CHAPTER 9

DEEPENED CONVICTION OF BOTH DESCENT AND DESIGN, 1862-1868

During the period between the publication of Gray's pamphlet on *Natural Selection not Inconsistent with Natural Theology* (1861) and Darwin's *Variation of Plants and Animals Under Domestication* (1868) Gray continued to play a critical role in advancing the scientific credibility of Darwin's theory.[1] Through his regular survey of current "Scientific Intelligence" in botany and zoology for the *American Journal of Science*, Gray reviewed important books and the growing body of studies in a variety of fields, including Darwin's own botanical studies, that strengthened the empirical foundations of Darwin's argument for the descent of species through modification. As the leading scientific journal in America, the *American Journal of Science* was widely respected in England and Europe where Gray already enjoyed an international reputation. Thus, Gray's efforts played a more important, though less conspicuous, role in advancing Darwin's arguments in the immediate post-*Origin* period in both America and England than did Huxley's pugnacious baiting of Darwin's critics.

[1]Edward Pfeifer has surveyed the sprinkling of additional responses to Darwin through the 1860s in "The Reception of Darwinism in the United States, 1859-1880" (Ph.D. diss., Brown University, 1957) and "United States," in *The Comparative Reception of Darwinism*, ed. Thomas F. Glick (Chicago: University of Chicago Press, 1988), 181-188. Edward Lurie, *Agassiz*, chapters 8 and 9, and Mary Winsor, *Reading the Shape of Nature*, 27-102, provide complimentary discussions of the response of Agassiz, and especially his students, to Darwin during these years.

The effect of Gray's interaction with this growing body of literature was to deepen and broaden his own commitment to descent with modification, though he still doubted that natural selection could bear all of the weight Darwin put on it, and his belief that descent could be harmonized with belief in design. Ironically, his convictions were often strengthened by the very studies that Darwin undertook to fortify the empirical foundations of natural selection and undermine the design argument.

Throughout this period Gray kept a busy schedule of publicizing studies that supported Darwin's theory of descent, writing favorable reviews of Darwin's own work, defending design against Darwin's attacks, updating his popular textbooks, and sparring with Chauncey Wright on descent and design. Gray's strong commitment to the harmony of the community of descent and the traditional design argument was the single thread that bound these diverse enterprises together. They also reveal the yawning philosophical and theological gulf that separated Gray and Darwin.

Advancing Darwin's Scientific Credibility

John Phillips, professor of geology at Oxford, had used his Rede Lectures at Cambridge in May 1860 to canvass and synthesize the knowledge then known about "Life on the Earth" and critically discuss its bearing on Darwin's theory of development. Gray offered his own commentary on the strengths and weaknesses of Darwin's theory when those lectures were published.[2] Gray believed that Phillips's

[2]John Phillips, *Life on the Earth, Its Origin and Succession* (Cambridge: University Press, 1960); Gray reviewed in the *Am. Jour. Sci.*31 (May 1861): 444-449.

strongest argument against Darwin was that the fossil record, especially that of the Mollusca, showed a remarkable similarity of structure all over the world and through all geological ages. This might be expected in marine environments where the conditions were more constant. But Phillips stressed that the fossil record showed similar continuity and changes within rather narrow limits for plants and animals as well. There were simply no traces of Darwin's supposed progenitors in the fossil record.

Gray clarified two important aspects of Darwin's theory at this point. It was most frequently assumed, so Gray observed, that Darwin's theory of natural selection presumed that plants and animals were undergoing constant change in response to a continually changing environment. Darwin was exasperated with this misunderstanding of his theory, even by those closest to him. Gray noted, however, that Darwin had not claimed that "actual variability is something constant and equable--a uniform and measurable force acting always and upon entire species-- so that so much time should bring to pass so much change; or else, that the external conditions really produce the variation." Thus, the continuity of unchanged Mollusca was not as strong a criticism against Darwin as Phillips thought. Gray further observed that the "*complex* which is condensed and rather boldly personified by the term Natural Selection is no better apprehended by many naturalists than is the Malthusian theory by many political economists."[3] Gray did not elaborate on how

[3]Phillips, 447.

Natural Selection had been "misapprehended." Perhaps he could have added Darwin's name to the list of those naturalists who "misapprehended" Malthus.

Gray pointed out that Darwin never intended to *explain* the origin of variations or why some species remained relatively constant over long stretches of time and others varied considerably. He only showed "how the struggle for life ensures the extinction of crowds of intermediate forms, and how the resulting natural selection may lead certain surviving races farther along the lines of favorable variation." Once this was understood many of the criticisms lose their force.[4]

Phillips believed that Darwin had transformed the venerable Christian doctrine of Providence into Natural Selection. What else would be appropriate to call an agent that was "gifted with the power of continually acting for the good of its subject, encouraging it, or rather compelling it to continual advancement, -- how is this beneficent personification to be separated from an ever-watchful providence, -- which once brought into view sheds new light over the whole picture of causes and effects." Gray answered that Natural Selection may be the "mode in which Providence may operate."[5]

Despite some controversial aspects of Darwin's theory, Gray, quoting Phillips, urged that the design argument still stood firm. "What would be regarded as remarkable inventions if they were due to human minds and hands . . . cannot be removed from the list of intelligent adaptations because they are frequent in nature,

[4]Ibid.

[5]Quoted from Phillips, 215-216; 448-449.

and are of higher perfection and greater beauty than any work of man. . . . No one will ever be satisfied with laws which had no Author, works which had no Maker, co-ordinations which had no Designer." All in all, Gray praised Phillips for the "acute" and "fair" criticisms he had made in a most "excellent spirit."[6]

Darwin, for his part, was greatly displeased with the book, informing Phillips himself that he regretted that "you are dead against me," and perhaps slightly annoyed that Gray had treated it so positively. He noted that Lyell thought it "fearfully retrograde" in not understanding natural selection or the issues surrounding the age of man. As for himself he had great fun "parodying Phillips arguments as applied to domestic varieties; & you might thus prove that the Duck or Pigeon has not varied because the Goose has not."[7] In subsequent issues Gray made sure that those most sympathetic and having the strongest evidence to support Darwin's claim for the derivation of species would be heard.

The strongest evidence supporting Darwin came from the botanical geography studies of Joseph Hooker and Alphonse De Candolle. Their studies of the "species problem" was moving those naturalists most keenly interested in the geographical distribution of plants and animals toward some version of the derivative hypothesis, though not necessarily Darwin's version. Joseph Hooker played a major role in shaping, confirming, and pointedly criticizing Darwin's theory of natural selection.

[6]Ibid., 449.

[7]Darwin to Phillips, 14 November 1862, *CCD* 8: 473; Lyell to Darwin, before 20 November 1860, *CCD* 8: 478; Darwin to Gray, 5 June 1861, *CCD* 9: 162-164.

He played a similarly important role in persuading Gray of the validity of the central outlines of Darwin's perspective. Consequently, Hooker's continuing work in solving the puzzles of biogeography by the light of natural selection was an important vehicle for convincing botanists especially that significant empirical evidence was available to support Darwin's work; or, at the minimum, that the traditional explanations were glaringly inadequate. Gray continued to use the pages of the *American Journal of Science* to give Hooker's work the broadest exposure possible.

While Darwin was examining his orchids, Hooker was busy sorting out the mysterious patterns of the geographical distribution of Arctic species.[8] He had earlier been intrigued by the presence of representative species of what he called "Scandinavian flora" scattered throughout the southern hemisphere. He now found it most impressively distributed throughout the circumpolar region of the Arctic. The theory of their separate, post-tertiary creation in isolated regions throughout the globe no longer made sense of the distribution patterns he discovered. It seemed most likely to Hooker that the Scandinavian flora was a primordial flora, in existence long before the glacial period. Glaciers subsequently pushed it into southern longitudes where it endured competitive struggles with native species. During the ensuing warming period Scandinavian species, along with some southern species and closely allied species, returned to northern alpine and Arctic regions.

Hooker concluded that Darwin's theory of natural selection offered the most

[8]The Arctic was one of the few places on the globe that Hooker did not visit. Kew, however, was overflowing with specimens that had been contributed by many botanizers to the region during the first half of the century.

reasonable and scientific explanation for the geographical distribution of the Arctic flora.

> Mr. Darwin's hypothesis accounts for many varieties of one plant being found in various alpine and Arctic regions of the globe, by the competition into which their common ancestor was brought with the aborigines of the countries invaded. Different races survived the struggle for life in different longitudes; and these races again, afterwards converging on the zone from which their ancestors started, present there a plexus of closely allied but more or less distinct varieties, or even species, whose geographical limits overlap, and whose members, very probably, occasionally breed together. [9]

Gray was quick to remind his readers that Hooker's flora greatly strengthened the credibility of Darwin's hypothesis. Recent investigations from many different sources have focused their attention on the relationship between the modern period and its immediately preceding epoch; they have each illumined the profound continuity that exists. Hooker's geographical botanies have made a "very valuable contribution" to resolving the remaining puzzles. To drive home the point Gray placed his review of Hooker's Arctic flora immediately following his review of Darwin's orchid book.[10]

Hooker's most ambitious project during these years, done in collaboration with George Bentham, was the compilation of a new *Genera Plantarum* that summarized and classified all known plants in the world.[11] Earlier synopses, based largely on

[9]Quoted from Gray's review of *Outline of the Distribution of Arctic Plants*, *Am. Jour. Sci.* 34 (July 1862): 144-45.

[10]Immediately after his review of Hooker's Arctic flora Gray reprinted Hooker's paper "On the Cedars of Lebanon, Taurus, Algeria and India," *Am. Jour. Sci.* 34 (July 1862): 148-150. Hooker explained the distribution and isolation of the three species of Cedar with the same framework he used to explain the distribution of the Arctic flora.

[11]This mammoth undertaking consumed 25 years of arduous labor, from 1857, when they first started planning, to 1883, when the final half of vol. 3 was published. The first half of vol. 1 was published in 1862; the second half of vol. 1 was published in 1865. Huxley, *LLJDH*, 2: 19.

book knowledge of a small number of plant specimens, were increasingly worthless in the face of thousands of new plants streaming into Kew from all over the globe. Hooker and Bentham faced the daunting task of examining, classifying, and arranging whole new floras and new plants in a natural system. Such a task required an intimate knowledge of plant taxonomy and geographical distribution. Even though they adopted De Candolle's system of morphological classification as their skeleton, the task of showing natural affinities threatened to overwhelm them. They were confronted over and over again with how to appropriately capture the infinite gradations between the numerous characteristics of their plants with the logical divisions of families, orders, genera, and species. Hooker groaned repeatedly to Gray that such divisions seemed so arbitrary to him; he was "utterly bewildered" by how they were going to turn their jumble of descriptions into a system. Any proposed "natural" system of classification was, in reality, "artificial" after all. He believed that the greatest virtue of their *Genera Plantarum* was "the subversion of old ideas as to limits of orders, all owing to the insidious creeping in of new genera, whose number and importance was hitherto imperceived & only now found out." His frustration only increased as he became more thoroughly convinced of the truth of Darwin's theory of genealogical affinity. In fact, if Darwin's theory were true to any degree, "a natural system can never be expressed in all its details" and botanists must be most tentative and humble in their judgments of affinities. While not constructed along explicitly Darwinian lines, their classification system could be read as showing the "natural" lines of descent. Despite Hooker's trepidations, the *Genera Plantarum*

was a magnificent achievement that still stands.[12]

Gray commended Hooker and Bentham for the "intimate knowledge and sound judgment which they everywhere reveal" in the *Genera Plantarum*. They were to be applauded particularly for their resistance to creating new genera on the narrow basis of a single technical difference. When taxonomists who believed in the fixity of species were confronted with the increasing number of unique plants being discovered, they were compelled to create new genera in which to place them. The ironic result was that a flood of "artificial" genera were created. The *Genera Plantarum*, by showing greater sensitivity to genealogical relationships among species, eliminated many of those genera and consolidated once-isolated species into larger genera based on general affinities. Gray's praise for this approach was an implicit endorsement of Darwin's understanding of species.[13]

Alphonse De Candolle, the renowned geographical botanist from Geneva, Switzerland, and friend of Gray, followed a path similar to Hooker and Gray in moving haltingly away from the belief in the separate and multiple creation of species toward a modified version of the derivative hypothesis since the publication of his *Geographie Botanique* in 1855. Gray's survey of De Candolle's major work bearing on this subject enabled him not only to add additional empirical support to Darwin's theory but gave him the opportunity to elaborate on several of the broader implications

[12]Huxley, *LLJDH*, 2: 19-23; Turrill, *Pioneer Plant Geography*, 224; Hooker to Gray, 22 January 1862, GHA; Hooker to Gray, 9 August 1862, GHA; Hooker to Gray, 5 April 1864, GHA.

[13]Gray reviewed the first half of vol. 1 of *Genera Plantarum* in *Amer. Jour. Sci.* 35 (January 1863): 134-136.

of the trend toward acceptance of Darwin' theory already then emerging.[14]

De Candolle had tackled the unpromising task of elaborating all of the species of Oaks. Fortunately, Gray observed, he carried out his study in light of the current intense interest in the meaning, limits, geographical distribution, origins, chronological continuity, modification, and destiny of species. His detailed study of the patterns of distribution in the major species of Oak showed significant parallels with the distribution patterns naturalists had discovered for a wide range of other species. In the same way that Gray had found a significant percentage of identical species in Japan and the eastern US, De Candolle found virtually identical species of Oaks in Europe, Eastern Asia, Oregon, and California. It appeared to him that all extant species of Oak were derivative of *Quercus Ilex*, the most ancient species of Oak yet discovered. These conclusion led De Candolle to admit that

> the theory of a succession of forms through the deviation of anterior forms is the most natural hypothesis, and the most accordant with the known facts in palaeontology, geographical botany and zoology, of anatomical structures and classification: but direct proof of it is wanting, and moreover, if true, it must have taken place very slowly; so slowly indeed, that its effects are discernable only after a lapse of time far longer than our historic epoch.[15]

Gray was keenly interested in the fundamental questions that De Candolle's work raised about the meaning of species. That work, based on a wealth of Oak specimens from different botanists, regions of the world, and time periods, was an

[14]Gray, "Species, Considered as to Variation, Geographical Distribution, and Succession," *Am. Jour. Sci.* 35 (May 1863): 431-444. This was a review of De Candolle's "Etude sur l'Espece, a l'Occasion d'une Revision de la Famille des Cupulifers" that appeared in *Bibliotheque Universelle* (November 1862).

