

BOOK REVIEW

Michel Anctil, *Animal as Machine: The Quest to Understand How Animals Work and Adapt*

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Saharan desert ants live in a profoundly inhospitable environment. Venturing out beyond their nests, they find temperatures higher than forty degrees Celsius. Not especially resistant to desiccation, their survival depends upon exiting and returning to their nests as efficiently as possible. In the 1960s, French graduate student Gérard Délye studied the ants and found that they avoided prolonged exposure to the sun in this way. But a few decades later, under the eye of physiologist Rüdiger Wehner and his colleagues, the impressiveness of their feat became even clearer. The ants, it happens, leave their nest at the hottest midday period – a seemingly disastrous choice. Their main predator, however, a desert lizard, retreats to its burrow during precisely this time. Walking a ‘thermal tightrope’, the ants explode out of their nests, race to find food, and return home with the help of a powerful ‘celestial compass’ supported by specialized retinal signals. ‘As the ants narrowed their search with experience, they gained two advantages: they gathered more food in a shorter outing, thus limiting the risk of overheating’, Michel Anctil reflects in *Animal as Machine* (p. 213).

Animal as Machine: The Quest to Understand How Animals Work and Adapt traces the history of comparative animal physiology from the ancient era to the present, focusing on efforts such as Délye’s and Wehner’s to understand how animals in a stunning variety of forms function and adapt to their environments. The first four chapters offer a conventionally chronological and Europe-focused history of the discipline’s early development, while Chapters 4, 5 and 6 focus on the specific national contexts of America, Belgium, and Canada. The last three chapters shift the style and organization of the book by focusing on themes: animals living in extreme environments (Chapter 8), changing understandings of animal brains (Chapter 9) and the role of chemicals in shaping animal moods (Chapter 10). Chapter 8, from which the above anecdote derives, is especially rich and enjoyable to read. It is likely to be the most accessible to a general reader, while the book as a whole offers a useful survey for teachers, thanks to short biographies of many important figures.

As Anctil notes in the introduction, *Animal as Machine* contains four overarching motifs: the acceleration of discovery by carefully designed technical apparatus; the special importance of studying marine animals; the value of diverse approaches to physiological problems; and the vital place of interdisciplinary collaboration for the development of the field. The latter two are relatively predictable topics for histories of science, but the former two are worth reflecting on. Anctil, now the author of multiple scientific histories, is most widely cited for his own work on the comparative physiology of marine creatures, from fish to sea anemones and sea pansies. With this background, it is perhaps

unsurprising that some of the liveliest sections of *Animal as Machine* concern the history of research on sea and ocean creatures, and that the book as a whole tends to emphasize this area at the expense of some more famous stories in the history of physiology, such as Pavlov's dogs. Thus we read frequently about time spent by various researchers at the world's marine zoological stations, such as the Stazione Zoologica Anton Dohrn in Naples or Woods Hole in Massachusetts, working with crabs, cephalopods and more. Anctil is especially interested in comparative physiology and wants to show how many insights emerged from the study of peculiar and exotic creatures. In highlighting these stories, the book counteracts an emphasis in some historical literature on the physiology of large, common animals. On the other hand, when later chapters mention work on large animals such as dogs, it can be difficult to fit those pieces back into the broader story.

Anctil is also interested in the significance of technical devices, such as the kymograph, which helped generations of physiologists to get closer to their objects of study. Many of the heroes of this story (there are few villains, with the possible exception of narrow-minded medical physiologists) were the inventors of one or another critical tool. Descriptions of these devices are not always as extensive as they might be, however, leaving readers with more information about the life of their inventors than of their construction, appearance or functioning. This tension appears visually in the book, replete with large, black-and-white photographs, all of which are portraits of scientists rather than schematics or reproductions of these vital instruments. (The portraits are also all, unless I am mistaken, of men, despite female physiologists who appear in the text.)

As a scientist-turned-historian, it might be said that Anctil gives us a scientist's history of science rather than an academic historian's. The first few chapters are principally a parade of great men and great discoveries, many of whom are undeniably fascinating and introduced with passion. Anctil occasionally gets overly caught up in adjudicating which individuals were doing real comparative physiology and which were not, but the book is a valuable survey on a vital topic and, as noted, likely to be useful to many historians of biology. It engages admirably with literature in the academic history of science, since Anctil tends to rely on secondary sources or (auto)biographies for the illuminating quotes or letters that appear throughout. There were, however, places where one might have hoped for more direct engagement with recent literature: Jessica Riskin's *Restless Clock* (Chicago, 2016), for instance, covers many of the figures and themes in early chapters of *Animal as Machine* but does not make an appearance; Richard Burkhardt's *Patterns of Behavior* (Chicago, 2005), relevant for later discussions of ethology's relation to physiology, is also absent.

The conclusion ends by discussing continuing areas of research in comparative animal physiology, such as evolutionary and developmental physiology (dissertation topics for future historians), revealing how active this world of study still is. Yet, as Anctil notes, despite manifold animals who adapted admirably to life within extreme environments, physiologists today spend much of their time focusing on animal responses to human-made environmental destruction. He ends with optimism that this condition will be reversed, allowing continued appreciation of the beauty of animals at work. We, his readers, join heartily in this hope.