



DARWIN'S DICE

The Idea of
CHANCE
in the Thought of
Charles Darwin

CURTIS JOHNSON

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OXFORD

UNIVERSITY PRESS

Oxford University Press is a department of the University of Oxford.
It furthers the University's objective of excellence in research, scholarship,
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Published in the United States of America by
Oxford University Press
198 Madison Avenue, New York, NY 10016

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Library of Congress Cataloging-in-Publication Data
CIP data is on file at the Library of Congress
ISBN 978-0-19-936141-0

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For my family

Acknowledgments



THE SYSTEMATIC STUDY of chance in nature's operations has an ancient pedigree, dating back at least to the writings of Empedocles (5th c. BCE) and Aristotle (4th c. BCE). If one were permitted to acknowledge debts to the no longer living, I would begin by acknowledging them. It is not simply that they wrestled with the idea of chance in nature; they did so in just the way Darwin did. Darwin himself was not directly influenced by these authors. I doubt he ever read anything by Empedocles, and his acquaintance with Aristotle's writings came only late in his life, long after he had developed and refined his own ideas. But these two ancient thinkers put a Darwinian sort of chance into a long tradition of thought that is with us still.

Any work of this sort could not be undertaken without the insights of other scholars laboring in the fields. It would be impossible to give an exhaustive account of what I owe to all of these men and women, but I refer the interested reader to the bibliography for a register of most of my debts to other authors. Several of these stand out for special mention: the volume of collected essays edited by Gigerenzer, G. et al., eds., 1989; a two volume work edited by Krueger and Morgan, 1987; and several individual works by those whom I regard as leading authorities in the study of chance in evolutionary biology today, especially John Beatty, James Lennox, and Roberta Millstein. I have no personal acquaintance with any of these authors but my work has benefited beyond measure by the foundations laid by them.

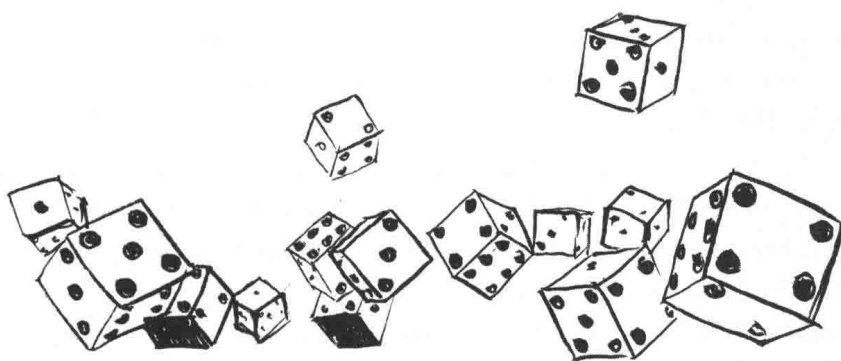
I take special pleasure in acknowledging Darwin scholars who have read some or all of the ms. and made invaluable suggestions, all of which have led to improvements. I am especially grateful to my father, Dr. Albert Johnson, an expert in ecology, who read the entire ms. and provided keen advice at every stage; J. David Archibald, who, with a firm touch, took the training wheels off the bike; Michael Ghiselin, who from the beginning has been unstinting in his encouragement and willingness to share his knowledge of all things Darwinian; and David Depew, whose comments on an earlier draft of the central ideas contained herein awakened me to subtleties I had not yet seen. My debts to all four run deep. Any remaining defects are attributable to me.

I give special thanks to two of my former undergraduate students at Lewis & Clark College, Julia Eckes and Kris Lyon, both of whom helped immeasurably with editing and editorial assistance at various points in the preparation of the manuscript.

I also must convey my gratitude to the editorial staff at Oxford University Press: Hallie Stebbins, who was the first to take notice of and interest in the project; Jeremy Lewis, who seamlessly took over where Hallie left off; Erik Hane, my day-to-day contact at Oxford, and to Jayanthi Bhaskar for her grace and professionalism in shepherding the work through the labyrinthine details of the production process. I also thank the several external reviewers for Oxford U.P. who read and commented on the ms. with erudition and sensitivity.