[15]"Species," 435.

ideal laboratory in which to test the traditional view of species. This wealth of material, however, confronted De Candolle with a daunting challenge. He found that forms and characteristics that seemed obviously distinct and stable when seen in only a few samples blended imperceptibly into gradations when seen in thousands of samples. Species seemed to be so variable that there were marked differences on the same branch of the same tree, to say nothing of the extreme variability he noted in the majority of Oak species. He concluded that "so long as a genus was imperfectly known, and its species were founded upon few specimens, that is to say, were provisional. Just as we come to know them better, intermediate forms flow in, and doubts as to specific limits augment." This same phenomena had overwhelmed every other taxonomist and geographical botanist. De Candolle glimpsed that traditional assumptions about the meaning and identity of species were being undermined by the abundance of his knowledge.[16]

Gray pressed De Candolle at this point.[17] He needed to acknowledge, Gray charged, that his own findings, taken in conjunction with those of many others, had challenged the traditional notion that the essential meaning of species was found in the mutual resemblance among individuals. This view was obviously incapable of handling the rich diversity of organic phenomena scattered through time and space: how could a botanist use the criterion of mutual resemblance when even specimens,

[16]"Species," 432-434.

[17]He also carried on a spirited correspondence with De Candolle on these issues throughout their long friendship.

known on other grounds to be members of the same species, did not resemble each other? This problem would only be magnified as more specimens were described. The work of many naturalists in several different fields was moving irresistibly toward the understanding that "the fundamental idea of species . . . is that of a chain, of which genetically-connected individuals are the links." Genealogical relationships, not mutual resemblance, must become the new understanding of species, Gray asserted.[18]

The tendency has been, Gray observed, to "extend the law of continuity . . . from inorganic to organic nature, and in the latter to connect the present with the past in some sort of material connection."[19] Louis Agassiz was the only prominent naturalist who substituted idealistic relationships for these material connections. Now the only material connection known in organic life is the genetic connection between parent and offspring. Genealogical relationships rather than mutual resemblance must therefore be the fundamental meaning of species, Gray contended; individuals look alike only because they are genetically related. That being the case there was no way *a priori* that any botanical systematist could declare "what amount of dissimilarity is compatible with unity of species; in wild plants it is sometimes very great, in cultivated races, often enormous."[20]

Genetic relationships must also be the basis of classification. It was this implicit understanding of species that led De Candolle to classify widely different

[18]"Species," 443.

[19]"Species," 437.

[20]"Species," 444.

varieties of Oak trees as derivatives from a single species, despite their significant visual differences. It is difficult to avoid the conclusion, Gray declared, that the origin of species is governed by laws, whatever they eventually turn out to be, that are similar to the origin of individuals.

Gray pointed out that adopting the derivative hypothesis for the origin of species did not commit oneself to all the specifics of Darwin's theory of natural selection. There were other options and variations. He was willing to entertain the possibility that species remained stable for long stretches of time and then, for some unknown reason, suddenly changed into a new form, a view technically known as saltation. This was the view of Oswald Heer,, the famous Swiss paleobotanist, and Hugh Falconer, most famous for his detailed study of elephants, living and dead. Falconer insisted that elephant fossils showed that their essential characteristics, most notably the teeth, had remained constant through vast stretches of time. At the same time he was confident that some version of Darwin's derivative hypothesis would be accepted. Gray also agreed with De Candolle, Heer, and Falconer that natural selection was insufficient to explain the full range of organic phenomena. Falconer suspected that there was some "deeper-seated and innate principle, to the operation of which Natural Selection is merely an adjunct." Gray, as we have seen, was sympathetic to this view.[21]

Naturalists needed to understand, Gray noted, that too many people overlook

[21] "Species," 438-440.

the important distinction between "variation" and "natural selection." The truth was that we simply do not know why organisms vary. We simply know that they do and that they can be encouraged to vary under certain conditions. It cannot be shown, however, that variations were either caused by external conditions or that they were random. Natural selection, on the other hand, was "the *ensemble* of the external influences, including the competition of the individuals themselves, [that] picks out certain variations as they arise, but in no proper sense can be said to originate them." It was thus perfectly legitimate, Gray counseled, for naturalists to accept the major principle of derivation to explain the origin of species without accepting more disagreeable features of Darwin's views.[22]

Sensing a tension between his continued belief in God's active agency in forming species and the growing conviction that species were formed by natural processes, Gray urged that "the results, whichever way it turns out, can be used by natural theology." How would he meet the criticism of those like Darwin who objected to God's interference in the natural order while yet maintaining the reality of God's role in that order? He adopted the strategy of those like Baden Powell and the Duke of Argyll who contended that God's role was best seen in the universal "reign of law." In support of this position he quoted John Tulloch:

> The stoutest advocates of interference can mean nothing more than that the Supreme Will has so moved the hidden springs of nature that a new issue arises on given circumstances. The ordinary issue is supplanted by a higher issue. The essential facts before us are a certain set of phenomena, and a Higher Will

[22]"Species," 440.

> moving them. How moving them? is a question for human definition; the answer to which does not and cannot affect the Divine meaning of the change. Yet when we reflect that this higher Will is everywhere reason and wisdom, it seems a juster as well as a more comprehensive view to regard it as operating by subordination and evolution, than by interference or violation.[23]

God, being just and wise, "interfered" in the natural order by subordinating himself to its developmental processes. He would soon learn what Darwin thought of this strategy.

Henry Bates, a promising entomologist, was one of the few men outside of his immediate circle of confidants to win Darwin's admiration for his scientific merits. Bates and his good friend, Alfred Russel Wallace, set off in 1848 for a natural history adventure in the Amazon. While Wallace departed for the Malay Archipeligo in 1850, Bates stayed on for an additional nine years collecting many insect specimens and reflecting on their habits and distribution patterns. Bates became well-known as the popular author of *The Naturalist on the River Amazon* (1863), a natural history adventure book, that stirred the scientific imaginations of many readers. He made his scientific mark, and first came to Darwin's attention, with his influential and controversial studies of Amazonian butterflies.

At Darwin's urging Gray reviewed Bates' research on "Variation and Mimetic Analogy in Lepidoptra."[24] Gray was impressed. Bates had skillfully employed

[23]"Species," 441. Gray found this quotation in the Duke of Argyll's essay on "The Supernatural" that he had read a few months earlier. It is found in John Tulloch, *Beginning Life: Chapters for Young Men on Religion, Study, and Business* (Edinburgh: ?), n.d., 85-86.

[24]Gray, "Variation and Mimetic Analogy in Lepidoptra," *Am. Jour. Sci.* 36 (September 1863): 285-290. Bates had earlier read a paper on "Contributions to an Insect Fauna of the Amazon Valley. *Lepidoptera: Heliconidae*," before the Linnean Society on November 21, 1861. It was subsequently published in the *Transactions of the Linnean Society of London* 23 (1862): 495-566. Muriel Blaisdell has provided an essential study of the natural theological understanding of mimicry that Bates

Darwin's theory of natural selection to explain how the *Lepidoptra*, few in number and apparently defenseless, had gradually acquired the identical markings of the much larger species of *Heliconidae* whose repugnant smell protected it from its enemies. Under the pressure of extermination those *Lepidoptra* that were inferior imitators were, over the course of generations, gradually eliminated so that only the most nearly perfect imitators survived to propagate their kind. Bates' findings confirmed the conclusions of naturalists who had studied the ways that other insects had imitated both organic and inorganic objects to insure their survival.

Gray was equally impressed with the insights Bates' paper provided into the phenomenon of variation in the animal kingdom. His study confirmed that animal species were as widely variable as vegetable species. Bates had found

> a perfect gradation in variability, from butterflies of which hardly two can be found alike, to slight varieties, to well marked races, to races that can hardly be distinguished from species, to true and good species. . . . These facts seem to teach us, that in this and similar cases, a new species originates in a local variety, where the conditions are more favourable to it than to the typical form, and that a large number of such are simultaneously in progress of formation from one variable and widely distributed species.

Gray noted that this same phenomena had already been noted in De Candolle's study of Oaks and in Cramer's study of Amazonian insects.

Bates concluded his study of variation with the observation that the appearance of direction and goal in the working of natural selection was an illusion. Gray resisted that implication, cautioning that it had not been shown that variations ever

challenged in "Natural Theology and Nature's Disguises," *Jour. Hist. Bio.* 15 (Summer 1982): 163-189.

occurred "lawlessly or at random." Allowance must still be made for the Creator to lead variations along certain beneficial lines.

The only American to contribute supporting evidence for Darwin's theory was Benjamin D. Walsh, a contemporary of Darwin's at Cambridge, who settled on the Illinois plains in 1838. He became an avid and respected entomologist, editing the *Practical Entomologist* between 1865 and 1867 and becoming the Illinois state entomologist in 1868. He enthusiastically informed Darwin in 1864 that his initial prejudices against Darwin's ideas melted away when he actually read the *Origin*: "the first perusal staggered me, the second convinced me, and the oftener I read it the more convinced I am of the general soundness of your theory."[25] Darwin greatly appreciated Walsh's keen observations and bold attacks on Agassiz; he even suggested some experiments for him to try. They corresponded regularly on these issues until Walsh's death in 1868.[26]

Walsh had little fear of challenging Agassiz's doctrine of multiple centers of the creation of species before the Boston Society of Natural History. Agassiz's theory, Walsh charged, required him to dispute the possibility that identical species of butterflies (or any other organism) could be native to both Europe and America. There were numerous objections to this view. The most notable was that the larvae of

[25]Walsh to Darwin, 29 April 1864, *More Life and Letters* II: 249; cf. Walsh to Hermann Hagen, 17 October 1864, M.C.Z. Archives; quoted in Winsor, *Reading the Shape of Nature*, 94.

[26]See David M. Walsten, "Darwin's Backwoods Correspondent: Letters between Charles Darwin and Illinois Naturalist Benjamin D. Walsh," *Field Museum of Natural History Bulletin* 45 (1974): 8-9, 12-15. *A Calendar of the Correspondence of Charles Darwin, 1821-1882* has uncovered additional letters.

several species of butterflies had become specially adapted to nettles and thistles as their source of food. Such an adaptation, Walsh emphasized, surely pointed to the fact that these butterflies were native to America. That identical species of butterflies were found in both Europe and America, he concluded, could best be explained "if, rejecting the Creative theory, we assume the Derivative Origin of Species, how simple and intelligible become the great facts of the geographical distribution of species!"[27]

At Darwin's prompting, Gray reviewed Walsh's paper on "Phytophagic Varieties and Phytophagic Species."[28] Walsh believed that he could "construct [an] unbroken series, from the first dawnings of the Phytophagic Variety to the full development of the Phytophagic Species." Walsh found it impossible to draw any sharp line between phytophagic varieties and phytophagic species, exactly what Darwin found in other plants and animals and explained by natural selection. Thus, he was "irresistibly led to believe, that the former gradually strengthen and become developed into the latter, and that the difference between them is merely one of mode and degree."[29] Gray had no comment. Walsh's conclusion, however, was perfectly consistent with the patterns that Hooker, De Candolle, and Bates had found in plants

[27]"On Certain Remarkable or Exceptional Larvae," *Proc. Boston Soc. Nat. Hist.* 9 (1863): 286-318; quoted in Pfeifer, "United States," 184.

[28]Darwin to Gray, 29 October 1864, GHA; "Phytophagic Varieties and Phytophagic Species," *Proc. Entomogical Soc. Phil.*3 (Nov. 1864): 427-428. A *phytophagic* variety is one in which two insects are identical in every respect except the plants they ate; they were presumed to mate and be fertile with each other. A *phytophagic* species is one in which two insects are identical in every respect except the food they ate, yet do not intercross.

[29]Gray, "Gradation from 'Individual Peculiarities' to Species in Insects," *Am. Jour. Sci.* 39 (September 1865): 282-283.

and butterflies.

Darwin's Flank Attack on His Critics

Darwin sought shelter from the storm unleashed by the *Origin* in a meticulous study of the adaptations that various plants had contrived to insure cross-fertilization. He believed that these "contrivances" provided solid evidence for his theory of natural selection. Following up a life-long fascination with flowers and the insights they held for his theory, Darwin published path-breaking studies on plant physiology in *On the Various Contrivances by which Orchids are Fertilized by Insects* (1862), six essays on dimorphism and trimorphism in plants, one long article on climbing plants, and numerous shorter pieces in the *Gardeners' Chronicle* soliciting help on his research and offering updates on his observations, all the while working away at *Variation of Plants and Animals Under Domestication*. These shorter pieces became the foundation for larger works he published later in life. Toward the end of his life he reflected that nothing in his "scientific life has given me so much satisfaction as making out the meaning of the structure of these plants."[30] Not only did these plant studies give him great personal delight in confirming his theory of natural selection, they also served a significant role in undermining the claims of the "ordinary" view of creation that the Creator had specially created each one of a plant's exquisite adaptations. These

[30]*Autobiography*, 128.

studies were, he admitted to Gray, a flank movement on the enemy.[31]

Orchids were the perfect flower for Darwin's opening salvo. Critics had already seized on the remarkably modified structures of this popular genera, most of which seemed utterly useless, to dismiss Darwin's claim that only those variations were selected that were useful for an organism's struggle to survive. What purpose, other than the Creator's sheer delight, did these variations serve? Even Huxley was incredulous that these characteristics had any functional use.

As he had already done with good effect in the *Origins*, Darwin used "contrivances," a favorite word of natural theologians, to advance his own argument. He announced that his study showed that the stunning variety of the orchid's "beautiful contrivances," far from being useless, actually functioned to insure their cross-fertilization through the agency of insects. Such knowledge could only serve to enhance the orchid's beauty in the eyes of "an observer who is fully convinced that the structure of each is due to secondary laws, as to one who views every trifling detail of structure as the result of the direct interposition of the Creator."[32] Having bowed politely to his critics, he launched his subterfuge.

