BOOKS: HISTORY OF SCIENCE

Origin Was Just a Beginning

Edward J. Larson

Janet Browne could have subtitled the much-awaited second and concluding volume of her Charles Darwin biography, "A man of many faces." Indeed, to introduce her subject, she writes, "Much of the lasting fascination of Darwin's life story surely lies in the relationship between [his] prolific inner world of the mind and the private and public lives that he created for himself." Browne follows this theme through the final quarter century of her subject's life, going back and forth between his thinking on evolution and his multiple lives. The result is a richly textured, highly complex biography—as befits its subject.

Charles Darwin
The Power of Place. Volume 2 of a Biography
by Janet Browne

Knopf, New York, 2002. 624 pp. $37.50, C$56.50. ISBN 0-679-42932-8. To be published 14 November by Cape, London. £25. ISBN 0-224-04212-2.

The complexity of Darwin's later life may explain why so few biographers have tackled it. There are, of course, shelves of Darwin biographies, but the accounts invariably center on his charmed early life and events through the 1859 publication of *Origin of Species* and its immediate aftermath. They present the Darwin we recognize: the engaging *Beagle* voyager who returns home to struggle over the mechanics of evolution by natural selection. For example, the cover of one notable biography that focused on these middle years, Adrian Desmond and James Moore's *Darwin* (Warner, New York, 1991), carried the subtitle *The Life of a Tormented Evolutionist*. Darwin lived until 1882, however, and the tormented single soul matured into neatly compartmentalized multiple faces. Browne, a historian of biology at University College London, explores this later life in greater depth and detail than any previous biographer. Hers is a welcome addition to any Darwin shelf.

Following his youthful travels and marriage to his wealthy cousin Emma Wedgewood, Darwin settled into the life of a country squire in Downe, which was near enough to London for him to participate (when he wanted) in its scientific culture. *The Power of Place* picks up the story there, when Darwin is shocked into publishing his theory of natural selection after another naturalist, Alfred Russel Wallace, hit upon the same idea. The country squire of Downe differed from the scientist of London, but Darwin straddled both lives. In the one, he fulfilled the traditional role of a proper English husband, father, and landed gentleman, going so far as to hold local office; in the other, he doggedly pushed and promoted his scientific theories. "His scientific associates almost inevitably met a different figure from the man that his wife and children knew," Browne writes, "a man different again from the controversial author that the public encountered when the *Origin of Species* was published or that his servants passed in the hall."

Browne could have subdivided him further. To his closest friends in science, Darwin was like a mirror: the orthodox Christian botanist Asa Gray saw a reluctant skeptic open to persuasion on God's role in nature; the militantly agnostic naturalist Thomas Henry Huxley saw a biological reductionist committed to utter materialism. Darwin pottered around his country estate like some dotty aristocrat from an English novel, all the while astutely (and proudly) managing his business investments. A lion on the world stage of science, he childishly tried to hide the extent of his tobacco addiction from his family, his servants, and even himself. Browne presents Darwin's various faces without reconciling them. Perhaps there is no reconciliation. He could be just as content finding a naturalistic explanation for an orchid's beauty as in besting his wife 2795 games to 2490 games in a lifetime of backgammon. "Hurrah, hurrah," he might cry in both cases.

Penciled portrait. During an 1878 visit to Down House, T. H. Huxley's daughter Marian sketched Darwin.

