The Engineering Ideal: Loeb's Ghost, or Something Else?

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LUIS A. CAMPOS, *Radium and the Secret of Life*. Chicago: University of Chicago Press, 2015. 378 pp., illus., index. ISBN 978-0226418742. $35.00 (paper).

HELEN ANNE CURRY, *Evolution Made to Order: Plant Breeding and Technological Innovation in Twentieth Century America*. Chicago: University of Chicago Press, 2016. 285 pp., illus., index. ISBN 978-0226390086. $55.00 (cloth).

SOPHIA ROOSTH, *Synthetic: How Life Got Made*. Chicago: University of Chicago Press, 2017. 251 pp., illus., index. ISBN 978-0226440460. $35.00 (paper).

"In the past two decades, biotechnology has aroused more interest than almost any other aspect of the scientific enterprise."[1] Though that sentence could easily be the opening of any recent book on the history of the biosciences, it was actually how Philip Pauly began his 1987 *Controlling Life: Jacques Loeb and the Engineering Ideal in Biology*. In the opening paragraphs, Pauly argued that the contemporary discourse surrounding biotechnologies—whether scientists were "playing God" in a totally new way or that it was a natural progression of the field—has historical roots. These roots were not just long-standing cultural reference points of Frankenstein and Faust, but rather philosophical and experimental ones imbedded in scientific practice itself. Pauly, of course, saw an origin story of sorts in the life and work of Jacques Loeb, an important

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1. Philip Pauly, *Controlling Life: Jacques Loeb and the Engineering Ideal in Biology* (Oxford: Oxford University Press, 1987), 3.

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late-nineteenth and early-twentieth century biologist who was well-known during his lifetime, and yet a figure whose life had been unexplored by historians.

Loeb, more than anyone else, Pauly claimed, consciously embodied the "engineering ideal" in biology. That is, Loeb believed that the goal of biology was to control nature. Experiments should be "demonstrations of the manipulative power of biologists," Pauly wrote of Loeb's approach.[2] In the early twentieth century Loeb's philosophy of control was one of the many markers of his outsider status in the field. However, Pauly argued that Loeb's philosophy came to dominant biology over the course of the century, eventually thriving in the post-recombinant-DNA world. Reviewers in the late 1980s and early 1990s made note of Pauly's argument regarding the engineering ideal, but often focused more on praising the biographical treatment of Loeb and the contexts of science at the turn of the century. Ruth Schwartz Cowan, however, did commend the book for demonstrating a long history of control, and recognized that "if we had but the eyes to see we would know that Loeb's legacy is now with us at every turn."[3]

More so than its fin-de-siècle insights, this latter sentiment regarding the engineering ideal in modern biology has become by far the dominant legacy of the book. After Pauly's untimely death in 2008, Jane Maienschein reflected that *Controlling Life* was "ahead of its time" and that she found "additional richness" in rereading it.[4] As I pick Pauly up today, I agree with such an assessment in many ways. For Maienschein, the legacy of Loeb's control could be seen in the cutting-edge regeneration research of the early twenty-first century, in which larger social institutions have sought to instantiate the goals of control that Loeb a hundred years earlier idealized. Many scholars have also seen Pauly's work to be an explanatory framework for contemporary bioscience. Karen Rader, in a recent example, described the work of scholars who have "further developed Philip Pauly's important early insights about how Jacques Loeb's 'engineering life' ethos infused a generation of laboratory projects in biology."[5] As I have shown in my own work, similar goals to illuminate

2. Ibid., 5.

3. Ruth Schwartz Cowan, review of *Review of Controlling Life: Jacques Loeb and the Engineering Ideal in Biology*, by Philip J. Pauly, *The American Historical Review* 95, no. 4 (1990): 1154–55.

4. Jane Maienschein, "Controlling Life: From Jacques Loeb to Regenerative Medicine," *Journal of the History of Biology; Dordrecht* 42, no. 2 (May 2009): 215–30.

5. Karen A. Rader, "Introduction to the Special Issue, Biology and Technology Reframed: Historiographical Reflections and Opportunities," *History and Technology* 35, no. 4 (2 Oct 2019): 366–73.

long-standing themes in modern biotechnology has motivated many histories since the first wave of scholars tackled the topic in the 1980s.[6] Yet, as historians we are also leery of suggesting that nothing is new, that contemporary moments are simply recapitulations of older ones. In our classrooms we fight against that idea that we study history so that we are not doomed to repeat it because, we argue, contexts matter. The tension between invoking long-standing themes and differentiating the work from the past is baked into histories of late-twentieth century biosciences, and historians often invoke concepts of control and the engineering of life in our analysis of them. Such tensions have inspired me to question the usefulness of the descriptive framework of engineering life.