Darwin's meticulous observation of scores of orchid species and hundreds of different plants revealed that many of their "useless" features actually served critical functions in the plants' survival. All of them took on new meaning when seen

[31]Gray to Darwin, 2 July 1862; Darwin to Gray, *CCD* 10: 291-294; Darwin to Gray, 23 July 1862, *CCD* 10: 330-334.

[32]*On the Various Contrivances by which Orchids are Fertilized by Insects* (London: John Murray, 1862), 1, 2.

through the lens of natural selection and genetic relationships stretching over vast eras of time. Darwin's initial hunch that insects were essential to cross-fertilization was confirmed. He discovered that each species was intimately adapted to take best advantage of the particular insect that visited it. Species after species revealed an intimate relationship between the structure of the plant and the particular insects that visited it--bees for this one, moths for that one, flys for the other, butterflies for yet another, and pollen grains uniquely adapted for transport by each. Not only was there an intimate relationship between each plant and its special insect pollinators, but each species showed subtle modification of its basic organs to facilitate the attraction, entry, and exit of its pollinating insects.

He discovered that the smallest details of an orchid's structure were beneficial to its survival in the struggle of life. These wondrous adaptations, so often dismissed as of "trifling" importance, all functioned to insure the perpetuation and strength of the species through cross-fertilization.

> The use of each trifling detail of structure is far from a barren search to those who believe in natural selection. When a naturalist casually takes up the study of an organic being, and does not investigate its whole life . . . , he naturally doubts whether each trifling point can be of any use, or indeed whether it be due to any general law.
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> .....
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> No one who has studied Orchids would have suspected that these and very many other small details of structure were of the highest importance to each species; and that consequently, if the species were exposed to new conditions of life, and the structure of the several parts varied ever so little, the smallest details of structure might readily be acquired through natural selection. These cases afford a good lesson of caution with respect to the importance of apparently trifling

particulars of structure in other organic beings. [33]

When these modified structures were studied more closely they revealed "that the now wonderfully changed structure of the flower is due to a long course of slow modification, -- each modification having been preserved which was useful to the plant, during the incessant changes to which the organic and inorganic world has been exposed."[34] A few simple organs had been repeatedly modified to serve new functions in the plant's ever-changing conditions of life.

By arranging the modifications of many different species of orchids in a graduated series, Darwin believed that he could trace their descent back into the mists of time to glimpse their common progenitor.[35] His study of the homologies of the orchids had "cleared away the mist from such terms as the scheme of nature, ideal types, archetypal patterns or ideas" to reveal true genealogical relationships.[36] Natural selection had created perfect or nearly perfect "contrivances" through successive modifications over time.

Having demonstrated that the basic organs of the orchid had been profoundly altered to meet new contingencies and serve new functions over the course of time, Darwin found it incredible that anyone could continue to believe that the Creator had created each minute variation and adaptation in each species or even plant. It defied

[33]*Orchids*, 286-287.

[34]*Orchids*, 246.

[35]*Orchids*, 234, 262.

[36]*Orchids*, 234.

common sense to believe that "the omnipotent Creator" created each orchid "exactly as we now see it" according to "one plan for the whole order" and then tinkered endlessly with those organs to fulfill many different functions and, at the same time, "converted other organs into mere purposeless rudiments, and arranged all as if they had to stand separate, and then made them cohere." It was far more credible to believe that the organs of the orchid had actually "been developed by successive slow modifications of . . . pre-existing parts." Creation of these adaptations by secondary laws was, after all, the more reasonable scientific inference. [37]

In his own mind Darwin had successfully unraveled the mystery of the orchid. He had shown how it had been "designed" by gradual modification over time in meeting the exigencies of its conditions of life. Such "design" only enhanced his awe and wonder.

> The more I study nature, the more I become impressed with ever-increasing force, that the contrivances and beautiful adaptations slowly acquired through each part occasionally varying in a slight degree but in many ways, with the preservation of those variations which were beneficial to the organism under complex and varying conditions of life, transcend in an incomparable manner the contrivances and adaptations which the most fertile imagination of man could invent.[38]

Natural selection was capable of creating even more beautiful and perfect adaptations than could the imagined Deity of the "ordinary" view of creation.[39]

[37]*Orchids*, 246, 247.

[38]*Orchids*, 285-286.

[39]Several prominent commentators have argued that Darwin's main strategy was to ridicule the notion that a "perfect" creator would have designed a far more "perfect" means of adapting orchids to their conditions of existence than the ramshackle means actually employed. (In doing so they neatly

Darwin's fascination with the odd and quirky characteristics of other plants served him well in showing how his theory of natural selection explained the function of sterility. Critics had claimed that sterility was a specially endowed impassable barrier to insure the perpetual distinction of species. It was impossible, they charged, for sterility to have been slowly acquired through natural selection since no sterile organism would have been able to leave progeny. Although Darwin had devoted chapter eight of the *Origin* to this question, he did not have the essential experimental foundation for a full answer to this challenge.

Now he had the time, patience, lush gardens, and willing correspondents. What better way to avoid the drudgery of his work on *Variations* and recover from crippling bouts of illness than to turn his passion for flowers to his advantage? In order to demonstrate the validity of natural selection, he knew that he must demonstrate that sterility could have been slowly acquired, that it varied throughout the vegetable kingdom, and that there were gradations of sterility in different species.

sidestep the question of how they gained this insight into what a "perfect" creator would/should/could do. There are, in fact, strong grounds within the Christian tradition for marveling at the seemingly tortuous path God took to achieve certain ends.) Ghiselin even refers to *Orchids* as a satire. This was Huxley's polemical perspective, but not Darwin's. On the contrary, Darwin focused on the *result* of the process of adaptation, not the *means*. He did not attack the traditional understanding of the Deity; such an attack would have been foolish and unnecessary. He began rather with the far more effective strategy of agreeing with the proponents of design that the adaptations were "perfect," "admirable," "wonderful," and "marvelous." This was the feature that so beguiled Gray and many other readers and pulled the sting from his assault on the "ordinary" view of creation in the *Origin*. His strategy was then to show that nature was as capable -- perhaps even more so -- of creating these adaptations as any alleged Designer. The success of this strategy created enormous difficulties for proponents of the design argument since they could no longer appeal to these marvelous adaptations as inescapable proof of a Designer. That was precisely the dilemma Darwin wanted to create for them. Cf. Michael Ghiselin, *The Triumph of the Darwinian Method*, Chapter 6, "A Metaphysical Satire"; Stephen Jay Gould, *The Panda's Thumb*, Chapter 1, "The Panda's Thumb."

In other words, contrary to his critics, he had to show that sterility and fertility were opposite ends of a continuum along which all organisms could be ranged. Thus, sterility was not a quality supernaturally imposed on organisms to prevent the blending of species but had been slowly acquired in the organism's struggle against the conditions of its life.

Darwin's extensive experimentation and close observation of his plants provided the most elaborate empirical support he would personally ever bring to his theory of descent with modification through natural selection. It was commonly known that the *Primula*, or cowslip, had two forms, which everyone considered mere varieties. Darwin, however, discovered that the two forms, which he called dimorphic, were sterile when pollinated by the same form but fertile when pollinated by the other form. Insects again played an essential role in transferring the pollen from one form to the other. Two hermaphrodite plant forms were bound together to insure fertility in much the same way that male and female were related in the animal kingdom. Darwin was persuaded that here was a case in which sterility and fertility were reciprocally related rather than distinct; each served a useful role in the perpetuation and distinction of the species. This relationship could best be explained by his theory of natural selection and against the "ordinary" view of creation.

> The simple fact of two individuals of the same undoubted species, when homomorphically united, being as sterile as are many distinct species when crossed, will surprise those who look at sterility as a special endowment to keep species distinct. Hybridizers have shown that individual plants of the same species vary in their sexual powers, so far that one individual will unite more readily than another individual of the same species with a distinct species. Seeing that we thus have a groundwork of variability in sexual power, and seeing that

> sterility of a peculiar kind has been acquired by the species of Primula to favour intercrossing, those who believe in the slow modification of specific forms will naturally ask themselves whether sterility may not have been slowly acquired for a distinct object, namely, to prevent two forms, whilst being fitted for distinct lines of life, becoming blended by marriage, and thus less well adapted for their new habits of life. But many great difficulties would remain, even if this view could be maintained.[40]

Darwin concluded that since sterility and gradations of sexual function were common within a species of plants it was much less tenable to maintain, as did his critics, that sterility was the touchstone of species identity. Sterility was not a "superadded" characteristic; it was a slowly acquired means to insure species identity. Natural selection in the struggle for life was a much more reasonable explanation for this phenomena than special creation.

Everyone was familiar with plants possessing the mysterious adaptations of coiling round an object for stability or climbing up trees, walls, and even rocks. These adaptations were so unusual that they seemed to shout "design" to most observers. Darwin understood that explaining the origin and function of this behavior of numerous well-known plants in terms of his theory of natural selection would close one more door of escape for his critics. Spurred on by a brief notice on coiling tendrils by Gray years earlier, Darwin set to work. His exhaustive study of the adaptations of numerous genera of climbers convinced him that all plants have the

[40]"On the Two Forms, or Dimorphic Condition, in the Species of *Primula*, and on Their Remarkable Sexual Relations," *Journal of the Proceedings of the Linnean Society* 6 (1862): 77-96, reprinted in *The Collected Papers of Charles Darwin*, ed. Paul H. Barrett (Chicago: University of Chicago Press, 1977), Vol. 2: 61. He subsequently discovered that the same principle applied to the phenomena of trimorphism in plants. He later drew all of these studies together in *The Different Forms of Flowers on Plants of the Same Species* (London: John Murray, 1877).

inherent capacity to twine and climb, though only some exploit it to their fullest advantage. He concluded that all of the various kinds of movements in plants were but modified adaptations each species had acquired in its search for maximum light and air while expending the least amount of energy. Climbing plants proved to be a "capital guide" for observing and convincing him of the change of species.[41] "It has always pleased me," he later reflected, "to exalt plants in the scale of organized beings; and I therefore felt an especial pleasure in showing how many and what admirably well adapted movements the tip of a root possesses."[42]

Gray pointed out that Darwin's studies of orchids, both dimorphism and trimorphism, and climbing plants had a direct bearing on the validity of his

> theory of the gradual transformation of specific forms through natural selection. . . . The gradual acquisition by certain plants of advantageous peculiarities is inferred from the gradation of forms and functions. Properties and powers which are latent or feebly developed in most plants are taken advantage of by some, made specially useful, and enhanced from generation to generation. Tendril-bearing plants, -- the most specialized in structure and the most exquisitely adapted to the end in view, -- are supposed to have been derived from leaf-climbers, and these in turn from simple twiners.[43]

Gray made it quite clear that Darwin's theory had powerful implications for explaining a broad range of other organic phenomena.

During the interlude between the *Origin* and *Variation of Plants and Animals*

[41]Darwin to Gray, 29 October 1864, GHA; Darwin, "On the Movement and Habits of Climbing Plants," *Trans. Linnean Soc.* 9 (1865): 1-118; Gray reviewed this in *Am. Jour. Sci.* 39 (Sept. 1865): 273-282; 41 (Jan. 1866): 125-130.

[42]*Autobiography*, 135-36.

[43]Gray, "On the Movements and Habits of Climbing Plants," *Am. Jour. Sci.* 39 (September 1865): 273-282; 274; (January 1866): 125-131.

Under Domestication, Darwin's fascination with his beloved plants paid rich dividends in broadening the empirical support he needed to silence his critics. He had tackled the most intractable challenges of useless parts, sterility, and twining and successfully explained all of them in terms of his theory of natural selection. No longer could his critics argue that these adaptations were so marvelous that they could only be explained as special endowments of the Creator.

Gray's Defense Against Darwin's Flank Attack

Gray was intimately involved in all of Darwin's projects during these years. Their mutual love of plants bound them together in spite of Darwin's frosty perspective on the Civil War and their disagreement on design. Hardly a letter passed between them between 1860 and 1868 that did not discuss the issues Darwin was considering in his experiments. Darwin peppered Gray with questions, his own extensive observations, and requests for help on all of his projects. Had Gray ever noticed the myriad curious contrivances in orchids all for same end? Would he have a student study gradation of sexes in Hollies? Would he ask Charles Wright to collect an extra set of orchid specimens while in Cuba? Would he check to see whether Rhexia was dimorphic? What further information could he provide on American species with coiling tendrils? Was he aware of any studies that measured the rate and angles of coiling? Gray obliged Darwin in every case, often taking precious time away from his own work to collect requested specimens, perform experiments for

him, and save him from errors. [44]

Gray was continually amazed at the new discoveries that Darwin was making in a field he claimed for his own. "If there be any adaptation--be it ever so pretty--I shall never see it without your direction. What a skill & genius you have for these researches. Even for the structure of the flower *Orphyrideae* I have to-night learned more than I ever knew before."[45] Darwin was clearly the "prince of investigators" who had the rare genius for turning his observations of common garden plants to the highest scientific purposes. [46]

Gray was deeply "charmed" by the functional adaptations orchids had acquired to insure their fertilization, most of them being new to him and the botanical community. [47] Liberal extracts from the book detailing the numerous and intricate modifications of a host of orchid species impressed them on his readers. At Darwin's

[44]cf. Darwin to Gray, 15 March 1862, *CCD* 10: 117-118; Darwin to Gray, 21 April 1862, *CCD* 10: 162-164; Darwin to Gray, 1 July 1862, *CCD* 10: 288-299; Gray to Darwin, 4 August 1862, *CCD* 10: 352-355; Darwin to Gray, 20 April 1863, GHA; Darwin to Gray, 19 April 1864, GHA; Gray to Darwin, 7 May 1866, *LAG* 2: 548-549. Gray, along with Jeffries Wyman, even distributed fifty of the questionnaires Darwin had prepared to solicit material for his *The Expression of the Emotions in Man and Animals* (1872). Interestingly, Gray thought agents of the Freedman's Bureau would be best able to answer the questions. Gray to Darwin, 26 March 1867, *LAG* 2: 553. Darwin thanked Gray for his efforts, though he doubted that his new "hobby horse" would take him as far as he thought it might. Darwin to Gray, 15 March 1867, GHA. Gray was still thinking about Darwin's interest in these matters during his trip down the Nile in the winter of 1868-69 and wrote Darwin a long letter full of his observations. Gray to Darwin, 9 May 1869, GHA typescript.

