence and could produce any of the fantastic events recorded in scripture. However, how could uniform, unchanging laws produce singular events that appear to be obvious disruptions of nature? Charles Babbage found a

solution to this problem in a parlor trick performed with his calculating machine. The machine, which of course ran on fixed rules, could produce a steady, regular sequence of numbers only to make suddenly a great jump—thus demonstrating that what appear to be exceptional events could be easily generated by fixed laws (Ruse 1975, 510–11).

But if God only works through natural laws, in what sense can these events be miracles? Argyll argued that the marker of a miracle is not the presence of supernatural causes, but rather that it has its origin in divine intent. This view, he said, was perfectly harmonious with scripture and allowed defense of all the essential events of Christianity (Argyll [1867] 1870, 17–30). Similarly, Frederick Temple argued that even if science were to someday give an explanation of all the miracles in the Bible, it would not at all change their role in revelation. The miracle could be in their timing, or intent, or effect, rather than in their breach of uniformity (Temple 1884, 195–96). This fit well with a traditional Protestant distinction between miracles, which required an objective witness to provide proof of supernaturalism, and special providence, which appeared to be normal events—except when viewed through the eyes of faith (Mullin 2003, 205–06). So, this move would essentially remove the category of formal miracles and subsume all divine actions under special providence. Miracles in a uniform universe might no longer be particularly miraculous, but the critical issue could be resolved. A providential God did not have to be incommensurable with uniformity, and therefore, with science:

Science will continue its progress, and as the thoughts of men become clearer it will be perpetually more plainly seen that nothing in Revelation really interferes with that progress. It will be seen that devout believers can observe, can cross-question nature, can look for uniformity and find it, with as keen an eye, with as active an imagination, with as sure a reasoning, as those who deny entirely all possibility of miracles and reject all Revelation on that account. The belief that God can work miracles and has worked them, has never yet obstructed the path of a single student of Science. . . (Temple 1884, 219–20)

The important religious function of miracles was retained, along with the power and potential of science. Similar strategies are being proposed by some twenty-first century theologians as well (Griffin 2000, 38–40).

The ultimate miracle, and the ultimate violation of uniformity, is of course the creation of the universe. Again, we might expect the question of the beginning of the universe to mark a sharp split in science. Lord Kelvin, considering the implications of the laws of thermodynamics, said that science must stop at the point in the past where matter and energy were created:

[We are all] organized forms of matter to which science can point no antecedent except the Will of a Creator, a truth amply confirmed by the evidence of geological

history. But if duly impressed with this limitation to the certainty of all speculations regarding the future and prehistorical periods of the past, we may legitimately push them to endless futurity, and we can be stopped by no barrier of past time, without ascertaining at some finite epoch a state of matter derivable from no antecedent by natural laws. (Burchfield 1975, 25–26)

In a similar vein, Maxwell said the uniformity of molecules confronts us with a process that cannot be described by science:

Thus we have been led, along a strictly scientific path, very near to the point at which Science must stop. . . . But in tracing back the history of matter Science is arrested when she assures herself, on the one hand, that the molecule has been made, and on the other, that it has not been made by any of the processes we call natural. Science is incompetent to reason upon the creation of matter itself out of nothing. We have reached the utmost limit of our thinking faculties when we have admitted that because matter cannot be eternal and self-existent it must have been created. (Maxwell 1890b, 376)

This is surely just religious scientists imposing their beliefs on science, by demanding a gap in which to put their God? Perhaps not. Tyndall grappled with same question of the origin of matter and energy, and concluded that “it entirely transcends us” (Tyndall 1875b, 93). He said this was “the outer rim” of science, and he was unable to make any scientific answer. The evolutionary hypothesis allowed many possibilities, and “is quite compatible with the simultaneous existence of all those virtues to which the term Christian has been applied. It does not solve—it does not profess to solve—the ultimate mystery of this universe. It leaves in fact that mystery untouched” (Tyndall 1875b, 161).

Both groups agreed that the moment of the creation was not something to be discussed scientifically. This was not a religious prejudice intended to safeguard Genesis—an unlikely goal for Tyndall—but rather a natural conclusion to draw from the uniformity assumptions on which they all agreed. The creation, one way or another, was clearly a moment when uniformity no longer applied, and therefore, forbade science from speaking. Both groups, in their own way, were following Herschel’s suggestion: “But to ascend to the origin of things, and speculate on the creation, is not the business of the natural philosopher” (Herschel 1830, 38).