My greatest debts are to my wife and daughters Sophia and Alexis, and my parents for constant encouragement and support. Sophia is the artist who produced the illustrations for the chapter headings; Alexis created the graphic on p. 59. Above all, I could not have undertaken this work without the untiring support and assistance in every manner of way—too many to enumerate—of my wife Loretta.

Introduction



CHARLES DARWIN'S "BIG idea" is generally thought to be his discovery of the mechanism of natural selection in evolution. That discovery was without question a big idea. But, as Darwin himself often confessed, natural selection cannot work without prior variations in the organisms that will be selected or not for survival. Whence the variations, or at least what did Darwin believe about this? That is the question I examine in what follows. Darwin thought "variations" are in many or most cases "just by chance." I hope to show what he meant by this expression and what he believed the implications are if one accepts it. "Chance variation" may have

been an even bigger idea for Darwin than natural selection, or so I shall attempt to show.

Thus, whatever “Darwinism” is, this is not a book about Darwinism. Nor is it a book about contemporary evolutionary theory or the “new synthesis” or the “extended synthesis.” It is rather a book about “chance” in Darwin’s writing. To that extent it must confront “Darwinism” more broadly, even in its recent and contemporary incarnations, if only to situate the problems it deals with in a proper context.

But an answer to “what is Darwinism” is surprisingly elusive. Even if we grant that “Darwinism is whatever Darwin said it is,” the problems of identifying Darwinism only begin there. Darwin’s views seem to have evolved over the course of a long and prolific career as a scientist, author, and correspondent. Did he maintain a consistent position? Was “Darwinism” always the same thing to Darwin? Many scholars who have considered this question, perhaps most, have held and defended the view that his ideas did change, so that “Darwinism” as “whatever Darwin said it is” is a moving target (Lennox, 2004; Beatty, in Mueller and Pigliucci, eds., 2010; Hull, in Kohn, ed., 1985; Ospovat, 1981; Browne, 1982; Gayon, 2003).

To mention only the most notorious example, the *Origin of Species*, from its first appearance in 1859 through the last edition (sixth, 1872) underwent revisions, many of decided significance, for each new edition (cf. *Origin* 1959, *Variorum* edition, editor’s introduction; and for additional discussions, Moore, 1979, 133; Vorzimmer, 1970, *passim*; Ruse, 1979, 210–11; Browne, 1995, 2002, 2006).² But that is only the beginning of the story. From the time of his *Notebooks*, containing Darwin’s earliest reflections on the origin of species question (1836–1842), through his late book on earthworms (1881) Darwin tinkered almost obsessively with the way he chose to present his theory. This fact raises the suspicion that he did in fact change his mind and that he came to make “adjustments” to the theory along the way.³

My view is that “Darwinism” had a single meaning to Darwin from beginning to end. Yes, changes were made in exposition, over and over again, and in one sense, as a philosophical platitude, one cannot change one’s way of saying something without changing what one says, and therefore what one is taken to mean.⁴ But another way of thinking about changes in presentation is to ask whether the author intended a change in meaning, especially as regards core beliefs and elements of a theory. In this regard, according to the well-established “principle of charity” in philosophical studies, one looks for “philosophical consistency” and decides that a significant shift in outlook has occurred only when forced to do so by irrefutable evidence.⁵

In the case of Darwin such evidence is hard to come by. Even explicit statements by Darwin such as “I probably underestimated the importance of factor ‘x’ (e.g., so-called ‘use-inheritance’) in earlier versions of my theory,” do not rise to the level of strong evidence for a shift in basic outlook, yet that is the sort of evidence upon

which arguments for a shift is often based.⁶ Placed alongside a considerable body of contrary evidence, the case for an ever-changing “Darwinism” is weakened. One is not free to ignore the evidence supporting a Darwinian change. But one may overcome it if counter-evidence is available and if a better explanation for the supporting evidence is available.