[45]Gray to Darwin, 18 May 1862, *CCD* 10: 206-208.

[46]Gray to Darwin, 15 May 1865, GHA typescript; Review of "On the Movements and Habits of Climbing Plants," 274.

[47]Gray wrote two long reviews of the orchids book: Review of *On the Various Contrivances by which . . . Orchids are Fertilized by Insects, and on the Good Effects of Intercrossing*, by Charles Darwin. In *Am. Jour. Sci.* 34 (July 1862): 138-144; "Fertilization of Orchids through the Agency of Insects," *Am. Jour. Sci.* 34 (Nov. 1862): 420-429.

urging Gray even added detailed descriptions of native American species of orchids that confirmed Darwin's observations. Darwin was to be congratulated, Gray urged, for undertaking the daunting task of finding out the various functions of modified organs in plants and overturning so many "unscientific and foolish . . . conjectures" on their role. He lamented that "under the study of homologies--so fertile in excellent results--botany and even zoology have become almost exclusively morphological." Darwin had made it clear, Gray pointed out, that in all future botanical research "teleology must go hand in hand with morphology, functions must be studied as well as forms, and useful ends presumed, whether ascertained or not, in every permanent modification of every organ."[48] Coming from one strongly influenced by the morphological approach to botanical structures, this was a significant statement.

Ever the superb strategist Gray transformed Darwin's arguments into broadening support for design in nature while adroitly remaining silent about Darwin's explicit challenge to the design argument in his last chapter. Gray assured his readers that "the grand and most important inference of *design in nature* being drawn from the same data, subject to similar difficulties, and enforced by nearly the same considerations" was unaffected by Darwin's book.[49] Indeed, Gray claimed, the adaptations Darwin had discovered were "obviously as evincive of design as are

[48]Gray, "Fertilization of Orchids through the Agency of Insects," *Am. Jour. Sci.* 34 (Nov. 1862): 429.

[49]"Fertilization of Orchids," 429.

analogous arrangements in the animal kingdom, from which intention is so irresistibly inferred." He advised that "had Mr. Darwin begun with this little book, and kept back a few theoretical inferences, it would have been a treasury of new illustrations for the natural theologians, and its author, perhaps, rather canonized than anathematized, even by many of those whom his treatise on the origin of species so seriously alarmed."[50] Readers need not fear Darwin's book; they should rather welcome it for the rich store of illustrations it added to the design arsenal. Indeed, it was.

While publicly exuding confidence in the harmony of descent and design, Gray's correspondence with Darwin on the implications of the orchid book reveal several ambiguities that continued to plague their understanding of the issues at stake. How was it possible for both of them to marvel at the perfectly modified and adaptive structures the orchid had acquired, yet disagree so fundamentally on the source of those perfections? Their discussion makes it clear that neither still fully understood the fundamental philosophical and theological assumptions of the other or what the other meant by key concepts in the debate. The central objectives of Darwin's flank attack on the design argument had been to show that: 1) the organs of orchids had gradually become modified over time rather than instantly given to each species as special endowments; and 2) the myriad of perfect and diverse adaptations were slowly acquired in the orchids' struggle against the conditions of life to insure their cross-

[50]Review of *On the Various Contrivances*, *Am. Jour. Sci.*34 (July 1862): 139.

fertilization rather than specially planned by the Creator.

A "perfect" Creator with a "perfect plan," Darwin assumed, would have created "perfect" adaptations immediately rather than endlessly tinkering with them over time. Darwin thus believed that the historical continuity, genealogical gradations, and diverse modifications to serve the same role that he had so clearly presented meant that it was "impossible to imagine so many co-adaptations being formed by a chance blow." That's exactly right, Gray retorted. In fact, the perfection of the coadaptations was "next to a demonstration against their having been formed by chance blows at all one or many!" Gray had completely missed Darwin's fundamental assumptions. Darwin was using coadaptations as evidence to support natural selection. "Chance blows" for him meant the "ordinary" view of creation in which an alleged Creator interfered in the continuities of nature to create adaptations *de novo*. Gray, on the other hand, as so many had done before, used adaptations as evidence of a Purpose conceived by the Creator. "Chance blows" for him were the opposite of unplanned or without purpose. This brief byplay illuminates a central ambiguity in the "design" argument.[51]

Both Darwin and Gray also failed to note the gradual differentiation that was occurring between two major connotations of design, *function* and *intention*. *Function* was an empirical phenomena having to do with the use of an organ, what physiologists studied. I*ntention* was a mental conception having to do with human

[51]Darwin to Gray, 23 July 1862, *CCD* 10: 330-334; Gray to Darwin, 22 September 1862, *CCD* 10: 428-430; Gray to Darwin, 17 November 1862, *CCD* 10: 534-535; Darwin to Gray, 31 May 1863, GHA; Gray to Darwin, 7 July 1863, *LAG* 2: 507-509.

motives, goals, ends, or purposes. These two meanings, though closely related, were fused in the early formulations of the design argument. Under pressure from the Positivist tradition that banished final causes from science, naturalists, like Darwin, were stripping function of all anthropomorphic associations with intentions. It is, for example, possible to examine the function of the ear without any knowledge or interest in its ultimate purpose in the scheme of the universe.

Darwin concentrated his attention on the physiological *function* of those allegedly "useless" structures in orchids. These functions, he contended, could be studied without any guidance from their alleged design by the Deity. Whenever he used the terms *contrivances* and *purposes* -- which he did intentionally -- of the orchids' modified structures, Darwin meant he was exploring their *function* in preserving the species, not the way they expressed the Creator's *intentions*. Darwin believed that his functional explanation had thereby undermined the claim that they had been created for a specific *end* or purpose. This was more than he could claim. In truth, demonstrating the *function* of the adaptations in orchids said nothing about the *end* for which those structures were created, even if it could be known. Gray was persuaded that "we believers in real design" could "pooh-pooh" Darwin's efforts to "resolve such contrivances into necessary results of certain physical processes."[52] He could not.

Furthermore, Darwin continued to assume that the *secondary laws* (i.e. natural

[52]Gray to Darwin, 22 March 1863, *LAG* 2: 501.

selection) he had discovered *caused* the orchids' organs to function in the way they did. But *laws* do not *cause* any phenomena. What Darwin had actually discovered were the regular patterns according to which organs were modified and adapted in their struggle for life. These patterns were the *laws* he so aggressively sought. He, as many of his contemporaries, transformed these empirical *laws* into metaphysical *causes* and resolutely upheld them against the doctrine of the Creator's interference with those processes. But empirical descriptions of the phenomena could never be treated as *causes*, so taught all contemporary philosophers of science. As he was at pains to clarify, Darwin believed that natural selection was an "ensemble" of the diverse processes in nature that sorted and preserved the fittest individuals. At best Darwin had demonstrated that whatever the *true cause* of modifications were, its effects conformed to empirically discernable patterns; it was under law. It was this ambiguity in Darwin's own language that critics rightfully seized on in charging him with deifying natural selection.

Gray introduced a similarly ambiguous understanding of teleology into the discussion. Recall that he had thanked Darwin for reintroducing teleology into botany. How did Gray believe Darwin had brought teleology back into biology? This was not a neat rhetorical device as some have thought. He meant that Darwin had shown the importance of studying the *function* (teleology) as well as the *form* (morphology) of plants. Gray correctly called attention to Darwin's major contributions to plant physiology. But in Darwin's framework, this was a confusing statement since for him *teleology* connoted preordained Purpose or *End* by the

Creator, not *function*. He was at great pains in all of his work to show that *function* supplanted *teleology* as a suitable scientific explanation.

These two distinct meanings of *function* and *intention* existed in the morphological tradition but had never been clearly differentiated. Their confusion was central to the debates between Cuvier and St. Hilaire in 1830 and was now playing havoc in understanding what Darwin's researches had and had not accomplished.[53]

Despite his confident public claims that Darwin's discoveries told equally well for both champions and critics of design, Gray's correspondence revealed that he realized the balance had tipped in Darwin's favor. Gray, along with all other design advocates, had declared on repeated occasions that one was irresistibly compelled to conclude that these adaptations had been created for this particular *Intention*. Gray believed that design was the most rational inference from the available evidence. But Darwin and the Positivists had undermined the epistemic warrant for this inference by declaring that naturalists could say something meaningful only about physiological *functions* and nothing whatsoever about the *intentions* of an alleged Creator for organic structures. It was this disconnect that Gray confessed gave him a "cold chill."

[53]Ernst Mayr has helpfully noted the differentiated meanings of teleological language in "The Multiple Meanings of Teleological," in *Toward a New Philosophy of Biology* (Cambridge: Harvard University Press, 1988), 38-66. He finds two clearly distinct kinds of end-directed behavior. *Teleomatic processes* characterize the ends produced by the automatic results of physical and chemical processes and natural laws, as when a stone falls from a cliff and reaches its "end" in the valley floor or water is the end-result of the union of two hydrogen and one oxygen atom. *Teleonomic processes* characterize the end-directed behavior of all living beings that results from the operation of an internal program that reaches an end-point, as in patterns of migration, physiological processes regulating propagating, eating, sleeping, flight from enemies, or the operation of DNA, etc. Much of Darwin's criticisms of "design" actually concerned the way it confused distinct phenomena and their behavior while Gray, and many others, failed to recognize these increasingly relevant distinctions.

Yes, he was keenly aware that it was no longer possible to "ignore" the difficulties the question of design in nature now faced. He had no answer to Darwin's severest question: "were not the variations [of the pigeons] accidental as far as the purpose man has put them to?" Darwin meant that breeders could have chosen to modify their pigeons in any number of ways; thus, the fact that they chose *this* variation rather than *that* variation was not preordained; it was *accidental.* So far Gray had "managed to keep off the chilliness by giving the knotty question a rather wide berth." Darwin stuck the knife in a bit deeper by noting that Lyell also "shirked" this question. In the end Gray agonized over the alternative: "if I adopt your view bodily, can you promise me any less difficulties?"[54]

These confusions over the meaning of function and intention were vividly displayed in an article by the Duke of Argyll on Darwin's orchid book.[55] The Duke took Darwin to task for his inconsistency in using a host of terms expressing intention while yet refusing to draw the obvious conclusion that only a Mind could entertain intentions. "He exhausts every form of words and of illustration by which intention or mental purpose can be described. 'Contrivance,' -- 'curious contrivance' -- 'beautiful contrivance,' -- these are expressions which recur over and over again." These are the exact words that humans use to describe "the instruments we use or

[54]Gray to Darwin, 7 July 1863, *LAG* 2: 507-509; Darwin to Gray, 4 August 1863, GHA; Gray to Darwin, 1 September 1863, *LAG* 2: 511-513.

[55]"The Supernatural," *The Edinburgh Review* 116 (October 1862): 378-397. Neil Gillespie provides a succinct overview of the Duke's "providential evolutionism" in *Charles Darwin and the Problem of Creation*, 98-104.

invent for carrying into effect our own preconceived designs. . . . The idea of special use, as the find end and controlling principle of construction, is so impressed on Mr. Darwin's mind, that, in every detail of structure, however singular or obscure, he has absolute faith that in this lies its ultimate explanation." Argyll claimed that Darwin simply flinched when confronted with the obvious presence of Mind in the contrivances he discovered in orchids.

> Purpose and intention, or ideas of order based on numerical relations, are what meet us at every turn, and are more or less readily recognized by our own intelligence as corresponding to conceptions familiar to our own minds. We know, too, that these purposes and ideas are not our own, but the ideas and purposes of Another -- of One whose manifestations are indeed superhuman and supermaterial, but are not 'supernatural,' in the sense of being strange to nature, or in violation of it.

The truth, from which Darwin could not even escape, Argyll concluded, was that Law, the expression of God's Will, reigns universal and supreme throughout both the material and moral world, the natural and the supernatural world. [56] Theists, thus, understood a miracle to be a superhuman act of God that used existing physical laws to accomplish his intentions and purposes without violating or interfering with those laws.

Henry Parker, Darwin's nephew, objected to what he considered the Duke's slight of hand on the meaning of miracle.[57] "If we admit, as every one does admit, that a miracle means something effected by a special interposition of the divine will,

[56]Duke of Argyll, "The Supernatural," *The Edinburgh Review* 116 (October 1862): 392, 393, 395.

[57]Henry Parker, "The *Edinburgh Review* on the Supernatural," *Saturday Review* (November 15, 1862): 589-590.

which could not be effected by man, and which would not have happened in the ordinary course of things, it is clear that, whether we prefer to call it supernatural or superhuman, is a merely verbal question."[58] The real question was whether the divine will ever interposed itself in the course of nature regardless of how distant and remote the interposition was or however adroitly the Divine will used natural laws to accomplish his desires. As soon as the divine will acted in nature we had a miracle and a violation of the laws of nature. It is such interpositions that modern proponents of the universality of natural law banished from their science.[59] This was the crux of the matter. The Achilles heel of natural theology had been its insistence on bringing the transcendent God into the immanent flow of nature as its Efficient Cause. thereby subjecting the Creator and ground of the universe to all of the scientific strictures against occult causes. As long as God's causal relationship to the universe was seen as analogous to all of the other causes science investigated, God's activity in the world would be challenged.

Darwin lamented that the Duke had not dealt with the grave "theological difficulties" in his position. Gray, on the other hand, believed that while the article was not particularly deep, it was "useful" in some measure since it raised many of the same points that he himself raised in his *Atlantic* articles. They both agreed that the evidence of design, of the manifestation of Divine Will in nature, is no "less certain or less convincing" after the "operation of natural causes can be clearly traced." At

[58]Parker, 589.

