Book Reviews

Debates on the Origin of Life

The Spontaneous Generation Controversy from Descartes to Oparin. JOHN FARLEY. Johns Hopkins University Press, Baltimore, 1977. xiv, 226 pp. $13.50.

The history of spontaneous generation controversies has until very recently been a paradigm of whiggish saga-telling. Redi, Spallanzani, Schwann, and above all Pasteur have been seen as the knights of the forces of truth; they ride into battle bearing their standards of gauze netting and hurl boiled infusions in swan-necked flasks as they charge. The forces of error, represented by J. T. Needham, Buffon, Liebig, and the hapless Felix Pouchet continually give ground until vanquished by the dazzling demonstrations of their conquerors. That there were uncomfortable anomalies in this story has long been apparent to those who teach skeptical students the traditional litany. Aristotle and Harvey, who espoused forms of *generatio equivoca*, were, after all, highly competent students of life; Spallanzani's triumphant experiments appear curiously tarnished by his accompanying belief in preformation; and if Pasteur's work had really been so decisive, why all the ruckus between Tyndall and Bastian, or between Oparin and Muller?

In the past 15 years historians have begun to reexamine the saga. Most notably, Jacques Roger (*Les sciences de la vie dans la pensée française du XVIII^e siècle*, Colin, Paris, 1963) has reoriented our thinking about 17th- and 18th-century theories of generation, and John Farley and Gerald Geison have begun a revision of the 19th-century picture. (See Farley and Geison, *Bull. Hist. Med.* **48**, 161 [1974]; Farley, *J. Hist. Biol.* **5**, 95 [1972]; and Geison's article on Pasteur in the *Dictionary of Scientific Biography*.) Farley's book-sized study now gives ample proof that the history of the controversy is far more complex and challenging than the standard version allows. The book also demonstrates that a professional scientist (the author is professor of biology at Dalhousie University) can bring his expertise to bear effectively on the problems of a humanistic discipline.

What we find is a story that weaves its way through four centuries of complex debates. Without attempting a summary of the varied episodes, it is worth indicating the diversity of events this history necessarily embraces. It is, in fact, one of the author's objectives to display the richness of the story. In the early 17th century Descartes, Paracelsus, and Harvey, despite their very different philosophical perspectives, accepted spontaneous generation to varying degrees. The 18th century saw the pendulum swing to a deistically inspired preformationism, which ipso facto ruled out such generation, and back to French materialism and German Naturphilosophie, dissimilar in most respects but both insistent upon some sort of *generatio de novo*. With the advent of the 19th century the work of Carl Rudolphi, Marcus Block, and Johannes Bremser on obligate parasites gave empirical support to heterogenesis; the French evolutionists Lamarck and Geoffroy St. Hilaire promoted abiogenesis at the lowest level of the organic hierarchy; while the British, snug in their natural theology, rejected both prospects as atheistic. Between 1830 and 1859 the pendulum swung again. Steenstrup's famous discovery of alternation of generations among invertebrates, parasite "feeding experiments" initiated by Kückenmeister, and advances in the cell theory, epitomized by Virchow's famous dictum, brought the doctrine into "disarray" (p. 70).

Immediately following the publication of the *Origin of Species* and the emergence of the protoplasmic theory of life, there was a resurgence of support for spontaneous generation. After all, if transmutation of species was to be accepted, one had to face up to the issue of the first appearance of life. Furthermore, medical investigations, like those by John Snow, promoted the possibility of the heterogenetic production of molecular pathogens. German materialism, supported by such different students of nature as Haeckel and Helmholtz, pushed de novo appearances to the abiogenetic extreme. The English, at first, tended to ignore the ultimate origins of life; while the French, under the obdurate leadership of Pasteur, turned fully against it. After the 1870's new discoveries in cytology and the success of the germ theory militated against a continuing *generatio equivoca*; so that Farley must report an "almost universal rejection of spontaneous generation." Yet "an undercurrent of doubts persisted—to appear again in the twentieth century" (p. 150).

After 1905, with an erosion of the distinction between inorganic and organic chemistry, the discovery of filterable viruses, and the rise of colloidal chemistry and the enzyme theory of life, the gap narrowed between what was obviously living and that which could be characterized as nonlife. The argument over spontaneous generation turned to a question of when and under what conditions. Farley sees Oparin as providing the final solution.

One of the more interesting aspects of the spontaneous generation controversy as it emerges in its totality is the apparent elusiveness of a definitive demonstration for or against the doctrine. Time and again Farley's story demonstrates that direct assaults on the question through specific observations or experiments always ran into a dilemma. Positive results could be faulted on the grounds that unwitting contaminants intervened; negative results could be equally faulted on the grounds that the appropriate generating conditions had not been met. The problem has long been recognized in the confrontation between Needham and Spallanzani, both of whom were excellent experimentalists but neither of whom could dispassionately explain the other's opposing results. (We now recognize that they used different kinds of infusions and left different proportions of air and broth in the boiled flasks.) It is the recognition of it that allows Farley to review more sympathetically the work of Pouchet, Bastian, and other proponents of spontaneous generation.

The lesson, moreover, has general applications for the history of science, for it becomes clear that opposing views are often drawn up not in response to the immediate investigations but to the dictates of peripheral scientific principles. The resolution of each controversy was to be found not so much in the extension of observations or refinements in experiments as in the fact that the debate was undercut each time by achievements in related fields: thus, the rise of microscopical anatomy, Steenstrup's discovery of alternation of generation, the discovery of heat-resistant spores, the tri-

umphs of the germ theory of disease, the discovery of filterable viruses, the gene theory, and the enzyme theory of life each in its own way refashioned the arena of debate. In fact, it is Farley's view that the issue disappears in the 1960's not so much because of a final resolution but because biochemistry and molecular biology transformed the debate into one between a gradualist and a saltationist view of the appearance of life.