On the other hand, Darwin did change his mode of exposition, repeatedly. An examination of the Darwinian corpus shows that many of the most important changes centered on how he wished to present the role of “chance” in evolution to an ever-expanding reading public, especially after the *Origin* first appeared. But the changes started to appear much earlier, from unguarded reflections in the 1836–1839 *Notebooks* to the more publicly attuned 1842 “Sketch” and 1844 “Essay” (Kohn and Stauffer, 1982) all the way through the several editions of the *Origin* and beyond. Something deliberate is going on here, and to discover what that something is motivates the work presented here. To anticipate, I wish to make and defend the following claims:

- (1) Darwin discovered “chance” as a basic factor in evolution from an early time in his career, perhaps mid-1837.⁷
- (2) Darwin understood some important implications of this discovery from a nearly equal early period for how his views would be received, specifically: (1) that “chance” (in its primary meaning for Darwin) would be regarded as a “dangerous” idea (in this he was correct); (2) that he probably had to readjust his own religious views in light of his discovery; (3) that he could not in good conscience pretend to himself or the world that he did not really mean it; (4) that to ensure scientific acceptance of his discovery he would need to cast the role of chance in ways that, while preserving its central meaning, would either obscure its role in his theory or at least make it seem innocuous to otherwise friendly natural philosophers and scientists; and (5) that to accomplish this end he would need to rework his wording in his published writings.
- (3) Changes made by Darwin in how he chose to present “chance” in his theory may be of greater significance than any others in the Darwinian corpus. At a minimum they are extremely important in seeing how he “evolved” in mode of expression.

I understand that these are strong and for some readers controversial claims. Whether they can be supported will depend on the evidence from Darwin’s oeuvre. I present what evidence I could assemble in the following pages and must let the reader decide whether the evidence and supporting argumentation are up to the challenge.

It may fairly be asked, against whom am I making these claims? Darwin's thoughts, as many commentators have observed, are often refracted through the lens of the reception of his views as they became more widely known by a broader reading public. For example, M. J. Hodge has suggested that Darwin's "reception" among a large reading public was created and promoted by his son Francis in published letters edited by Francis, as well as in Francis's own interpretive essays—the so-called Franciscan interpretation. Francis did not alter Darwin's words but he did make choices about what should be published after his father's death and what should remain private. Later commentators have offered different interpretations of what Darwinism meant to Darwin as more of Darwin's "private" writings became public. The point here is only that how a thinker is understood is often a result as much about what others have said as it is about what the thinker wrote himself.

I have not been motivated in this work by a desire to show disagreements with previous interpretations, although, inevitably, my arguments will challenge many of them. But I got my start in Darwinian studies by examining only the words and works of Charles Darwin. I thus started out with no axes to grind. I believe this is an advantage, insofar as my readings were not at first influenced by the readings of other scholars. Naturally, over the course of years of engagement with the vast literature on Darwin and Darwinism I have come to see where my work intersects, overlaps, and disagrees with this literature. I try to give a full account of my many debts to the scholars who have been laboring in the field and to show where my arguments differ from theirs. But I try to set out and move through with a clean slate, basing my claims on Darwin's *ipsissima verba* rather than on what others have said.

DARWINISM

The Darwinian theory, usually rendered in shorthand as the theory of "descent with modification by means of natural selection," may be reduced to a syllogistic core that goes something like this:⁸

- (1) Variation. All creatures that reproduce (sexually or asexually—it doesn't matter⁹) will produce offspring that *vary* slightly from themselves. An offspring might have slightly longer legs, or a slightly shorter beak, or slightly more hair, than its parents, and so it is said to vary. It is important to say that Darwin often claimed that he did not know *how* or *why* variations occur, only that they do occur. No parents' child is identical to its parents, but how it will vary no one can predict. Darwin could often do no better than to say that any variation from parent to child is due to what we must, in our ignorance, call *chance*.

- (2) Heritability. Variations are often passed along in reproduction. Children with longer legs or more hair are likely to have children with these same traits, or even with these same traits more pronounced, and so on down the line of generation. In other words, variations often have a tendency to be *preserved*.
- (3) Competition for survival. More creatures are born in every species or group than can normally survive. They reproduce faster than the resources upon which they depend for sustenance. Therefore, some—actually many—must perish, as a regular fact of life. Only the few ever survive. This phenomenon came to be called by Darwin “survival of the fittest,” an expression that was invented by Herbert Spencer and brought to Darwin’s notice by the co-discoverer of the theory of natural selection, A. R. Wallace.

If these three events occur in nature—and Darwin was certain they did—then the mechanism of Natural Selection would allow evolution to happen.