SCIENTIFIC PRACTICE ACROSS THE RELIGIOUS BOUNDARY

I have shown how uniformity did not, as both Victorian scientific naturalists and ID theorists would suggest, indicate the absence of religion in science. Religious scientists working at the time of the emergence of scientific naturalism agreed completely with the uniformity of natural laws as a methodological precept. Indeed, they thought that precept only made sense in a world with a caretaker deity. Although theistic scientists saw it as a religious concept, and naturalistic scientists saw it as an areligious (or

even antireligious) one, virtually no practicing scientists rejected it. This created a common space for the two groups to work side by side despite the fact that they disagreed on an enormous range of subjects. It is quite remarkable that, despite the jeremiads offered by each side against the other, the scientific community continued to function smoothly. No one suggested expelling James Clerk Maxwell from the British Association for the Advancement of Science; no one proposed evicting John Tyndall from the Royal Institution. This was possible because both groups actually agreed on almost everything needed to actually *do* science, as the current example of the uniformity of nature illustrates. They might disagree bitterly about specific claims of fact or interpretation, but the actual activity of scientific research was surprisingly smooth.

There was a genuine shift within the scientific community marked by naturalism, but it had little impact on scientific practice. In the 1820s, it would have been difficult to find a scientist at Cambridge University who was not religious. By the 1920s, the presence of a religious scientist at Cambridge was worthy of note (Bowler 2001; Stanley 2007). But if Kelvin had time-traveled 50 years into his future, he would have been perfectly comfortable with the assumptions still driving science. The transition from theistic science to naturalistic science changed little in scientific practice and, indeed, was made smoother by the essential similarities between the two positions because the actual methodologies did not have to be altered.

So if the scientific naturalists did not come to dominance because of their methodological superiority, how did their views become the scientific orthodoxy? They did not have a unique way of thinking about science, and I do not think they convinced their opponents that their approach was superior.⁶ This question requires more detailed research to give a thorough answer, but I would like to suggest a tentative possibility: the X-Club and allies seized the means of production. Production, that is, of the next generation of scientists.

WHY DID THE NATURALISTS WIN?

The X-Club worked very hard to place themselves in locales of scientific power (Barton 1990, 72). One easy measure of their success was the staggering number of leadership positions they occupied in scientific societies (Barton 1990, 59; MacLeod 1969, 310). But even beyond the personal achievements of its members, the group was able to have an enormous impact on the future of science by focusing on science education.

Huxley was the exemplar for this. He wrote and spoke a great deal about science education (even serving on the first London School Board) and thought strategically about how best to reform science to meet his naturalistic goals. A major part of his strategy was to shape the next generation of science teachers, so as to start a pipeline of like-thinking

scientists. When the 1870 Elementary Education Act was passed, it created a huge demand for science teachers and, by implication, training for those teachers. Huxley pounced on this opportunity, writing textbooks and lab manuals, and running summer courses for these new teachers that would inculcate both teachers and students with a naturalistic, secular worldview (Desmond 2001, 28).⁷ He was not reticent to share his plans in colorful language: to one correspondent he described “a course of instruction in Biology which I am giving to Schoolmasters—with the view of converting them into scientific missionaries to convert the Christian Heathen of these islands to the true faith” (Huxley 1871). Many X-Club members were also examiners for the Department of Science and Art and, thus, could directly control what qualified someone to teach science (Gooday 1991).

This strategy worked on the university level as well. Huxley was deeply involved in the creation of biology professorships all over Britain in the 1870s and 1880s, and worked hard to influence who received those positions (Huxley 1901, 33). His goal was to place candidates who were ideologically sound (i.e., purely naturalistic) as well as scientifically talented. In this, he was quite successful. In a short number of years Huxley had already managed to place his students, allies, and demonstrators at University College London, Edinburgh, Leeds, Johns Hopkins, New Zealand, and even Anglican institutions such as Oxford and Cambridge (Desmond 2001, 33; Geison 1978, 130–47). They were noted for bringing a naturalistic perspective with them and evangelizing for the new scientific outlook (Pauly 1984, 378). In addition to the effect of their own personalities, these protégés developed courses of study and training that had their roots with Huxley and became standard for generations to come (Howarth 1987, 339).