Farley pushes out the sphere of relevant concerns even beyond related scientific theories. This brings us to the most controversial aspect of the book. Throughout, the author endeavors to associate particular scientific positions with religious and philosophical commitments. Historians of science have been attempting such bridge-building for some time with only moderate success. The recent interpretations of Pasteur developed by Farley and Geison stand out as some of the most successful efforts. Farley's chapter on Pasteur, which is one of the best in this book, follows closely this revisionistic line and is going to upset many an uncritical Pasteur admirer. In short, Geison and Farley have argued that much of our historical understanding of spontaneous generation arguments has been dictated in the first instance by Pasteur's own highly subjective history of events. They also show that Pasteur's strong commitment to Catholicism and to the Second Empire fanned to the point of intolerance his reaction to opponents. They show that the judgments of the Académie des Sciences on the Pasteur-Pouchet and Pasteur-Bastian controversies were far from the evenhanded evaluations expected from the scientific community. These demonstrations may say little about the context of Pasteur's discoveries, but they suggest a lot about the justification of scientific ideas. Farley attempts similar "political" interpretations of the Tyndall-Bastian controversy (p. 141), of the views of the Haldanes, father and son (pp. 164–165), of the views of Oparin (pp. 171–173), and of the outcome of the First International Symposium on the Origin of Life of 1957 (pp. 179–181), among others. This reviewer finds these latter efforts at an "externalist" treatment of scientific ideas less developed and consequently less convincing than the exposé of Pasteur.

In short, in putting together this complex story so effectively Farley has shown us that the history of the life sciences has unexploited riches. By promoting a multifaceted history, which includes social as well as intellectual elements, he has attempted one of the most difficult of syntheses in our discipline. In places, to be sure, he remains tantalizingly brief in his analysis, for example in his discussion of the relation between the acceptance of the germ theory of disease and the spontaneous generation issue (pp. 144–146); occasionally he glosses over the contributions of major personages, for example Von Baer (p. 34); and now and then he slips into inadequately documented assertions, as in the account of the Ralph Spitzer episode at Oregon State (p. 178). But these are the shortcomings to be expected in any project so ambitious and comprehensive. This book is enormously rewarding to read and will be the necessary starting place for any future work on the subject; it can serve as a good survey of much of the history of 19th- and early 20th-century biology.

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Science as Problem-Solving

Progress and Its Problems. Toward a Theory of Scientific Growth. LARRY LAUDAN. University of California Press, Berkeley, 1977. x, 258 pp. $10.95.

What constitutes progress in science, and how is scientific progress to be explained? These are the large questions Laudan tackles in this ambitious book. He starts out with an aggressive prologue, contrasting his own approach to these questions with that of "most contemporary philosophers of science." Where others have defined scientific progress in terms of increase in the power of successive theories to explain facts, he proposes to define it in terms of increase in problem-solving capacity. And where others have treated the scientific rationality that may be invoked to explain progress as a quest for truth based on confirmation and refutation of theories, he proposes to show that scientific rationality can be defined in terms of choice based on assessment of the problem-solving capacities of theories, without appeal to the notion of truth. He promises to show that his approach can "avoid many of the paradoxes which previous models have generated, and make some sense of the historical data."

The rest of the book falls into two parts. In the first part the promised definitions of scientific progress and scientific rationality are spelled out. As a preliminary we are offered a taxonomy of the conceptual and empirical problems a theory may have to solve, each type being illustrated with snippets from the history of science. Next it is argued that individual theories should not be considered the units between which rational choices have to be made. Rather the scientist must decide between the "research traditions" that are associated with series of theories. Research traditions are "sets of general assumptions about the entities and processes in a domain of study, and about the appropriate methods to be used for investigating the problems and constructing the theories in that domain." After these preliminaries we are presented with the author's new criteria of scientific rationality. The "acceptability" of a research tradition is to be judged by the problem-solving effectiveness of the most recent theories associated with it. Its promise or "rational pursuitability" is to be judged by the "progress or rate of progress" in solving problems that it has exhibited in the past. In the second part of the book the author attempts to justify his earlier claim that his account of scientific progress and rationality can "make some sense of the historical data." He presents two tests for any proposed account of scientific rationality. As far as I am able to understand his argument, these are: first, it should enable us to show that those developments in the history of science that we all intuitively judge to be rationally motivated were in fact so; and second, it should provide the historian of science with adequate guidelines for selecting and weighting his material, without committing him to insensitive and anachronistic attempts to impose our present-day criteria for theory assessment and choice on past scientists who held to very different criteria. The author insists that on these tests his account fares better than traditional accounts but offers no evidence for this claim.

The mathematician Hardy is said to have remarked of a friend's fallacious proof, "There is less in this than meets the eye." Here too the remark applies. To start with, the author fails to show that his "new" approach is original. The illusion of originality is sustained by repeated contrast of his own views with a naive caricature that is variously described as "the traditional analysis," "the conventional wisdom," and "the standard view." This is misleading, for in fact the approach to the study of science the author defends, an approach customarily known as "instrumentalism," has a long history and many well-known recent exponents. The author appears to be unaware of this history and makes no attempt to answer any of the