philosophy the location of such a divine fluid. Nevertheless, there was perhaps a sense in which the confessionalization of physics – the spatial separation between Christ and the host (the Eucharist) and the temporal separation between God's intention and historical events (predestination) – had reached a stalemate by the end of the sixteenth century, as Christoph Lüthy suggests. Mersenne's solution was to develop a republic of letters, a new type of community, in which the establishment of observational and experimental facts formed the basis of interconfessional dialogue. This was not a secularization of nature, though, since for Mersenne the point was to focus on the phenomena of God's creation rather than causes, in the way advocated by other newly emerging scientific societies.

This is a rich collection of case studies which should provide much food for thought for those scholars interested in the topic of 'science and religion', not least because the essays, collectively, militate against any simplistic generalization about the relationship between the two spheres. Orthodoxy and heterodoxy are correlative terms in that one is defined by the other, though perhaps 'heterodox' is more often a term of criticism and abuse, rather than a badge to be worn with pride. Those whom we historians regard as heterodox in their scientific and/or religious views frequently believed that theirs was the right and true view and that theirs was the position that should be orthodox.

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Justin E. H. Smith (ed.), **The Problem of Animal Generation in Early Modern Philosophy.** Cambridge Studies in Philosophy and Biology. Cambridge: Cambridge University Press, 2006. Pp. xiii + 456. ISBN 978-0-521-84077-4. £45.00 (hardback).
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Biology is currently undergoing a phase of rapid conceptual change. Genomics, epigenetics and systems biology are exploring causal models beyond the linear paradigm of the central dogma. At such moments the historical interests of scientists and philosophers, especially in connection with the theorizing of the past, tend to revive. Justin E. H. Smith has assembled a collection of essays clearly designed to meet this particular demand, by bringing into focus a number of profound conceptual developments during the early modern period. To be sure, for historians, the material here examined cries out for additional analysis in relation to social, political and cultural contexts. But to ignore the volume for the absence of wider context, or for the occasional blatant anachronism – for instance, Saul Fisher musing about 'broad parallels' between Pierre Gassendi's speculations about the role of parental imagination in the formation of the foetus and 'the modern account of genetic dominance' (p. 116) – would be to miss an opportunity to confront some of the most puzzling changes in the history of the life sciences.

To early modern natural philosophers and physicians, as Smith highlights in his concise and informative introduction, generation was the 'mother of all causal events' (p. 13). It was with respect to the generation of individual, living beings that Aristotle – whose impact on William Harvey is explored by James G. Lennox in the first chapter – fully put to work his theory of causes. And it was in the same respect that Cartesianism, with its rejection of formal and final causes, found its greatest challenge. The volume explores the wide terrain of theories proposed in the seventeenth and the eighteenth centuries to explain animal generation, with most of the chapters focusing on the work of individual thinkers: Réné Descartes (Vincent Aucante), Pierre Gassendi (Saul Fisher), Walter Charleton (Andreas Blank), Daniel Sennert and Gottfried Wilhelm Leibniz (Richard T. W. Arthur), Anne Conway (Deborah Boyle), Nicolas Malebranche (Andrew Pyle), Pierre Bayle (Dennis Des Chene), Georg Ernst Stahl (Francesco Paolo de Ceglia)

and Charles Bonnet (François Duchesneau). Two contributions with more sophisticated approaches stick out. Smith explains why maternal imagination – to modern eyes a bizarre piece of superstitious belief – held a systematic place in seventeenth-century mechanistic theories of generation. And Karen Detlefsen provides a fresh interpretation of the Haller–Wolff debate, relating it to differences in explanatory and experimental style. The four final chapters are all devoted to Immanuel Kant and his relation to, respectively, Pierre Moreau de Maupertuis (John Zammito), Johann Friedrich Blumenbach (Brandon C. Look), the 'speculative sciences of origins' in general (Catherine Wilson) and contemporary evolutionism (Michael Ruse).

The main advantage of this collection lies in the extreme care with which most authors provide a fair and detailed reading of early modern generation theories. None of the usual 'Russian dolls' caricatures (Pyle, p. 194) of mechanicist pre-existence theories are to be found, nor is the impression given that pre-existence dominated the early modern period as a monolithic doctrine. Even radical defenders of pre-existence such as Pierre Malebranche or Charles Bonnet could reach conclusions that sound surprisingly epigenetic (Pyle, p. 208; Duchesneau, pp. 303–5). Rather than one doctrine dominating the other, it seems that the very meaning of preformation and epigenesis changed fundamentally from the seventeenth century to the eighteenth. Initially, the debate was concerned with the moment and mode in which an individual living being is generated, and closely reverberated with the theological debate between traducianists, who saw generation as mediated by parental seeds, and creationists, who maintained that generation always involved divine intervention (Arthur, p. 148). As Smith points out in his contribution (pp. 80–1), this focus on the generation of individuals differs sharply from the focus on reproduction that gained prominence among naturalists and natural philosophers in the eighteenth century. With this shift in focus, the question was not any more whether the embryo, in one form or other, existed before its conception. Preformation and epigenesis became aspects of one and the same continuous process of regeneration and reproduction, and the question now was whether this process always presupposed some organic structure, or whether it could instead be initiated by unstructured matter endowed with specific life forces (Detlefsen, pp. 246–7). This was the fundamental opposition that Kant tried to resolve in his biological writings (Zammito, pp. 250–1), and that would mark nineteenth-century theorizing about inheritance as well.

Another major intellectual trend is highlighted by Smith in the introduction, and indeed runs like a visible thread through the various contributions to this volume, binding them together. This is the rise of what Smith calls 'theories of … microsubstantiality: the view that there are vastly more true, fully real, particular primary substances or individuals than meet the eye, indeed, than Aristotle had ever dreamed' (p. 9). Invisible, living germs began to populate not only the world around us – 'like atoms flying in the air, scattered and dispersed here and there by the winds', as Harvey put it – but also within us. 'An animal is a world inhabited by other animals; these are in turn their own worlds, and we have no idea where this ends', to use Charles Bonnet's words. The idea of microsubstantiality was closely connected with the idea of pre-existence, and again prefigures nineteenth-century biology's preoccupation with a general theory of reproduction and cellular life. If the search for 'forerunners of Darwin' still has some legitimacy, then this volume – and, it should be recalled, Jaques Roger's magisterial *Les Sciences de la vie dans la pensée francaise au XVIIIe siècle* (Paris, 1963) – opens a door to a rich world of pre-Darwinian biological thinking. 'There was', as Smith states at the end of his introduction, 'no sudden discombobulating moment with Darwin: the new way of seeing things we now attribute to Darwin was in fact centuries in the making' (p. 18).

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