[59]Parker, 589-590.

most, Gray admitted, Argyll could be faulted for implying that this was not equally true for the "derivation doctrine."[60]

Gray used the occasion of an anonymous review of a new edition of James Dwight Dana's *Manual of Geology* to demonstrate the essential harmony between the views of Darwin and Richard Owen on the derivative hypothesis of the origin of species. [61] Forging a unity between the views of Owen, the premier English comparative anatomist who was also well-known as a theist, and Darwin, charged with being an atheist, played an important role in Gray's efforts to salvage the harmony of descent and design. Darwin and his circle of English friends, as previously noted, bitterly resented what they considered to be Richard Owen's savage attacks on Darwin and his presumption to take credit for having been the first to offer a derivative hypothesis. Huxley's gleeful jabbing at his thin-skinned former mentor is well-known. Despite Darwin's repeated groanings about Owen's unfair barbs, Gray retained his early sympathy with Owen's efforts to synthesize the teleological and morphological emphases of Cuvier and St. Hilaire.

Owen, largely under the influence of the morphological tradition, had been gradually moving toward his own version of a derivative hypothesis since the late

[60]Darwin to Gray, 23 November 1862, *CCD* 10: 546-548; Gray to Darwin, 22 March 1863, *LAG* 2: 501.

[61][Asa Gray], "Dana's Geology," *North Am. Rev.* 97 (October 1863): 372-386. Neil Gillespie survey's Owen's "providential evolutionism" in *Charles Darwin and the Problem of Creation*, 90-93. Nicolaas Rupke has most recently provided a much-needed thorough discussion of Owen's gradual formulation of "theistic evolutionism" in *Richard Owen: Victorian Naturalist*, chapter five, "Eclipsed by Darwin."

1840s. His zoological description of the exotic Aye-Aye published in 1863 gave him the opportunity to offer the fullest statement to date of his own position in contrast to Darwin's.[62] Liberally quoting from key portions of Owen's booklet, Gray showed how similar were Owen's views to those of Darwin. He believed that species were derived from existing species by a "continuously operative secondary creational law" through "the operation of forces and influences which are part of the ordained system of things." Organisms were disposed "to vary in form and structure according to variation of surrounding conditions." All subsequent higher and more complex organisms have been derived from the earliest and simplest. The entire process was the "pre-ordained result of the Creator."

Gray pointed out that Owen's position was remarkably similar to Darwin's in its broad outlines; their differences were neither "fundamental nor irreconcilable." The critical common ground was their shared belief in the genealogical connection among both past and present organisms and the belief that those organisms gradually ascended the scale of organizational complexity. Though Owen explicitly asserted his belief in the superintendence of a Divine Power over this process, Darwin at least implied such a belief. Their widest difference came in their respective explanations for how species have become diversified. Darwin's theory of natural selection has the great virtue of inviting scientific testing. Owen's "creation by law" was unfortunately hollow since it suggested no glimpse of what this law was or how it could be tested.

[62]Gray quoted *inter alia* from Owen's *Monograph on the Aye-Aye* (London, 1863), 60-66.

That being admitted, Gray saw them advancing in the same direction.

In private Gray teased Darwin about how really close he was to Owen. Owen's recent paper on the Aye-Aye confirmed Gray's earlier suspicion that "Owen had a transmutation theory of his own! It is your Hamlet, with the part of Hamlet left out! But as you say now, you don't so much insist on natural selection, if you can only have derivation of species. And Owen goes in for derivation on the largest scale. You may as well lovingly embrace."[63]

Gray assured his readers that there were a number of respected naturalists, such as Argyll and Lyell, who were confident that natural theology would emerge as strong after its contest with Darwin as it had been before.

> However delicate the ground upon which the naturalists have presumed to tread, the arena is now fairly open. We cannot debar them if we would, nor ought we if we could. The discussion must needs proceed, and we may fearlessly await the issue. The fortress of natural theology has not become less impregnable through successive changes of its outworks. These may well assume new forms from time to time, according to the attack. None of the threatened positions command the citadel. [64]

Presumably that citadel was the irresistible inference that the Deity had designed, in however a mysterious or unknown manner, the derivation of species.

Gray wavered between "design" being an inescapable inference from an empirical study of the world and it being a major premise of a design argument. Should the design argument be presented as an inductive argument *from* the phenomena to a Designer or a deductive argument *to* design in the natural world from

[63]Gray to Darwin, 21 July 1863, *LAG* 2: 510.

[64]"Dana's Geology," 386.

the major premise of a Divine Mind?

> The *no-design* view, if one can bring himself to entertain it may well enough lead to all she says, and we may very much admire how *collission*, [*sic*] and destruction of least favored brings about apparently orderly results, -- *apparent* contrivances or adaptations of means to ends. On the other hand, the implications of a designing mind must [bring] with it a strong implication of design in matters where we could not directly prove it. If you grant an intelligent designer anywhere in Nature, you may be confident that he has had something to do with the "contrivances" in your Orchids. [65]

Gray had virtually conceded the force of Darwin's objections to the design argument. Not only did the design argument fail to provide guidance for investigating the natural realm but it failed to provide an inescapable inference of a Designer from the evidence. Darwin's "no-design" view had vividly illustrated how "collission, and destruction of least favored brings about . . . *apparent* contrivances or adaptations of means to ends." He found that a Designer was neither required for his research nor a compelling inference from his study. Gray had no answer. He could only shift the ground to argue that *if you granted* an intelligent designer, then you would somehow see the Designer's role in the adaptations of Darwin's orchids.[66] Of course, Darwin refused to grant Gray's major premise.

Design and Descent in Gray's Textbooks

Perhaps the most important way that Gray mediated acceptance of descent with

[65]Gray to Darwin, 2 July 1862, *LAG* 2: 292-294.

[66]Darwin to Gray, 10 June 1862, *CCD* 10: 239-244; Gray to Darwin, 2 July 1862, *CCD* 10: 291-294.

modification was through his textbooks.[67] Gray was an influential and prolific textbook author throughout his professional life. It is a wonder that he even found the time to write texts in light of his steady stream of comprehensive reviews, unending systematic work, teaching, and extensive correspondence with colleagues and collectors. Writing textbooks was both a scientific and a financial necessity; they enabled him to introduce essential reforms in the study of botany and supplement his meager Harvard salary to fund his own ambitious botanical projects. New editions and printings became a virtual annuity for him. He was at the forefront of introducing the natural system of classification and the related emphasis on plant morphology in his first text, *Elements of Botany* (1836). Subsequent texts and editions were equally abreast of the latest developments in botany. His were among the first texts to discuss the bearing of Darwin's theory of the derivation of species on botany.

He was equally adept at writing lucid introductions to botany for elementary school students (*How Plants Grow*) and sophisticated studies that built on his intimate understanding of the major departments of botany for the most advanced students (*Botanical Textbook*, 2 vols.). He was lauded as the ideal text writer: "for to a perfect knowledge of his subject he adds a clearness and exactness of style seldom met with, and the power of condensing in a few words a great amount of information."

[67]Gray also wrote two very important floras, both of which are still considered essential references. The *Flora of North America*, which he and John Torrey initially worked on together was brought out in 2 vols. between 1838 and 1843. Gray expended enormous labor on expanding it till his death; his students subsequently took it over. His *Manual of Botany*, a shortened reference book, was first published in 1848; a commemorative edition, based on the eighth edition, was published in 1950.

The "discriminating public" should throw away existing "trashy volumes" and embrace this small volume containing "the learning and research of a life devoted to the subject."[68] By 1870 Gray's school texts had become the dominant botany text in the state of New York; by 1885 they had captured nearly 80% of the market. *How Plants Grow* was used almost exclusively by elementary students in the Midwest throughout the latter half of the nineteenth century. Virtually every university botany course used one of Gray's texts. Each of his texts went through numerous editions and printings, a testimony to their growing popularity. They were still selling strong well into the twentieth century. [69]

Gray's textbooks were an important channel for introducing the morphological tradition into American botany. As a young man he had enthusiastically read A. P. De Candolle's *Theorie elementaire* (1813); he was convinced that scientific botany must thereafter be firmly established on the morphological foundation De Candolle had laid.[70] De Candolle, the premier botanist on the continent at the time, was persuaded that the unity of type concept that had been so successfully employed by his colleague, Cuvier, in comparative anatomy could be equally serviceable to a more

[68]Anon., "Gray's Botanical Text-Books," *North Am. Rev.* 87 (October 1858): 322, 324.

[69]Keeney, *The Botanizers*, 66-68; Clifford H. Peterson, "The Incorporation of the Basic Evolutionary Concepts of Charles Darwin in Selected American College Biology Programs in the Nineteenth Century" (Ph.D. diss., Columbia University, 1970), 85. Early editions of *The Botanical Text-Book* were also used as class texts at the University of Edinburgh. Anon., "Gray's Botanical Textbooks," *North Am. Rev.* 87 (Oct. 1858): 326.

[70]Dupree, *Gray*, 40, 53-54.

"philosophical botany."[71] Gray had found a compelling philosophical framework to guide his taxonomic studies and shape his teaching of many generations of students.

Throughout the decade following the publication of the *Origin*, Gray's textbooks assured his students that the single Plan they would be discovering in the vegetable kingdom was the product of the Divine Mind.

> The great variety which we observe among the herbs and shrubs and trees around us, -- in foliage, flower, fruit, and everything, -- gives to vegetation one of its greatest charms. We should soon tire of plants or flowers made all after one exact pattern, however beautiful. We enjoy variety. But the botanist finds a higher interest in all these differences than any one ese, because he discerns one simple plan running through all this diversity, and everywhere repeated in different forms. He sees that in every plant there is root growing downwards, connecting the vegetable with the soil; stem rising into the light and air, and bearing leaves at regular places, and then blossoms, and that the parts of one kind of blossom answer to those of another, only differing in shape; and he delights in observing how the tens of thousands of kinds of plants all harmonize with each other, like the parts of concerted music, -- plainly showing that they were all contrived, as parts of one system, by one Divine Mind.[72]

Morphology was not only the most scientific approach to the study of plants, but it likewise gave pious observers a more penetrating understanding of the Creator's grand

[71]Toby Appel, "Jeffries Wyman, Philosophical Anatomy, and Darwin," 80-81; Ernst Cassirer, *The Problem of Knowledge* (New Haven: Yale University Press, 1950), 135-136. The most thorough modern study of De Candolle is P. F. Stevens, "Hauy and A. -P. Candolle: Crystallography, Botanical Systematics, and Comparative Morphology, 1780-1840," *Jour. Hist. Bio.* 17 (Spring 1984): 49-82.

[72]Asa Gray, *How Plants Grow* (New York: American Book Company, 1858), 17; cf. Gray's text for secondary schools, *Gray's School and Field Book of Botany* (New York: 1872), 4-5, for less elaborate references to the Divine Plan and Mind. Gray's university text, *The Botanical Text-Book* went through five editions between 1842 and 1878 with several printings of each. Presumably because it was an advanced text it contained few explicit references to the Deity's Plan; its most direct references came in his discussion of the natural system of classification, 352-72. This text was entirely rewritten for the sixth edition in 1879; his discussion of the Creator's Plan was replaced with a discussion of Darwin's theory of descent, 315-331. The plant's morphology was more reasonably explained by tracing its descent from ancient progenitors. Similar changes occurred in his elementary and secondary texts in the 1880s.

design in the organic world.

Discerning students of botany must understand, Gray urged, how the plant "is worked out in the greatest variety of ways, through the manifold diversity of forms which each of its three organs of vegetation -- root, stem, and leaf -- is made to assume."[73] This was a lucid statement of De Candolle's unity of type concept. The "Great Author of Nature" had so designed these organs that "the same organ may appear under a great many different shapes, and fulfil very different offices." It was thus not necessary that new organs be created for each new function. The Deity modified the single Plan so that one of the "three general organs of the vegetable, *root, stem, or leaf*, is made to serve the purpose, and is adapted to it by taking some peculiar form."[74]

Understanding the single Plan enabled the student to understand both the transformations of the three major organs into all of the other parts of the plant and to understand the many deformations of the plant. The morphological tradition gave Gray an abiding appreciation for gradations in the parts of plants. There is a such a "regular gradation from the last leaves of the plant . . . to the calyx that it is impossible to say where one ends and the other begins."[75] There were equally fine gradations between sepals and petals, calyx and corolla, and stamens and petals. No matter the profusion of new parts, they were all transformations of the three essential

[73]*School and Field Book of Botany*, 29.

[74]*School and Field Book of Botany*, 47, 49.

[75]*School and Field Book of Botany*, 98.

organs.

Knowledge of the single Plan enabled the botanist to understand how it was variously disguised and became unsymmetrical. Some species of plants showed that a number of its parts had either been wiped out, aborted, multiplied beyond necessity, or remained as vestiges with no use. They were all deformations of the ideal plant.[76]

Understanding that the vegetable kingdom had been called into being by "an intelligent mind working according to a system" gave botanists the key to classifying its diverse forms, Gray maintained. With this insight botanists understood that though there were wide differences among the forms of plant life,

> yet the extremes are connected by intermediate grades of every sort, so as to leave no wide gap at any place; and not only so, but every grade, from the most complex to the most simple, is exhibited under a wide and most beautiful diversity of forms, all based upon the one plan of vegetation which we have been studying, and so connected and so answering to each other throughout as to convince the thoughtful botanist that all parts of one system, works of one hand, realizations in nature of the conception of One Mind. We perceive this, also, by the way in which the species are grouped" according to rank.[77]

At the same time Gray appreciated that it was impossible to reduce the rich diversity of organic forms to the logically tidy categories of species, genus, order, and family. Botanists were

> often obliged to make arbitrary divisions where nature shows only transitions, and to consider genera, &c., as equal units, or groups of equally related species, while in fact they may be very unequal, -- to assume on paper at least, a strictly definite limitation of genera, of tribes, and of orders, although observation shows so much blending here and there of natural groups sufficiently distinct on the whole as to warrant us in assuming the likelihood that the Creator's plan is of

[76]*School and Field Book of Botany*, 98, 87, 94-95.

[77]*School and Field Book of Botany*, 175, 195.

gradation, not of definite limitation, ever perhaps to the species themselves.[78] Gray found that the morphological tradition was elastic enough to understand that a truly "natural" system of classification had to accommodate the continuous flow of plant life.