- (4) Natural Selection. This principle determines who are the winners and losers in the perpetual struggle for existence. Those creatures that have varied in “favorable” directions are more likely to survive than those that have not varied, or have varied in unfavorable ways. For example, in a climate where longer hair provides a better protection against death by freezing than shorter hair, a variant individual with longer hair will be “selected” by nature to survive against its rivals who have been born with shorter hair, and this successful variant is likely to pass along the winning trait to its offspring. Again, Darwin did not claim to know how or why some individuals happened to vary—happened to be born with longer hair in our example—but only that if they did vary in favorable directions, they had a better chance to be selected for survival than ones that did not vary.¹⁰

Of these four parts or ideas of the theory, this book is mainly about the first—variation—and even more narrowly, only variations that Darwin attributed to chance. The other ideas, of course, are fundamental to the theory, and no one believes that Darwin ever wavered from his belief in them, or in the primacy of natural selection among other factors that play a role in evolution. What is usually at issue in arguments for a changing Darwinism, rather, is the role played by “chance” in explaining variation. This idea more than any other sets Darwin’s theory apart from all other evolutionary theories in his day, and thus is important for establishing Darwin’s

theory as distinctively “Darwinian.” The idea of “chance,” and the role it plays in the modification and “transmutation” of species, remained steadfast and the same in Darwin’s thought from his first revelations in 1837–1838 about what goes on in nature to all subsequent works where he addressed the question.¹¹ It is also, as I shall show, the one part of his theory that underwent the most dramatic changes in exposition.

These changes, directly and indirectly, account in turn for most of the suspicion that Darwin actually changed his mind, even though those who bring forward this argument have not been entirely clear about the importance of this shift for their own arguments. For example, one typical argument is that Darwin became more “Lamarckian” over the years.¹² This is generally taken to mean that he came to strengthen a role for so-called “use-inheritance” in evolutionary change. What generally goes unnoticed in these accounts is that “use-inheritance” can only be strengthened by diminishing a role for something else, and that something else is usually “chance.” In fact the impression that Darwin strengthened “use-inheritance” is generated in part by the fact that he did (in words) reduce or even disguise the role that he had earlier assigned to chance. But if he did not really change his mind about chance, he did not really change his mind about use-inheritance.

DARWIN’S APPROPRIATION OF CHANCE

Chance as an important factor in how to understand nature was not Darwin’s unique discovery. Philosophers and naturalists had much to say about “chance,” even in quasi-evolutionary contexts, long before Darwin, as is the case, for example, with the Greek philosopher Empedocles (4th c. BCE), as recorded in Aristotle’s *Physics*. Aristotle too considered what sort of role chance might be said to play in natural events.¹³ But the idea that chance might play a role in shaping the organic world, in such a way that random variations paradoxically give rise to apparent design and order, was no part of the scientific mainstream of Darwin’s day. If anything, chance was anathema to most scientists and philosophers (cf. D. Hull, 1973, 15, 55–68; Browne, 2006, 92–3). To most thinkers, chance connoted a variety of ideas that seemed contrary not only to revealed and natural religion but also to common sense. Even skeptical thinkers like David Hume, who made serious efforts to consider the possibility that chance may have some role to play in nature, came to reject it (*Dialogues Concerning Natural Religion*, 1779, Pts. II, IV, V, VII, XII; cf. D. Dennett, 1995, 28–33; Dawkins, 2006, chapter 4). Most people did not even consider the possibility. The many writers who most influenced Darwin’s thinking about nature—men like Lyell,

Whewell, Herschel, and before them William Paley, with their deep admiration for nature's orderliness and evident design—dismissed a role for chance out of hand.¹⁴

Darwin, by contrast, understood from his earliest reflections on the origin of species question in 1837–1838 that he would be required by the tenets of his science to make room for a role for “chance” in the evolution of new species. Our question concerns how he handled this issue. “Chance” as Darwin used it was a bogey for most of his audience, friendly and unfriendly alike. Chance, at least in one important sense, means fortuity, and most people in Darwin's day, and even now, could not accept a world in which fortuity played a guiding role in evolution.¹⁵ Yet Darwin believed fortuity was at the very core of modifications leading to the origin of new species.¹⁶ The implications of any such view were significant. The earth, its geological features, and its organic inhabitants are here only through lucky accidents? For many people that was a hard pill to swallow. Darwin did accept it, but also knew he would have to get his audience to accept it too if he were to succeed in establishing his theory as the correct account of the origin of species.