Several recent historians have deployed novel approaches to understanding and resituating the themes of control and engineering of life, offering a chance for us to reflect on how we deploy the engineering ideal and its history. Luis A. Campos's *Radium and the Secret of Life*, Helen Anne Curry's *Evolution Made To Order*, and Sophia Roosth's *Synthetic: How Life Got Made* represent an array of thematic and chronological approaches that suggest we should we be wary of invoking Loeb's ghost outside of his time and place.

NEW SOURCES OF INSPIRATIONS AND METAPHORS

Unlike many other histories that make claims of extending Pauly's idea of engineering life into later periods of the twentieth and twenty-first century, Luis Campos's *Radium and the Secret of Life* (2015) resituates the origin story of those conceptions. Campos weaves the story of radium through history of physics, classical genetics, and debates about the origin of life and the nature of mutations. The central focus, however, is on the discourses and metaphors that surround radium and life. It may not be his main goal, but Campos's work showcases other ways in which the language of control and engineering penetrated the life sciences beyond Loeb's work.

Campos's book follows a succession of stories that are broadly chronological, beginning with radium's discovery and moving through the half-life, as he calls it, of the association between radium and life. These connections, which were rich and inseparable in the initial moments of radium's history, slowly

6. Nathan Crowe, "The Historiography of Biotechnology," in *Handbook of the Historiography of Biology*, ed. Michael Dietrich, Mark Borrello, and Oren Harman (New York: Springer, 2019).

deteriorated over the twentieth century, becoming only faint echoes by the time molecular biology rose to prominence.

Both the chronology and the actors sometimes take a back seat to the thick description of the metaphors and discourses that permeate Campos's work. This is part of Campos's goal, though it can be hard to digest at times. What he achieves is to show just how deeply the language of manipulation permeated the biological and popular consciousness of the period. It was a discourse of control broadly conceived, and one in which radium became a focal point. Campos dives into the work of Hermann J. Muller, for instance, a figure that Pauly himself pointed to as an acolyte of Loeb's engineering ideal. Here, Campos provides an additional source for Muller's scientific philosophy, situating him in the half-life of radium rather than, or in addition to, the genealogy that Pauly places him within.

Loeb himself makes a small appearance in Campos's book, providing a crucial counter argument to the University of Cambridge physicist John Butler Burke, who sought to use radium to uncover the secrets of the generation of life. Campos notes that Loeb rejected Burke's claims for multiple reasons, not the least of which was Burke's overuse of metaphorical language in his biological descriptions. Despite this disagreement, Campos says that the popular press lumped both Loeb and Burke together in the early twentieth century as manipulators and creators of artificial life. Pushing back, Campos argues that there was a key difference between the two: Loeb sought control over life, whereas Burke desired the production of it (83).

Differentiating between these positions is relevant in many ways, though ultimately Campos's project reveals that the discussions, metaphors, and meanings of control and production were rife in the early part of the twentieth century, and it was difficult for many people of the time to differentiate between control and production. Varied influences made these discussions not just an experimental biology that had become focused on explicating function over form, as it has classically been construed. New discoveries in nature—in this case, radium—and a changing cultural understanding of science and technology at the turn of the century also played vital roles in reinforcing the values of control and engineering in the life sciences. What Campos's work does is to uncover another context in which these concepts worked their way into the *zeitgeist*. Whereas Loeb became inspired by a specific engineering ideal from his German mentors, Campos depicts a concept of control that emerged from the very nature of radium itself. Inspired by its promises, several of Campos's characters believed that radium could be used

to direct and create biological change in a way that provided more than an illusion of control.

Pauly argued that Loeb embodied a particular goal for the life sciences, one that often set him apart from his peers but would become a dominant thread as the century went on. Here, Campos's work reinforces that such ideas took shape during the late nineteenth and early twentieth centuries, but their origins should not be necessarily derived from Loeb himself—that these ideas, as Campos would say, had their own half-life that permeated the rest of the century.

CONTROLLING EVOLUTION IN THE MIDDLE OF THE TWENTIETH CENTURY

Helen Anne Curry's story of plant breeding innovations in the middle of the twentieth century is in many ways an amalgamation of Pauly's work on engineering life and Campos's history of radium. Curry's *Evolution Made to Order* (2016) examines the transformation of, or at least the promises to transform, American agriculture in the middle decades through the application of radiation technologies. The x-ray, as Curry shows, offered plant breeders promising ways to control the production of new varieties. Industrial plant breeders, academic geneticists, horticulturalists, and farmers all took part in deploying these technologies in novel ways. Many of these attempts failed to live up to the hype, never leading to the agricultural advances that have come to dominate our modern conceptions of genetically modified plants. However, as Curry points out, "breeders, geneticists, and observers of the twentieth century" did believe that these technologies would create real change and thus she has rightfully investigated their history (9).