Gray's morphological framework for the study of botany made it relatively easy for him, as it did for many others who were influenced by the morphological tradition, to accommodate his belief in the Creator's Plan with Darwin's claims for the descent of species. While he never mentioned Darwin's name or theory in his texts, it was really not necessary to do so. Many of the themes Darwin stressed were already anticipated in Gray's textbooks--infinite gradation of parts, the subtle transformations of parts to fulfill new functions, intermediate forms, and species as continuum. Viewed in this light it was not surprising that Gray would have been as enthralled by the many curious adaptations Darwin had discovered in his quirky plants. They were all wonderful adaptations of the single Plan the Creator had designed for the vegetable kingdom. So close, but yet so far away.

Gray's textbooks, in the final analysis, may have been the singular most important way that Gray prepared thousands of young people to see that Darwin's derivative hypothesis was but a further elaboration of the morphological tradition and compatible with the principles of natural theology.

[78]*School and Field Book of Botany*, 195-196.

Asa Gray and Chauncey Wright on the Neutrality of Science

Various commentators have argued that Gray's effort to show that natural selection was not necessarily incompatible with natural theology inspired Chauncey Wright to elaborate his doctrine of the neutrality of science.[79] This claim needs extensive qualification. In reality, Gray and Wright brought sharply contrasting philosophical and religious orientations to their discussions of Darwin and the implications of his thought. The gradual shift from the older natural theology framework in which Gray was intellectually formed to the modern positivist framework that Wright was forging, was far more nuanced and encumbered with philosophical and conceptual difficulties than the received interpretation suggests. By 1865 Wright had already moved far beyond Gray, past William Hamilton and the Scottish philosophy, and into the new world of positivism as articulated by Mill's rigorous inductive logic.[80] This led to his vigorous campaign to cleanse scientific method and motives of all contaminants, especially natural theology and its secular substitutes, and establish a pristine, neutral, and autonomous science. While Gray and Wright may have come to a superficially similar *modus vivendi* in understanding the

[79]Philip Wiener set the pace for this interpretation by noting, in passing, that "it is altogether likely that Wright's own key conception of the neutrality of science owed much to Gray and to Jeffries Wyman." *Evolution and the Founders of Pragmatism*, 253, n. 1. Dupree elaborated on this influence in contending that "in his scientific practice and his ideas about Darwin, Gray provided Chauncey Wright with a model which was not lost upon the philosopher. Wright made explicit in philosophical terms the influence which shaped Gray and the conclusions he drew." *Asa Gray*, 290. James Turner, *Without God, Without Creed*, 187, and Paul Jerome Croce, *Science and Religion in the Era of William James*, 163, accept this basic interpretation.

[80]Wright's move out of Hamilton's orbit can be traced in "Mill on Hamilton," *The Nation* 1 (August 31, 1865): 278-281 and "Mill on Hamilton," *North Am. Rev.* 103 (July 1866): 250-260.

relationship between descent and design, they were motivated by significantly different philosophical spirits.

Shortly after Wright died, Gray fondly recalled that he and Wright "always got on admirably as to our antagonisms, which came to play only as we neared the last question of all; and each understood the others [*sic*] ground too well to entertain the idea that he could drive the other clean out of it." Their "antagonisms" over "the last question of all" take us to the heart of the issue.[81] In fact, Gray failed to realize that their "antagonisms" were there already at the beginning as a pretheoretical framework. What appeared at the "end" were the logical implications of those prior assumptions.

Gray established a warm friendship with his former student, Chauncey Wright, the brilliant, eccentric, yet congenial, philosophical champion of positivism in Cambridge. Gray, although not well-read in the critical philosophy bubbling out of England, enjoyed his intellectual jousting matches with Wright on the foundations of science. Wright returned the favor with a deep respect for Gray's eminence as an internationally renowned botanist and friend of Darwin. It did not hurt that Wright shared Gray's exasperation with Bowen and Agassiz. Gray fostered the promise he saw in Wright by taking him under his wing and becoming his unofficial promoter. He may well have opened the doors of the American Academy and supported him for the office of secretary, a position Wright held for twelve years until his death. Gray also encouraged Wright to publish important mathematical articles on the symmetry of

[81]Gray to Norton, 9 August 1876, bMS 1088, Norton Papers, Houghton Library, Harvard University.

the bee cell and the phenomenon of phyllotaxy, both of which Wright claimed could be explained by natural selection.[82]

The bond between Gray and Wright grew strongest in their mutual respect for Darwin. We have already noted that Gray introduced Wright to Darwin and his persistent efforts to get Wright's early review of the *Origin* published in England. Unfortunately, Darwin was put off by the review's turgid philosophical slant; Huxley could not use it in his propaganda wars.[83] Gray may well have been instrumental in having their mutual friend, Charles Eliot Norton, the editor of the *North American Review*, and E. L. Godkin, the editor of the new periodical, *The Nation*, invite Wright to publish review essays of contemporary philosophical and scientific books, most of which dealt with a defense of positivism and the logical and methodological issues Darwin raised.[84] Gray insured that Darwin was particularly aware of Wright's severe criticisms of Spencer.[85]

The emboldened Wright took the initiative in sending Darwin the review he was preparing on, among others, St. George Mivart's *The Genesis of Species* (1871), which attacked natural selection as unscientific and immoral. Darwin was deeply

[82]"The Most Thorough Uniform Distribution of Points About an Axis," *Mathematical Monthly* 1 (1859): 244-248; "The Economy and Symmetry of the Honey-Bees' Cell," *Mathematical Monthly* 2 (June 1860): 304-319.

[83]The essay, which Gray sent to Darwin, has never been found.

[84]For a complete listing of Wright's reviews in these two periodicals see Edward Madden, *Chauncey Wright and the Foundations of Pragmatism* (Seattle: University of Washington Press, 1963), 149.

[85]Darwin to Gray, 13 September 1864, GHA; Gray to Darwin, 3 October 1864, APS; "A Physical Theory of the Universe," *North Am. Rev.* 99 (July 1864): 1-33.

impressed; he flattered Wright with a request to have it printed as a pamphlet, which Wright gladly accepted.[86] Wright answered Mivart's counter-attack with "Evolution by Natural Selection."[87] Darwin was particularly pleased with how Wright explained that species should be understood as both "permanent" and "fixed," yet subject to natural selection. In the fall of 1872 Wright made a pilgrimage to Down and came away transformed by his "beatific" encounter with Darwin. Spurred on by Darwin's request, Wright made his most substantive contribution to the Darwinian project with a fully naturalistic account of the "Evolution of Self-Consciousness," something that had perplexed Darwin for decades.[88] They continued their correspondence until Wright's death.

Wright came to intellectual maturity at the time when the great promise of the Scottish philosophy, that all important realms of human knowledge, from science to theology, could be established on and confirmed by the inductive principles laid down by Bacon and Newton had been successfully challenged by positivism.[89] Induction

[86]Wright to Darwin, 21 June 1871, Darwin to Wright, 14 July 1871, Darwin to Wright, 17 July 1871, Thayer, *Letters*, 231;"The Genesis of Species," *North Am. Rev.* 113 (July 1871): 63-103. Alas, Wright's opaque style was no match for Huxley's riveting counter-blast against the pernicious influence of Popery on his former student, Mivart, in "Mr. Darwin's Critics," *Contemporary Review* 18 (1871): 443-476. Wright's pamphlet sold only fourteen copies by late October. Moore and Desmond, *Darwin*, 584-586.

[87]*North Am. Rev.* 115 (July 1872): 1-30.

[88]*North Am. Rev.* 116 (April 1873): 245-310; Wright to Grace Norton, 24 May 1872, Thayer, *Letters*, 236-238; Darwin to Wright, 3 June 1872, *LL*, 2: 342-343; Wright to Sara Sedgwick, 5 September 1872, Thayer, *Letters*, 246-249.

[89]Published primary sources on the philosophy of Chauncey Wright include James Bradley Thayer, ed., *Letters of Chauncey Wright, with Some Account of His Life* (Cambridge: John Wiley and Son, 1878), Charles Eliot Norton, ed., *Philosophical Discussions by Chauncey Wright* (New York: Henry Holt, 1877), and Edward H. Madden ed., *The Philosophical Writings of Chauncey Wright:*

proved to be a two-edged sword; it mercilessly destroyed all claims to knowledge that could not meet its stern tests. Even William Hamilton, the last noteworthy representative and Wright's early intellectual mentor, had been dealt a death blow by the empirical sword of John Stuart Mill. One by one the many realms of knowledge, those dimensions of life we could truly *know*, had been reduced to one, that which was accessible only to the senses. All others had failed the stern test of the empiricists. Physics became the paradigm form of knowledge; only it had been built solely on empirical foundations. *Science*, historically identified with *knowledge*, became synonymous with physics. "All Positivists, so called, are agreed in regarding the methods of discovering truth exemplified in the maturest of the modern sciences, as the methods of all true knowledge, namely, the methods of induction from the facts of particular observations, and are agreed in ignoring all problems as idle and foolish which cannot receive such solutions."[90] Comte's neat turn of phrase, "positive

Representative Selections (New York: The Liberal Arts Press, 1958). Norton took regrettable liberty in editing the selections he chose without informing his readers; Madden has included only those extracts from Wright's literary output that best illustrate the philosophical themes he finds in Wright. Consequently, readers must return to the originals for context, chronology, breadth, and accuracy.

Important secondary sources include Philip Wiener, "Chauncey Wright's Defense of Darwin and the Neutrality of Science," *Jour. Hist. Ideas* 6 (1945): 19-45; Philip Wiener, *Evolution and the Founders of Pragmatism*; Joseph L. Blau, "Chauncey Wright: Radical Empiricist," *New Eng.. Quart.* 19 (1946): 495-517; James Collins, "Darwin's Impact on Philosophy," *Thought* 34 (1959): 185-248; Edward H. Madden, *Chauncey Wright* (New York: Washington Square Press, 1964); Bruce Kuklick, *The Rise of American Philosophy: Cambridge, Massachusetts, 1860-1930*, chap. 4; Daniel J. Wilson, *Science, Community, and the Transformation of American Philosophy, 1860-1930* (Chicago: University of Chicago Press, 1990), chap. 2; and Paul James Croce, *Science and Religion in the Era of William James*, chap. 6.

[90]"Peabody's Positive Philosophy," *North Am. Rev.* 106 (January 1868): 286. Wright excoriated A. P. Peabody's address on "The Positive Philosophy" given for the Phi Beta Kappa Society at Amherst College in July 1867. Peabody was the University Preacher and Plummer Professor Christian Morals at Harvard. He and Gray were good friends.

science," for this new paradigm of knowledge captured the imagination and inspired confidence in this new project. Henceforth, according to the empirical tradition, all claims to "positive" knowledge must pass the tests set by induction or be banished to the nether world of beliefs and opinions.

Wright assumed the responsibility to alert the intellectual elite of Cambridge to the profound implications that positivism held for many of their cherished, though uncritically examined, beliefs.[91] They needed to understand that the "science" to which they were so dedicated contained elements whose claims to knowledge were indefensible. The great accomplishments of modern science, Wright claimed, had been achieved by rigorously applying the objective method and overthrowing the subjective method and pursuing scientific knowledge for objective rather than subjective motives.

> The objective method is verification by sensuous tests, tests of sensible experience, -- a deduction, from theory of consequences, of which we may have sensible experiences if they be true. The subjective method, on the other hand, appeals to the tests of internal evidence, tests of reason, and the data of self-consciousness: authorities on which, as the history of philosophy shows, there is little unanimity among philosophers.[92]

There was, however, unanimous consent that our senses are trustworthy; they alone produced a solid conviction that what they deliver could be accepted as true

[91]Wright articulated his understanding of science, philosophy, natural theology, and religion, between 1864 and 1868, in a series of essay reviews for the *North Am. Rev.* and *The Nation*, as well as in personal correspondence.

[92]"The Philosophy of Herbert Spencer," *North Am. Rev.* 100 (April 1865): 427.

knowledge.[93] Any claim, however elevated and inspiring it may be, that could not be verified by the senses must be dismissed. Among the claims that failed this stringent test were cosmological speculations, philosophy, natural theology, the arts, morality, religion, desires, hopes, and feelings.

Many in Wright's audience would have believed that their interest in science was motivated by the lofty desire for the moral elevation of society, pushing back the frontiers of ignorance, and even glorifying God. Wrong, Wright charged. These were all subjective motives, contaminated by "our fears, our respects, our aspirations, -- our emotional nature; . . . our personal destiny, our ambitions, our moral worth; . . . [and] man, his personal and social nature. " The only motives which ought to inspire the pursuit of science were those "having an empirical origin, arising in the course of an inquiry; springing from interests which are defined by what we already know, and not by what we have always felt, -- interests which depend on acquired knowledge, and not on natural desires and emotions," and "determined chiefly or solely by the felt imperfections of knowledge as such, and without reference to the uses this knowledge may subserve."[94]

Metaphysical, philosophical, and theological speculations were the worst offenders against objectivity with their "unverified conclusions, vague ideas, [and] crude fancies." They arose out of a desire to satisfy deep religious and emotional longings for simplicity, consistency, and comfort. These goals, possibly noble in their

[93]Ibid., 426.

[94]Ibid., 430.

own right, had no place in the house of science since they had absolutely nothing to do with "sensible experience" and matters of fact. Thankfully, Kant's critical philosophy had emancipated philosophy from superstition and myth and begun to serve the interests of "positive" science. Under its guidance science was now freed to explore those "extensive areas of history , society, laws, and morality" once considered the exclusive preserve of philosophy. Wright was supremely confident that science, by faithfully adhering to the principles of objectivity, would overwhelm the older traditions of metaphysics, theology, and philosophy and "occupy more and more the attention of mankind."[95]

These older traditions were encumbered by the metaphysical phantoms of cause, will, and self-consciousness. The ancient school of philosophy had searched in vain outside human experience for the "real" connections between causes and effects and believed it has found them by analogy with the human will. But, Wright pointed out, the analogy of cause and effect with human volition and action was seriously flawed. There was no such entity as the "I" with a "will" that is the efficient cause of a person's actions; "motives are phenomena of willing, not the efficient Will itself." We could neither observe nor truly know in any meaningful sense what the relationship was between our desiring and our acting; we merely observed the succession of "certain mental states of thought, feeling, and desire [being] followed by certain external effects." We only observed the regular order of antecedent and

[95]Ibid., 431, 433, 434.

consequent, whether in nature or our actions. It was for that reason that modern science used the well-known methods of physical science, such as physiology, to understand self-consciousness rather than the introspective method of the metaphysical school. The result was that "so long as the will is not phenomenally known as so and so determined to action by definable motives, it bears no analogy whatever to observed causes or to the relation of regular antecedents to their consequents."[96] Having undermined the central analogy between will and cause "those who have reached the positive mode of thought" understand a "cause" to merely mean "the sum of the conditions or antecedent phenomena, which by the laws of nature, material and spiritual [by which Wright meant non-observable, not supernatural], are followed by a determinate effect."[97]

Wright did not have to look far to find examples of people and ideas that failed the test of objectivity. Herbert Spencer was the worst offender, especially since he boasted that his ideas were thoroughly grounded in "positive" science.[98] He was, in fact, bewitched by the "grand idea" of "Universal Progress," the master theme of modern culture.