Darwin realized he would need to tread carefully. His early public presentations of the theory, especially in the *Origin* itself, were not careful enough. Under the onslaught of criticism that the *Origin* received after its first appearance in 1859, Darwin decided that he needed to downplay, or perhaps better disguise the role of, chance if his theory were to be generally accepted.¹⁷ In light of this recognition he adopted a variety of rhetorical strategies that added up to a deliberate campaign to retain chance as a central element while making it appear to most readers that he did not; or, as with the “stone-house” metaphor (discussed in chapter 7 of the present work), making it appear less “dangerous” an idea than many supposed.

DARWIN'S RELIGIOUS VIEWS

Darwin's early recognition of chance in causing variation also has implications for how we understand the evolution of his religious beliefs. The customary view, based mainly on his *Autobiography* and the small selection of letters that was available to a large audience previous to the mammoth “Correspondence Project” (1985 to present), is that he gradually shifted from “early orthodoxy” to a “liberal form of theism,” and then in later years “into an agnosticism tending at times toward atheism” (Herbert, 1974, 232; Moore, 1979, 314–15; Ruse, 1979, 180–4; Ruse, 2010, 1–8; Lennox, 2004; R. J. Richards, 1989, 77–7; N. Gillespie, 1979, ch. 8; Beatty, 2006).¹⁸

It seems probable that his departure from Christian faith was earlier, more abrupt, and more complete than this view indicates. The reason for thinking so

stems from the same source that so many of Darwin's contemporaries rejected a role for chance in nature's workings: a chance-governed world seems tantamount to a godless world. Einstein made this very connection himself 75 years later when he famously said, "God does not play dice with the universe."¹⁹ Darwin undoubtedly understood this implication of his theory, but rather than conclude that chance plays no role in nature he appears to have concluded instead that God does not have much to do with nature at all.²⁰

How new this idea was in Darwin's day is suggested by a quote from one who could not accept it. Charles Kingsley (a distinguished professor of History at Cambridge University and correspondent with Darwin), no doubt reflecting a common view, observed in 1871, "God is great, or else there is no God at all" (in Moore, 1979, 339; for Moore's analysis of Darwin's religious views in the *Notebooks*, 319–25 and nn. 56–87). The 1871 comment of St. G. Mivart's (a younger aspiring biologist and devout Catholic) was more pointed: "Unhappily the acceptance of your views means with many the abandonment of the belief in God and the immortality of the soul" (*CCD*, vol. 19, 36). Unlike Mivart, Kingsley, and many others, Darwin appears to have adopted the second half of the disjunct: not that "God is great," but rather "there is no God at all."²¹

Some students of Darwin's thought will wish to make an objection to this claim. But let us look at Darwin's words. In May 1860, only a few months after the *Origin* first appeared, Darwin had this to say to his early American supporter, the Harvard botanist Asa Gray:

With respect to the theological view of the question; this is always painful to me.—I am bewildered.—I had no intention to write atheistically. But I own that I cannot see, as plainly as others do, & as I shd. wish to do, evidence of design and beneficence on all sides of us. There seems to me too much misery in the world. I cannot persuade myself that a beneficent & omnipotent God would have designedly created the *Ichneumonidae* with the express intention of their feeding within the living bodies of caterpillars, or that a cat should play with mice. Not believing this, I see no necessity in the belief that the eye was expressly designed. On the other hand, I cannot be contented to view this wonderful universe, and especially the nature of man, & to conclude that everything is the result of brute force. I am inclined to look at everything as resulting from designed laws, with the details, whether good or bad, left to the working out of what we may call chance. Not that this notion at all satisfies me. I feel most deeply that the whole subject is too profound for the human intellect. A dog might as well speculate on the mind of Newton.—Let each man hope and believe what he can.