CREDIT: NATIONAL PORTRAIT GALLERY, LONDON

The post-*Origin* Darwin is significant for more than just his character though, and it is here that Browne's book shines. Despite his disabling illnesses (which Browne diagnoses in detail), Darwin worked compulsively tying up the fraying ends of his evolutionary theory, particularly the causes of variation and the processes of inheritance. Some of his best research dates from the last two decades of his life, during which time he published at least a book a year and over sixty scientific articles. Most current readers know Darwin primarily from his youthful *Voyage of the Beagle* and his landmark *Origin of Species*, but some of his later books are better at addressing present-day questions in biology. In them, Darwin's fertile mind bore into such critical issues as the evolution of human morality and consciousness, the impact of inbreeding (cousin marriages were a particular concern), the accumulated effect of small agency, and the power of sexual selection. Along the way, Darwin gradually lost what was left of his spiritual beliefs and, in his own gentle way, adopted the materialism of Huxley and Ernst Haeckel. His thinking on such matters remains highly relevant. For example, Darwin's 1869 *Descent of Man* should be required reading for anyone interested in evolutionary psychology. Browne's biography gives vital context to Darwin's later work, detailing his brilliance as well as his biases and integrating the scientific with the social. Her Darwin is knee-deep in Victorian sexism, racism, and classism, and he sinks deeper with age.

After *Origin of Species* made him both famous and infamous, Darwin became part of the intense Victorian debate over the origins and nature of life and humanity. Browne follows various twists and turns in this debate, at times reaching far beyond Darwin's direct role in it. Indeed, after devoting the first third of this volume to the writing of and immediate reaction to *Origin of Species*, she turns to this ensuing public discussion. Darwin's landmark book dealt only with the origin of species other than *Homo sapiens*, and in it he also avoided any speculation about the origin of life. These two issues (humans and life) soon became the focus of the scientific and popular debate over origins, with Darwin only reluctantly joining it. Wallace, Huxley, Haeckel, and Charles Lyell (among others) featured prominently in the widening debate. Browne follows the trail of this debate where it leads, even when Darwin is temporarily left behind. She ceases only when Darwin dies at age 73, with the debate still raging. As long and dense as *The Power*

The author is at the Department of History, University of Georgia, 220 LeConte Hall, Athens, GA 30602–6012, USA. E-mail: edlarson@arches.uga.edu

of Place is, I wanted it to continue following the disputes, Darwin or no Darwin. By this point in Browne's biography (as in his life), the country squire of Downe had become secondary to the debate that he launched a quarter century earlier.

BOOKS: DEVELOPMENT

What Is an Explanation?

Jonathan Slack

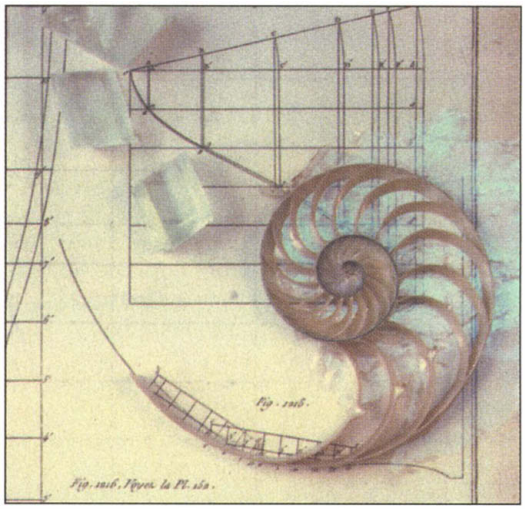
Inasmuch as there is a theoretical physics, why is there no theoretical biology? This is a question that has exercised many, from the London Theoretical Biology Club of the 1930s, through the influential symposia of Conrad Waddington in the 1960s, to today's theorists of computer-based "artifical life." Physicists traditionally feel that their science should represent an aspiration for all and that the separation of a distinct caste of theoreticians is a natural event in the development of any subject. Biology has not followed this pattern, probably because biology cannot choose its subject matter freely, but has to deal with actual life as it exists on Earth. In *Making Sense of Life*, Evelyn Fox Keller pointedly reminds us that, because of natural selection, "organisms solve the problems they face with little regard for elegance, efficiency or logical necessity."

Making Sense of Life Explaining Biological Development with Models, Metaphors, and Machines
by Evelyn Fox Keller
Harvard University Press, Cambridge, MA, 2002. 400 pp. $29.95, £20.50, €29.95. ISBN 0-674-00746-8.