This was not a magic bullet for Huxley and his allies, but theistic scientists and interpretations of science did become less and less common in British universities. With their allies in charge, the X-Club could be assured that the next generation of science students were trained in a naturalistic perspective, which they would then pass on to their students.⁸ By the end of the century, Huxley’s outlook was well entrenched in the educational system, and by the end of the Great War, few could imagine it being otherwise (Bibby 1959, 111). This is not to say that the scientific naturalists corrupted science education: the professors they placed were talented and skilled. But their teaching methods were not value neutral either. Huxley designed his teaching to stand for what Adrian Desmond calls a “distinct ideological faction” that clearly marked off acceptable (naturalistic) from unacceptable (theistic) ways of thinking about science (Desmond 2001, 32).

A side effect of this is that once the scientific naturalists gained dominance in the scientific community, they were able to rewrite the history of their discipline to erase the long tradition of theistic science.

Scientists frequently reimagine their past in order to support their vision for the future, and the wave of scientific naturalists at the end of the nineteenth century did so to establish a particular way of thinking about science and religion, that is, that science as an enterprise only made sense in an areligious context.⁹ Concepts like uniformity, which were both theistic and naturalistic in practice, became recast as *only* naturalistic.

How could this be done? It might seem that overthrowing a centuries-old tradition such as theistic science would require a dramatic revolution, but in fact, it was surprisingly smooth. This was because, as I have argued here, the positions of the theistic scientists and the scientific naturalists were actually quite similar in terms of basic concepts such as the uniformity of nature. So, the practices and methods of theistic scientists could often be imported into naturalistic work with simple relabeling, or sometimes without comment at all. Huxley was particularly skilled at this. For example, he proclaimed that William Carpenter's work, particularly his textbooks, was the foundation of "rational" methods for thinking about living things (Carpenter 1888b, 66–67). Huxley argued that Carpenter's goal of explaining life in terms of laws (as opposed to vital forces) was the key step in removing religious and spiritual legacies from the life sciences. But this was quite different from the way Carpenter saw laws, of course—as discussed earlier, he saw natural laws as manifestations of the Creator, and, thus, infused with religious significance. And, it is not that Huxley was unaware of Carpenter's thoughts along these lines, as in his private correspondence, he is quite hostile to Carpenter's spiritual interpretations (Huxley 1896). But in his published work, Huxley took a different approach. He simply stressed the points on which they agreed—natural laws—then elsewhere argued that natural laws were solely naturalistic. He did not have to persuade his colleagues that natural laws were important, because everyone already agreed on that. When theists read Huxley's discussions of laws in life, they could nod along happily, thinking of those laws in theistic terms. When scientific naturalists read about such laws, they too were happy, thinking of those laws in naturalistic terms. So in his published research, Huxley could gain support from both camps, while his naturalistic interpretation of that research was passed on through his students and teaching.

Similarly, Bernard Lightman has shown how Huxley coopted literary strategies associated with natural theological writings to promote a naturalistic cosmology (Lightman 2007, 2010). The "common object" strategy used by natural theologians to show God's contrivance in the world was clearly on display in Huxley's lectures and writings (such as "On a Piece of Chalk"). But, he deftly used the same strategies to arrive at different conclusions, often subtly framed to paint a closed world of only natural phenomena with no room for God. Again, a theist could read many of Huxley's pieces, appreciate the science, and see the argument as familiar. Huxley even managed to do this in his teaching. He successfully

made the fundamentals of his scientific methods palatable to theists, even to the point where his religious enemies such as St. George Jackson Mivart and J. W. Dawson sent their children to study under him (Desmond 2001, 32).

The overlap of theism and naturalism that, I have discussed here, allowed a gradual transition over the course of a generation or two as the X-Club's protégés more and more fully took over the universities. Older theistic scientists could read the work of younger naturalistic scientists and still see comforting continuities, and the younger naturalists could read classic work and see essential similarities. In this way, the work of religious scientists such as Carpenter became secularized without requiring rejection of the work as unscientific.¹⁰ Our modern understanding of the uniformity of natural laws as being purely naturalistic, then, is contingent and not inevitable, and a close historical examination of the issues shows that uniformity can be, and was, a tool used both for and against religion. The victory of the scientific naturalists in removing theism from the expectations and parlance of the scientific community had little to do with how science was done (despite their claims to the contrary) and much more to do with attempting to secure better access to professional positions, resources, and cultural authority (Numbers 2003, 281; Turner 1978).

