

The fourth case study bookends the first by returning to the domain of the spiritual. It is about the development of dianetics by the science fiction writer L. Ron Hubbard, as a therapeutic self-help technique, and its transformation into Scientology. This chapter brilliantly illustrates the tensions between science and pseudoscience as they manifest in attempts to come up with objective measures. It shows that the ability to come up with a technological measurement does not necessarily offer evidence of veridicality. This case study furthermore illustrates the complex intertwinement of the politics of popularization and monetization.

Overall, Bollmer's book offers a far-reaching and engaging study of four moments in the history of the emotions. It highlights as yet underappreciated connections between traditions of spiritualism, aesthetics, education, therapy and measurement. It is not a comprehensive survey – but it is not meant to be. This is, in some ways, a strength of the work insofar as it opens up space for further investigation. This book will be of interest to anyone working in the history and philosophy of the human sciences, and especially to anyone curious about how measurement shapes our lives.

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

**Montreal: McGill-Queen's University Press, 2022. Pp. 334. ISBN 978-0-2280-1053-1. CS\$49.95 (cloth).**

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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.

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## **Karl S. Matlin, *Crossing the Boundaries of Life: Günter Blobel and the Origins of Molecular Cell Biology***

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At first glance, Karl Matlin's *Crossing the Boundaries of Life* appears to be a straightforward history of the emergence and impact of Günter Blobel's work on cell signaling pathways. Carried out in the 1970s, Blobel's experiments articulated how cellular parts functioned within the cell, linking specific proteins and their activity to localized cell organelles. The profundity of the work earned Blobel the Nobel Prize in 1999. How Blobel uncovered these mechanisms, which involved generating new experimental designs such as the cell-free assay and linking the activity of cell parts with the products they generated, is certainly deserving of a detailed historical analysis, and motivates much of the narrative in the book. However, Matlin has bigger ambitions than simply tracing the genesis and impact of Blobel's discoveries. Rather, Matlin suggests that a close analysis of Blobel's work and its influence, which retained a vision of the cell as a whole while articulating the functions of proteins acting within them, undermines the post-Second World War narratives that have given primacy to the rise and importance of molecular biology. Instead, he argues that molecular cell biology, which practised a new way of approaching and uncovering cellular mechanisms, transformed much of the biological sciences, many of which still retain the essential epistemic practices that Blobel perfected. In doing so, Matlin makes the case that cell biology, not molecular biology, should be seen as having most enduring legacy of the twentieth-century biological sciences.

*Crossing Boundaries* is divided in ten chapters grouped into three unequal parts. The first three chapters make up Part 1, 'The cytologist's dilemma', which sets up the problems of linking form, function and the essence of life within the cell itself. Part 2 comprises Chapters 4 to 8, and traces how cytologists moved from examining cells as wholes to teasing out how cell organelles and associated molecules worked within the cell itself. The final two chapters and the epilogue are grouped into the third part, 'Form redux', which not only outlines the ways in which Blobel's approach can still be found in