Darwin continues in the same letter:

Certainly I agree with you that my views are not at all necessarily atheistical. The lightning kills a man, whether a good one or a bad one, owing to the excessively complex action of natural laws.—A child (who may turn out an idiot) is born by action of even more complex laws,—and I can see no reason, why a man, or other animal, may not have been aboriginally produced by other laws; & that all these laws may have been expressly designed by an omniscient Creator, who foresaw every future event & consequence. But the more I think the more bewildered I become; as indeed I have probably shown by this letter (CCD 8, 223 [May 22, 1860]).

The question for Darwin came down to whether the notion of an “undesigned nature” made any sense. Two months later, after continuing to ponder, Darwin wrote again to Gray, and again showed that he was still in a quandary:

One more word on “designed laws” & “undesigned results.” I see a bird which I want for food, take my gun and kill it, I do this *designedly*.—An innocent & good man stands under a tree and is killed by a flash of lightning. Do you believe (& I really shd. like to hear) that God *designedly* killed this man? Many or most persons do believe this; I can’t and don’t.—If you believe so, do you believe that when a swallow snaps up a gnat that God designed that that particular sparrow shd. snap up that particular gnat at that particular instant? I believe that the man and the gnat are in the same predicament.—If the death of neither man nor gnat are [*sic*] designed, I see no reason to believe that their *first* birth or production shd. be necessarily designed. Yet, as I said before, I cannot persuade myself that electricity acts, that the tree grows, that man aspires to the loftiest conceptions all from blind, brute force (CCD vol. 8, 275 [July 3, 1860]).

Well, which is it, designed laws, or “blind, brute force,” with no foresight or intention by any designer about what laws should be created or how they would operate? For anyone who wonders what Darwin really believed, the passages just quoted give no clear answer. “Brute force,” which Darwin could not fully accept as an explanation for life’s diversity, apparently refers to the means by which variations arise, and may equally well be rendered by the word “chance.” He had no doubt that once variations did arise they would be pruned and preserved by non-intelligent processes. But how did they arise in the first place?

Darwin continued to express his doubts and uncertainties to other correspondents in the months after the *Origin* first appeared. For example, to Charles Lyell in

August 1861 Darwin responded with skepticism to Gray's argument that the course of streams are "designed" by an intelligent maker:

I doubt whether I have made what I think clear; but certainly A. Gray's notion of the course of variation having been led, like a stream of water by Gravity, seems to me to smash the whole affair. It reminds me of a Spaniard whom I told I was trying to make out how the Cordillera were formed; & he answered me that it was useless for "God made them." ... I must think that such views of Asa Gray & Herschel merely show that the subject in their minds is in Comte's theological stage of science²² (CCD vol. 9 [August 1, 1861]).

This was a bold claim for Darwin to make to his mentor and friend Lyell, whose own religious convictions that God made the laws governing geological nature were often affirmed in his great work *Principles of Geology* (1830–1833). Darwin must have known that he was challenging Lyell's deepest theological convictions. Perhaps to soften the blow, Darwin added the following:

The view that each variation has been providentially arranged seems to me to make natural selection entirely superfluous, & indeed takes the whole case of appearance of new species out of the range of science.—It seems to me that variations in the wild and domestic conditions are due to unknown causes & are without purpose & insofar accidental; & that they become purposeful only when they are selected by man for his pleasure, or by what we call natural selection in the struggle for life under changing conditions. I do not wish to say that God did not foresee everything which would ensue; but here comes very nearly the same sort of wretched embroglio as between free-will & preordained necessity (CCD vol. 9 [August 1, 1861]).

These letters to his close associates must be taken to disclose some of Darwin's deepest thoughts in 1860–1861 on the subject of divine intelligence in the creation of species. What do the passages tell us? Strictly speaking they tell us three things that are not mutually consistent: (1) that Darwin had never *intended* to write "atheistically" (by itself, of course, that does not mean he had no atheistical leanings); (2) that he can see no evidence of "design" (or, therefore, an omniscient God) in natural productions; and (3) the whole subject of design and God is too profound for him to know what to believe. Perhaps God created natural laws at the beginning and then left the world alone so as to allow His laws to play out according to an invisible divine plan. But it is not clear that Darwin really believed that. His ultimate refuge in all the passages reproduced above (and many more) was that the whole question