> Moral idealism is the religion of our times. What the ideas of God, the One and the All, the Infinite First Cause, were to an earlier civilization, such are Progress

[96]"Positive Philosophy," 287, 289.

[97]Ibid., 288; cf. "Bowen's Logic," *North Am. Rev.* 99 (October 1964): 598-600; "Mill on Comte," *The Nation* 2 (January 4, 1866): 20-21.

[98]Wright was playing on the prevalent tendency to lump Spencer in with the Positivists. Spencer vigorously denied being a disciple of Comte, lamented adopting even a few of Comte's terms, and insisted on his own originality. At the same time Spencer's peers chalked up his protest to his large ego and craving for attention. Charles Cashdollar, *The Transformation of Theology*, 142-158.

> and Universal Progress to the modern world, -- a reflex of its moral ideas and feelings, and not a tradition. Men ever worship the Best, and the consciousness that the Best is attainable is the highest moral consciousness, the most inspiring of truths. And when indications of that attainment are visible not merely to the eye of faith, but in sensible progress, scientifically measurable, civilization is inspired with a new devotion. Faith that moral perfectibility is possible, not in remote times and places, not in the millennium, not in heaven, but in the furtherance of a present progress, is a faith which to possess in modern times does not make a man suspected of folly or fanaticism. He may forget the past, cease to be religious in the conventional sense of the word, but he is the modern prophet.[99]

Spencer had gained his popularity precisely because he satisfied the widespread religious yearning for assurance and certainty, something which science could not provide.

Spencer was still smitten by the metaphysical allure of cosmology, Wright warned. He only substituted an Unknowable Cause for the more traditional theological notions of a "Creator" or "Great Artificer." His Unknowable Cause was actually the "law of evolution," which Spencer considered to be "the profoundest conception which the human mind can compass of the divine agency of creation." Evolution became for him an immanent power that unfolded the potential of matter, motion, and force into the manifold phenomena of the present universe. Wright found Spencer's vision suitable only for those unable to "restrain [their] speculative faculties." They were not only unnecessary to scientific explanations, but could distort their proper formation.[100] The fact that naturalists had extended secondary causes to explain many facts once considered inexplicable and ultimate offers no

[99]Ibid., 450.

[100]Wright, "Spencer's Biology," *The Nation* 2 (June 8, 1866): 725.

grounds for Spencer's cosmological speculations.

Spencer suffered from the illusion that his "law of evolution" revealed an objectively verified principle of nature. It had not. He seemed to be "too easily impressed by mere analogy, and sometimes mistaking a figure of speech for a matter of fact."[101] Spencer based his law on only one class of scientific phenomena, that of embryology. He then extended uncritically an appropriate insight in embryology to "theories of society and of the character and origin of social progress, theories on the origins and the changes of organic forms, and theories on the origins and the causes of cosmical bodies and their arrangements."[102] The result was that "evolution implies more in Mr. Spencer's philosophy than the transmutation hypothesis postulates. It implies and necessitates progress, a progress which is inherent in the order of things, and is more than the continuity and community of causation which the physical sciences postulate. It borrows an idea from the moral sciences, the idea of an end," and transforms it into a cosmic vision of development throughout. Wright stressed that "all that the transmutation hypothesis presupposes is continuity and uniformity in the temporal order of nature." Wright cautioned that it offered the most plausible explanation for the large class of facts in paleontology, classification, and the geographical distribution of plants and animals. It offered only weak analogical

[101]Ibid.

[102]Ibid., 453. One wonders what Wright's response would have been, had he lived, to the subsequent history of the uncritical application of the evolutionary and development metaphors to precisely these areas of thought.

grounds for a cosmic law of evolution.[103] He strongly doubted whether evolution would ever be verified in any other department of science that was not specifically connected with the growth and life of an organism. He thus preferred the term "derivative hypothesis" because it "implied only continuity, not growth or progress, in the succession of races on the surface of the earth."[104]

It was easy to understand how Spencer was misled, Wright suggested. Since we gain our knowledge of phenomena in the order of simple to complex, we naturally expect to find that same order in nature. The human mind required order. Where it is not observed the mind will supply it. Myth had historically served this need by providing a dramatic story, poem, or play that had a beginning, middle, and end. But "teleology is a subtile poison, and lurks where least suspected." Spencer was not alone in being infected; it was found in all of the newer historical sciences as well.[105]

Although the passion to read nature teleologically was understandable, Wright warned that science has no place for any other order than that for which "we have solid observational evidence" or for which we can make legitimate inferences. All that we ever observe is continuity and regularity, nothing more. We do not even observe "cause," as Hume rightly taught us.

[103]Ibid.

[104]"A Physical Theory of the Universe," *North Am. Rev.* 99 (July 1864): 7-8.

[105]"The Philosophy of Herbert Spencer," 451. Misia Landau has explored Wright's insight into the powerful way that the narrative form shapes and guides philosophical and scientific explanations in *Narratives of Human Evolution* (New Haven: Yale University Press, 1991). Perhaps Wright overlooked the teleological temptations Darwin fell prey to in the *Origin*.

> The 'law of causation,' the postulate of positive science, does not go to this extent. It does not suppose that there are throughout nature unbroken series in causation, forming in their entirety intelligible wholes, determinable in their beginnings, their progressions, and their ends, with a birth, a growth, a maturation, and a decay. It only presumes that the perhaps unintelligible wholes, both in the sequences and the coexistences of natural phenomena, are composed of intelligible elements; that chaos does not subsist in the heart of things; that the order of nature which is discernible vaguely even to the unobservant implies at least a precise *elementary* order, or fixed relations of antecedents and consequents in its ultimate parts and constituents; that the apparently irregular heterogeneous masses, the concrete series of events, are crystalline in their substance.[106]

The sole task of science was "discover these elementary relations of antecedents and consequents" and abandon forever the teleological elements that have intruded themselves into science. The only kinds of order humans could know through their senses were the numerical order of before and after, the spatial order of continuity, the kinematic order of motion, and the physical order of antecedent and consequent. This was the lesson that physics and mathematics have taught us and led the advance of science. Every other department of learning that wants to obtain knowledge must follow their example.

Wright offered his novel hypothesis of counter-movements to challenge the teleological tendencies of both the nebular hypothesis and the Spencerian speculations on evolution and development. Perhaps inspired by Newton's first law of motion, Wright argued that every action in nature is met with an equal counter-action. We see this in biology where "the forces of life and death, of nutrition and waste, of growth and degeneration" are continuously in play. Likewise, geology has made us familiar

[106]Ibid., 451-452.

with how the movements of the earth's crust, with thrust and counter-thrust, have carved out the current landscape. Even the weather resulted from the movements and clashes "of the gaseous and liquid oceans which surround the earth." But it has been the counter-movements of heat and gravity that has "led to the formation and destruction of systems of worlds, always operative in never-ending cycles and in infinite time." The nebular hypothesis opposes this more rational explanation with its implicit teleological assumption that the universe is moving toward a definite goal and that when that goal is reached the counter-forces of heat and gravity will cease. But the only rational conclusion Wright claimed that people could draw from their unbiased observation of phenomena in the universe was change, continuity, and regularity through indefinite time. These alone must thus be the focus of objective science.[107]

Unlike some of his more austere English brethren, Wright accepted religion as an important aspect of the human condition, provided that it recognize that it had no right to claim its tenets as *knowledge*. All of religion's claims were about ideals and transcendental abstractions that had no roots in objective sensible experience. God's existence could not be proven by rational proofs, putative revelations, or mystical experiences. People were still, of course, free to believe in God, but only on the basis of faith, not knowledge. Such faith could well be emotionally satisfying, morally ennobling, and culturally enlivening. However, Wright cautioned, such

[107]"A Physical Theory of the Universe," 9-10.

sentiments needed to be strictly quarantined; they must not be allowed to distort the pursuit of knowledge.

Wright graphically outlined the practical distinction between faith and knowledge in his reply to Henry Mansel's attack on Mill. Mansel, the self-appointed interpreter of William Hamilton , offered the analogy between father and child and between God and humans to illustrate the principle that there are rational grounds for those, like children and persons with limited experience and understanding, to accept on faith the instructions of the older and wiser, like fathers and God. Wright aggressively took up the gauntlet.

> The real question is as to the child's obligation to respect his father's wisdom and goodness independently of any experience of them, and solely on the ground of that parent's word for them. If, from the wisdom and goodness which the child has seen and understood, he infers uncomprehended higher degrees of these qualities, reasoning from the known to the unknown, just as he does in all other relations of life, and just as we all do, then the child bases his faith on the sure and only ground of knowledge; and his deference to the father's judgment in all cases of doubt or conflict is the natural and direct consequence of a faith so grounded. But if, bewildered and oppressed by a metaphysical difficulty in trying to comprehend the peculiar duties of a father, he should base his faith on his ignorance of them, and believe in the goodness which he cannot comprehend, believing because of his ignorance and not on account of the little knowledge he does possess; and if, in his blind devotion, he should abdicate his own intelligence, reject his own clear judgments of right, when they are brought into apparent conflict with the parent's selfishness, or with that of servants claiming to speak by authority, then the child's devotion would not be that of an igneous, filial piety; it would rather be an abject slavish submission. Such we conceive to be the really parallel case, involving the real practical issue between the two philosophies. Faith is, in one, founded on knowledge by experience; in the other, it is independent of knowledge.[108]

The "two philosophies," the metaphysical and the positivist, could not be further apart

[108]"Mansel's Reply to Mill," *The Nation* 4 (1867): 27.

on the meaning of religion.

Wright accepted the challenge of natural theology's claim to be a "positive science."[109] Natural theology had gained its prestige from its claim that it was dutifully following the same inductive method that the mature sciences, such as physics, had followed to achieve their impressive results. It was confident that it need not appeal to revelation, mystical experience, or intuition to support its arguments.[110] It need only apply the inductive method to the obvious facts of natural history to derive the morally certain inference that a Divine Intelligence was the only rational explanation for the amazing adaptations of means to ends found throughout nature. The inductive method was just as virtually infallible in disclosing the world as the handiwork of God as it was in yielding up the secrets of the universe. Of course, Wright could not resist the chance to challenge this pretender to the mantle of being an inductive science.

It appeared to Wright that natural theologians were not conversant with the latest developments in both science and theology that had already begun to challenge the validity of natural theology's inductions from nature. Paley's crude arguments were passe. The reason was that advanced theologians had learned that science itself

[109]"Natural Theology as a Positive Science," *North Am. Rev.* 100 (January 1865): 177-185. This was a review of *Religion and Chemistry: or, Proofs of God's Plan in the Atmosphere and its Elements* (New York: Charles Scribner, 1864). Cooke was professor of chemistry and mineralogy at Harvard; Gray counted him as a friend.

[110]Wright sharply attacked James McCosh, the most influential proponent of a moderate strand of the Scottish philosophy, for his bankrupt theory of consciousness that could allegedly steer us safely through the shoals of atheism, materialism, subjectivism, and pantheism, in "McCosh on Intuitions," *The Nation* 1 (November 16, 1865): 627-629.

was incapable of translating causes and effects into means and ends, the critical necessity of the design argument. The scientist asked:

> By what criterion . . . can we distinguish among the numberless effects, that are also causes, and among the causes that may, for aught we can know, be also effects, -- how can we distinguish which are the means and which are the ends? What effects are we warranted by observation in calling final, or final causes, or the ends for which the others exist? . . . . The designation of those effects as final in nature which contribute to human desires or human welfare, or even to the welfare of all sentient beings, cannot be legitimately made for the purposes of this argument, since human and other sentient beings are not the agents by which these supposed ends are attained; neither can the causes which bring these effects to pass be regarded as servants obedient to the commands of the agents to whom these effects are desirable.[111]

The harsh and sober reality was that close observation of nature disclosed only a continuity of causes and effects. It neither revealed the origin of causes nor means and ends. After all, means and ends do not *imply* intelligence; they *are* what we mean by intelligence.

The point at issue between natural theology and positivism was whether intelligence was essential to the meaning of order. They both agreed that order pervaded nature. They disagreed on the source of that order, whether that source could ever be known, and whether the observed order required intelligence for its existence. The natural theologian concluded that this order, being lawful, was an essential mark of intelligence wherever it is found, whether in human or natural order; thus, nature, being orderly, was pervaded with "design." The positivist, on the other hand, assumed that whatever "design" there was in order was *incidental* to the

[111]"Natural Theology as a Positive Science," 180.

regularly observed order of antecedent and consequent; it was not *essential* to the phenomena of order we observed. Whenever the positivist, Wright pointed out, referred this order to "law," he was merely using a short-hand expression denoting regularity; he was not ascribing agency to this "law," as the natural theologians accused him. Thus, natural theology found adaptation of means and ends and design in nature because it already assumed their existence. But, in that case, Wright asked, why use such an elaborate argument, which turns out to be flawed in any case, to prove what they take as axiomatic?[112] Since its claims were clearly not based on induction, natural theology did not deserve to be called a positive science.