INTELLIGENT DESIGN (ID)

To bring us back to where we began, we can consider the lessons of the Victorians for the ID movement: ID is not the only way to bring God and science together. If their goal is truly to develop a theistic science, there is a long historical tradition on which they could model themselves that works very well. This does not have to result in a watered-down or weakened religion—the theistic scientists of the Victorian period were profoundly religious, and their example shows that scientists can draw inspiration and guidance from their religious beliefs. The ID movement might try to point to that as a defense for their own use of scriptural literalism, but the burden is on them to make the case that their ideas are relevant and useful. Both Maxwell and Thomson drew on scripture to shape their scientific practices, but they did so in a way that persuaded their less-religious colleagues. Scientists can get their ideas from all sorts of strange places (cold empiricism, mystical inspiration, dreams), but in the end, they need to be able to justify them in terms that make sense to other people trained and experienced in the exploration of the phenomena in question.

In the case discussed here, those terms include the uniformity of natural laws. As with politicians, we cannot prevent people from having their views formed by their religion, but that also cannot solely be enough to justify their ideas. It would be difficult to make the case that Martin

Luther King Jr. should not have been involved in politics because of his religious motivations, but he was able to convince many people that his views were worth supporting even if they did not share his religious beliefs—just so with scientists. If a scientist can convince other scientists that his methods or conclusions are useful, what does it matter whether he was thinking about God when he did the work (Koperski 2008, 436)?¹¹ In the examples of theistic scientists discussed in this essay, we can see an essential common outlook: despite the presence of divine action in the world, explanations should be sought in natural laws—and there was always more to be explained. Naturalism can prod one to these deeper and deeper levels of explanation, but so can theism. The key is whether or not a scientist actually does this.

The ID movement and its allies have essentially bought into the propaganda of the X-Club, that science is inherently an enemy of religion. To a certain degree, they can be excused for this given that there is no lack of current scientists (e.g., Richard Dawkins) making the same claims. The ID movement seems content with this framework's insistence on the incompatibility between science and religion: if told that they must choose between Darwin and Jesus, it is not surprising that most Americans reject Darwin (just the outcome ID wants). But it is also damaging for scientists to insist on this false dichotomy, as it makes an unnecessary enemy of anyone with religious beliefs (the vast majority of Americans). A realization and acceptance by both sides of how religion can appear productively in science could help moderate what is now a toxic and paralytic debate. The Victorian period, for all that it gave birth to the myths of the warfare between science and religion, may provide a useful model of theists and naturalists working side by side in support of science.

NOTES

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1. While virtually all of the "theists" discussed here were Christian, "theistic science" is the chosen term of the ID movement and I will use it here.

2. Hooykaas (1963) distinguishes between "actualism" (the attempt to explain past events by reference to causes now in operation) and "uniformitarianism" (the idea that these causes have always operated with the same intensity). This is an important distinction, but "uniformity" is the more commonly used term today, and I will rely on it here.

3. This strong claim is sometimes called "ontological naturalism"; that is, the claim that there really is no spiritual realm. This is in distinction to "methodological naturalism," which says that scientists should not invoke spiritual or supernatural forces. For the remainder of this essay, I will use "naturalists" or "naturalistic" as referring to ontological naturalism.

4. While it would be more accurate to speak of "natural philosophers" in this period rather than "scientists," I will use the latter term for clarity.

5. This fusion of theism and apparently naturalistic reasoning is sometimes today called "religious naturalism." For more, see Drees (1996), Griffin (2000), Stone (2003).

6. The common story that many Victorians were turned away from their faith by developments in science is addressed thoroughly in John Brooke's contribution to *Numbers* (2009).
7. Desmond points out that many of these new teachers came from industrial, dissenting regions of Britain and were, thus, particularly receptive to Huxley's outlook. Huxley's efforts toward science education are described in detail in Bibby (1959). For an overview of the development of science education in this period, see Layton (1981).
8. Geison (1978) and MacLeod (1982) point out the particular importance of Michael Foster's students in furthering Huxley's teaching system.
9. On how scientists rewrite their discipline's history for current purposes, see Galison (1983), Gilbert and Mulkay (1984), Staley (2009).
10. Other examples of secularization or naturalization of previously theological concepts can be found in Young (1985), Lightman (1987), Moore (1990), Turner (1993).
11. This has some similarities to the classic distinction between the "context of discovery" and "context of justification." See Reichenbach (1938) and more recent work in Steinle and Schickore (2006).

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