Focused specifically on developmental biology, the book recounts various attempts to harness theoretical approaches to understanding the mysteries of embryonic development. Throughout, Keller tries to establish what has been considered a legitimate theoretical approach and what constitutes understanding in this area of research. A recurring theme is the arbitrariness of what we choose to regard as a proper explanation and the associated clash of cultures between mathematics and biology. In general, mathematicians value conceptual simplicity and the idealized model of a process, whereas biologists want to know how the specific system they are confronting actually works. Nicholas Rashevsky, a pioneer of theoretical biology in the 1940s and 1950s, seems to have encountered vituperative criticism for producing idealized models of processes that might exist, rather than applying quantitative treatment to actual processes in all their messy complexity. Keller herself is willing to adopt an historian's approach rather than that of a philosopher. She therefore recounts what has, in fact, been considered a valid type of explanation, instead of pontificating about what ought to be valid. This is a refreshing perspective, but perhaps it leans a little toward cultural relativism.

Oddly, the first case study in the book is not a theoretical one at all but a claimed creation of "artificial life," or at least something that might be considered a representation of the essence of life. This is the celebrated work of Stéphane Leduc around the end of the 19th century, in which simulacra of algae and colonial animals were produced by allowing crystals to "grow" in a strong solution of sodium silicate. As anyone knows who has ever made such a "chemical garden," the shapes that are produced can be quite remarkable, but few other than Leduc himself considered the inorganic growths to be a useful model for understanding any aspect of real life. Keller then discusses D'Arcy Thompson, but she does not explain why he is so much better known to the biological community than Leduc or Rashevsky, even though his ideas have similarly failed to be incorporated into any ongoing program of work.

Although Keller gives dynamical systems theory only a brief mention, she devotes much space to what some regard as the discrete equivalent, the class of models known as "cellular automata." This approach owes its origin to the work of von Neumann in the 1940s. After persisting for some decades in a half-forgotten byway, it has recently been revived and developed in different ways by Christopher Langton and Stephen Wolfram. Artificial life has been reborn in silico, this time not as messy flasks of actual sodium silicate but as computer-based cellular automata. Keller is very impressed by this, and she discusses at length whether a computer program is really life or simply a representation of life and whether it could be realized in a nonvirtual form. A more down-to-earth development of discrete mathematics is the use of formal logic to model genetic regulatory systems. Interestingly, it seems that physicists do not regard the representation of a gene by a logic circuit to be a "real model." To them, that is simply a formal restatement of the data, itself requiring explanation by a more abstract and general theory.



Olivia Parker's photograph *Marine II*.

With regard to the book's main theme, the nature of explanation, I found one of the clearest statements to come from the reviled Leduc. As a science develops, he once said, the first stage of explanation is a classification of the entities defined by the science; the second stage is an enquiry into their intrinsic mechanisms; and the final stage is the ability to synthesize them. So will the theory of cellular automata enable us to design and make new forms of life? Keller is aware that molecular biology currently creates new forms of life by rearranging preexisting components rather than by de novo design. She argues, however, that it is reasonable to expect a higher level of rational design in the future, and I agree with her. In this regard, the discrete mathematics of the cellular automaton is likely to prove a more appropriate tool than the differential equation.

Making Sense of Life does not include a discussion of what is really worrying many molecular biologists: the vast mass of genetic and molecular data that is being generated in the post-genomic era and the apparent impossibility of organizing all the material collected into any manageable type of explanation. But Keller has given us some food for thought. My own view tends towards coming off the relativistic fence and affirming that biology is now mature enough, by Leduc's criteria, to construe "explanation" as meaning "the ability to design" new types of organism—or at least to reprogram in specific ways the organisms we have. It is not very fashionable to quote Karl Marx now that his political program is so discredited, but the famous "11th Thesis on Feuerbach" does seem rather apposite to the future of biological explanation: "The philosophers have only interpreted the world in various ways; the point, however, is to change it."

The author is at the Developmental Biology Programme, Department of Biology and Biochemistry, University of Bath, Bath BA2 7AY, UK. E-mail: j.m.w.slack@bath.ac.uk