Modern theologians, taking their cue from William Hamilton, had quietly abandoned nature as the primary source of design and turned more and more to mental and moral phenomena as the basis for their arguments to Intelligence. Hamilton had declared "that intelligence stands first in the absolute order of existence, -- in other words, that final preceded efficient causes, -- and that the universe is governed by moral laws." He thus rested his entire proof for the existence of God exclusively on mental phenomena. This *a priori* presumption of intelligence was what had always been the unacknowledged foundation of the design argument, Wright stressed. Only with this as an assumption was it possible to interpret the design in nature as that of "a free, undetermined power." But even this appeal to psychological phenomena ran into the same difficulties as the earlier appeal to physical phenomena since a person's

[112]Wright to Professor Lesley, 19 January 1865, Thayer, ed., *Letters*, 67-70.

"faith in final causes is not a guide by which he can determine what the final causes are by which he believes the order of nature to be determined."[113]

It turned out that these recent developments had put natural theology in a double bind. The only way that the design argument could be logically constructed was to assume the existence of a Divine Intelligence and then interpret the adaptations found in nature as products of that designing Mind. But that undermined its appeal to the inductive method and its appeal to nature, since all observations of nature only illustrated the *a priori* assumption; they did not prove the conclusion. If natural theology followed Hamilton, it encountered similar difficulties with mental phenomena. Natural theology was thus left with bare assertions of Divine Intelligence; neither natural nor mental phenomena could be appealed to as proof of God's existence.

Natural theology also ran afoul of positive science with its peculiar idea of the "supernatural." Wright advised its proponents that the popular notion of the "supernatural . . . as a power . . . operating independently of orderly or natural causes -- as one which interferes with them or sets them aside . . . finds little favor with thinkers most advanced in scientific culture." For that reason he welcomed the Duke of Argyll's *Reign of Law*. The Duke valiantly tried to overcome this barrier by maintaining that a Christian understanding of miracles must see them as natural events

[113]"Natural Theology as a Positive Science," 183.

using "natural means" and observing the universal reign of law and causation. [114] God's activity in nature, according to the Duke, rather than being seen as interfering in nature or violating the laws of nature, should be seen as applying his Will to converting the course of the Laws' operation to accomplish divine purposes. The divine, as much as the human will, according to the Duke, employed natural means to accomplish freely determined designs.

Unfortunately, this strategy did not work either, Wright observed, since it showed a singular failure to understand how "the doctrines of modern scientific culture" understand the meaning of "law." The Duke retained the view of the "ancient metaphysics" that understood causal relationships moving vertically from the "natural" to the "spiritual," so that Divine Will became the "spiritually antecedent" cause of natural events. Modern writers, such as Comte and Mill, however, understood that the "chain of cause and effect . . . reaches backwards and forwards *in time* indefinitely, not upwards and downwards in the 'spiritual' hierarchy." While Wright recognized that the Duke allowed Darwin's law of natural selection some role in perfecting the adaptations of organisms, he nevertheless criticized him for still retaining the unfounded assumption that "intention" lay behind these adaptations in the grand scheme of nature. This was the fundamental assumption that modern science did not accept because it could not be verified empirically.

That natural theology was not a "positive science" and was unable to offer

[114]"The Reign of Law," *The Nation* 4 (1867): 470. He reviewed the fifth edition of the Duke of Argyll's *The Reign of Law* (London: Alexander Strahan, 1867). This work, first published in 1866, was widely read in England; it was in its second American edition by 1868.

either natural or psychological proof of design did not mean that the enterprise was a complete waste of time for its practitioners, Wright counseled. It could still be used for devotional purposes, to enliven the religious sentiments, and strengthen faith in final causes. No one, not even the Positivist, could be offended by this use. In fact, Wright held that

> the conception of a Being with a nature akin to our own, but perfect in all that we aspire to be; infinite in power, with perfect goodness and knowledge; who does not 'providentially modify' the laws of his universe, since no laws can be supposed more wisely adapted to his own highest ends; whose will is just as immediately manifested in the order of nature as in any supposable miracle, -- such a conception is to many thinkers, who are called Positivists, a most cheering and inspiring one, and is not inconsistent with anything which human science has yet disclosed, or is ever likely to discover.[115]

He simply wanted it clearly understood that natural theology must give up its pretensions that its affirmations of the existence of this Being were scientific. It could neither offer proofs based on the inductive methods of positive science nor substitute religious interpretations of nature for scientific ones. Natural theology must confine itself to the realm of faith; only science could provide knowledge of all natural phenomena.

When this elementary distinction between faith and knowledge was understood, Wright noted, any conflict between science and religion would evaporate. Once theology gave up its pretensions to dictate scientific truth and denounce those who disagreed with them as atheists, the two could live in harmony. Even more, religion should welcome all progress in understanding nature as the only way to liberate us

[115]"Peabody's Positive Philosophy," 293-294.

from ignorance, errors, and superstitions. Religious people would learn that "whatever evils result from the discoveries of science are attributable to the rashness of the theologians, and not to the supposed irreligious tendencies of science." Theologians would be well served to adopt the virtues of "humility and cautiousness, and that suspension of judgment in matters about which we really know so little."[116]

Wright's views on religion were far in advance of even his debating partners in the Metaphysical Club. He seemed not to have the passionate interest in religious themes that had motivated their philosophical quest. Questions about God's existence, immortality, the religious ground of morality, or the Purpose of life, never aroused his curiosity. He was confident that the experience of life itself would reveal appropriate ends and purposes. John Fiske, who experienced a spiritual epiphany while reading Spencer and articulated it in his *Outlines of Cosmic Philosophy*, experienced Wright's cool reception. Francis Abbot, defrocked as a Unitarian minister for views too radical even for Unitarians, could not even persuade Wright that his own "transcendental theism" merited serious consideration. Wright had little patience with Peirce's efforts to wed his Kantian idealism to Positivism. And William James spent his professional life demonstrating that while faith was incapable of proof one nevertheless had the "duty to believe" in the face of such uncertainty. Many other religious friends experienced similar responses. Undoubtedly Gray experienced more than one "cold chill" from his conversations with Wright.

[116]"Natural Theology as Positive Science," 184-185.

Further evidence of the subtle, yet significant, philosophical differences between Gray and Wright is found in Gray's reflections on the work of J. D. Morrell, a British physiologist, whose *An Introduction to Mental Philosophy, on the Inductive Method* had just been published.[117] Gray told Darwin that "a friend just handed me Morrell's new book, which-- looking at psychology from the physiological side, I see brings up several notions which have been turning over in my mind for some years. He is coming out a good Darwinian, I see and is quite of my way of thinking about design."[118] His "friend" was most likely either Chauncey Wright, who was deeply interested in the physiological foundations of psychology at the time, or Jeffries Wyman, who taught physiology at Harvard. That Gray thought Morrell offered support for his view of design is most intriguing. A closer examination reveals that Morrell's study provided only a half-way house, at best, between the claims of natural theology and positivism.

Morrell was intent on creating a middle ground between the equally false doctrines of a sharp dualism between mind and body and materialism. He forged an unbroken and ascending physiological continuity from the unconscious state of the infant to the highest realms of thought and action. Human beings were energized, according to Morrell , by three sets of forces, vital-force, nerve-force, and mind-force, each emerged in order through time. "The vital-power builds up the human frame according to a certain definite type; the nerve-force prompts us to all those

[117](London: Longman, Green, Longman, and Roberts, 1862).

[118]Gray to Darwin, 31 March 1862, *CCD* 10: 140-141.

instinctive movements which are necessary for the preservation and well-being of the frame when formed; and the mind-force brings the purposes of life into the light of consciousness, and teaches us to pursue them with an intelligent adaptation of means to ends." Each force was present in the infant and slowly emerged and differentiated themselves as the child matured.[119]

Morrell gave the name "soul" to the "teleological tendencies [that were] inherent in our nature" from the first breath of life and realized most fully in conscious thought and willing. This "nascent spark" of Divine Intelligence permeated a person's entire being and was active in all of the body's processes, from cell-building to contemplating a moral course of action. "There is a *latent* intelligence within us which works teleologically, apart from will, feeling, sensation, or any other kind of consciousness whatever." Morrell believed that this understanding would save physiology from the twin dangers of confining the Deity's relationship with humans only to their minds as well as believing that the Deity "interfered" continually to energize our bodily functions. This position was closely parallel to the position that Gray seemed to be groping toward in understanding how God guided variations toward beneficial ends without "interfering" in the natural process of the origin of new species. [120]

Perhaps Gray did not read far enough to feel the cold blast that Morrell delivered to the epistemic premises of the design argument. Morrell adopted a

[119]Morrell, 19-20, 24.

[120]Morrell, 36-37, 39, 52.

continuum of understanding, from knowledge, based completely on objective sensory evidence, to personal conviction, based solely on subjective feelings. This continuum had significant implications for whether the existence of a First Cause could be known. Human beings, he recognized, were often overwhelmed by the feeling that a "great First Cause" existed; in fact, they were "*morally* bound to accept the fact of a Divine Being." At the same time, he warned, we must recognize that religious faith could claim to be nothing more than a personal conviction; it was impossible to "bring a fellow-creature face to face with the Divine *reality*, and oblige a mental acquiescence in it." The Deity could not be an object of human knowledge.[121]

> The chief object of religious faith is a Supreme Being--the great First Cause and Creator of all things. The Infinite, however, . . . cannot be grasped as an element of *knowledge*, any more than the objects indicated by other ultimate intellectual ideas. Thus, we do not *know* the real objective existence of space, or matter, or force; and, for the same reason, . . . we do no possess any positive *knowledge* of an infinite cause. [122]

Morrell had drunk deeply of the thought of Hamilton and Mansel, the English heirs of Kant. Such an epistemic understanding destroyed the traditional design argument. The vaunted inescapable inductive inference of Mind behind the exquisite designs in the world was reduced to an intense feeling that the world depended on some indefinable, unknowable "thing" beyond. This was exactly the conclusion that Gray was resisting.

Gray and Wright inhabited different universes of discourse that shaped their

[121]Morrell, 310, 311, 320, 330, 335.

[122]Morrell, 330.

understanding of the "neutrality" of science. In Gray's world, physicists, philosophers, and theologians shared the same epistemic assumptions; they spoke to one another in a shared language about a shared universe. Their disputes involved territorial conflicts and evidentiary questions, but not the terms of the framework itself. Gray assumed that natural theologians were within their epistemic rights to draw inferences from natural history to support their claims for design; they were not trespassing when they did so. In fact, "good" science for Gray and the natural theology tradition should include some reference to theism. Natural theologians and scientists may have erred in the sources and strength of the evidence they used and the inferences they drew, but they were following the correct method. Virtually all natural theologians assumed that if the inductive method were followed properly, it would lead inescapably to the conclusion that the world was designed by Intelligence. If someone drew the wrong conclusion, they had misused the method or had not seen enough empirical evidence. For Gray the evidence for design was weak enough so that both theists and atheists were warranted in drawing the conclusions they did, though, as his ongoing debate with Darwin showed, Gray earnestly believed that the evidence was just strong enough to support design. Additionally, since both perspectives were only scientific hypotheses they could not claim demonstrative proof. Science was thus "neutral" because both theists and atheists were justified in drawing the conclusions they did.

Wright, on the other hand, was following the positivist line that the claims of physical science and all theological and religious discourse were incommensurable;

they could not touch each other because they inhabited different universes. Positivism had destroyed the epistemic foundations of natural theology and had successfully transformed the meaning of key terms and concepts natural theologians had used to support its arguments, e.g. cause, law, order, purpose, creation. Theologians and religious people were *not* warranted in drawing conclusions from science to support their beliefs or coloring the findings of science with a religious veneer. Science was thus "neutral" *vis-a-vis* theology and religion because science was a distinctly different realms of thought; each was irrelevant to the other.

In another equally important sense, Wright *believed* that science was *not* neutral about the presuppositions, the philosophical framework, that the scientist brought to the study of nature. He and the Positivists had clear and strong ideas about what assumptions the scientists *ought* and *ought not* to bring to their study of nature; they each had firm *prescriptive* notions of what counted as "science," "good" science, "knowledge," and "belief." Labeling them as "positive" science and the "objective" method only hid the pretheoretical nature of these commitments from themselves, and often their critics. Wright believed that whatever conflicts there were resulted from theological trespass or scientific ignorance. He overlooked the pronounced epistemological conflict between positivism and the natural theology tradition on the meaning of "science" and "religion," a debate about the foundations of thought. His vigorous polemical defense of a positivist epistemology *illustrated* rather than *proved* his fundamental axioms in the same way that the natural theology tradition *illustrated* rather than *proved* design. He was helpless to appeal to the inductive method to

support his position without falling victim to the same *petio principii* of which he accused natural theology. Gray was unable to perceive the roots of this significant shift in positivist thought.

If Gray's understanding of "neutrality" mirrored Wright's, his entire defense of the compatibility of theism and Darwinism would have been pointless. In fact, Wright represented the advanced stage of positivism that Gray intuitively sensed in Darwin, though was unable to penetrate. Neither Gray nor a considerable number of others in the natural theology tradition in the latter half of the nineteenth century recognized the roots and implications of these profoundly different ways of thinking for understanding the meaning of science and religion or descent and design and establishing their proper relationship.

We gain additional insights into the theological and philosophical gulf that separated Gray and Darwin as we watch these two gentle, yet determined, friends wrestle over the implications of Darwin's meticulous studies of the curious adaptations of orchids, dimorphic flowers, and climbing and twining plants. Darwin was persuaded that by showing how the function of these marvelous adaptations was gradually developed over vast stretches of time as organisms struggled against their life conditions that he had successfully short-circuited the design argument's appeal to God's intervention to create each adaptation anew. Gray felt the full force of Darwin's argument, yet fought off the "cold chill" of removing God completely from the organic realm. His chill was about to get much colder.

After all of their private sparring since the publication of *The Origin of Species* Darwin finally revealed the gulf between he and Gray for the first time in the concluding chapter of *Variation of Plants and Animals under Domestication*. There he elaborated on his now-famous stone-house analogy that he had been trying out and perfecting for many years. This was to be his final answer to Gray's contention that variations had been led along certain beneficial lines, that descent could be harmonized with design. Gray found it unanswerable. Why Darwin had spent so much time working on this analogy, what he intended to say about descent and design with it, and why Gray was unable to mount an effective counter-attack takes us into the final phase of their debate.