Curry's book begins with the promise of x-rays in the 1920s to solve inherent questions about the role of mutations in evolution. It moves through their adoption into industry and explores how they became integrated into the global technological systems surrounding the atom. Curry's x-rays, however, are not those of Campos, which lived far more in a world of metaphors and discourses. Rather, Curry situates these manipulative technologies within the history of innovation. In doing so, she integrates histories of technology with genetic manipulation, a topic that has too often been embedded simply within the historiographies of biology. Curry is thus able to demonstrate a wide variety of actors, motivations, and importantly

contexts in which x-rays and related technologies were used to manipulate and control plant breeding. Her book is a welcome addition to the history of biotechnology as it continues to expand the interpretative lenses that can be brought to bear on these topics.

Curry recognizes that her story resides within a longer history of biological control, pointing to the histories of Pauly and Campos as places where the reader could go to find earlier beginnings. However, the strength of Curry's work lies in the innovative connections she builds between plant breeders and the technological systems of the middle decades of the twentieth century, rather than an extension of earlier conceptions of control and engineering. Her narrative depicts the swift uptake of radiation-based technologies by farmers, plant breeders, horticulturalists, and scientists at national laboratories in America and around the world. The ease by which this happened, Curry shows, was dependent on the larger technological systems that dominated these decades. The political investment into atomic power, for instance, created spaces in which innovations flourished. One certainly gets the sense that without these larger techno-scientific contexts, there would have been far less interest or motivation in developing radiation-generated flowers for amateur gardeners, to use one of her examples.

Curry, in other words, demonstrates that the contexts, desires, and means of control were highly specific. The political push to maximize the investment into atomic infrastructure and the ability to market irradiated seeds as novel rather than potentially dangerous only lasted a short period of time. People became increasingly skeptical of radiation-connected technologies as the 1960s wore on, and though such technologies once held the key to controlling plant genes to suit the pleasure of horticulturalists, by the end of the 1970s the molecular methods of recombinant DNA became the next best thing in plant breeding, and the power of x-rays became passé.

Despite examples of scientists exerting control over life, in her epilogue Curry illustrates that there was a real difference between the ways in which plant breeders and the public understood using x-rays to transform marigolds in the 1940s versus the ways in which geneticists and the public understood the genetic modification of tomatoes in the 1990s. Curry argues that the broader connection between these histories is not necessarily a long history of control, but rather in the way that Americans have constantly sought the "quick and easy route to innovating living things," and in general she observed that "researchers hoping to find tools for altering genes looked immediately to those technologies newly dominant elsewhere in America" (215).

SYNTHETIC BIOLOGY: CONTROL IN OUR CONTEMPORARY MOMENT

For many, the twenty-first century endeavor to build living systems, often dubbed "synthetic biology," best encapsulates the philosophy of control over life. For those engaged in the goal of designing and building something that can be said to be alive, such work, they believe, will lead to new knowledge about life itself. In *Synthetic: How Life Got Made* (2017), Sophia Roosth draws upon anthropological and ethnographic methods to examine the goals of a select group of synthetic biologists as they attempt to gain knowledge about life by making it. Here, in this context, Roosth shows how her synthetic biologists not only engage with concepts of control and engineering of life, but essentially embody these values, becoming such proselytizers of the philosophy that the very definitions of life become blurred in their work. Roosth claims that a core goal of her work "queries what synthetic biologists mean by 'life'" (23).

Roosth's account is focused mostly in the contemporary moment, bringing to bear her ethnographic experience in specific laboratories as a way to examine the intellectual commitments of her subjects. The chapters are not chronological, but rather examine individual themes in an effort to analyze and deconstruct the work of synthetic biologists. This means that she sometimes, for example, ties the language of design and engineering to the early twenty-first century cultural wars surrounding the Intelligent Design movement, and in other chapters articulates the economic structures that differentiate design and manufacturing in the work of synthetic biologists and the larger political economy. Neither the themes nor her subjects are fully representative of synthetic biology as a whole, but the work suggests that several different frameworks could be used to analyze the genre.

Roosth's account is historically informed, rather than driven by historical methodologies, and thus she makes connections to the past, though these are often chosen for inspirational reasons rather than dictated by a coherent historical argument. The chapters are interspersed with short, thought-provoking interludes in which Roosth engages with one of the multiple historical meanings of "synthetic." Such a structure demonstrates that synthetic biology draws on a multitude of meanings.

In the introduction, Roosth acknowledges that "synthetic biology is the latest instantiation of a centuries-long debate as to whether nature may be known through artifice" (5). Moreover, she points to a familiar figure as an

important beginning. "Perhaps the closest philosophical forebear of synthetic biology was the German American biologist Jacques Loeb," Roosth writes, and immediately quotes Pauly, who described in 1987 Loeb as "consider[ing] the main problem of biology to be the production of the new, not the analysis of existent."[7] For Roosth, this directly resonates with her experiences with the synthetic biologists. However, Roosth does not dwell on the historical connection that might link Loeb to synthetic biology. Instead, she draws heavily from the immediate contexts to explain many of the actors' choices. For example, Roosth demonstrates the impact of the contemporary religious discourse on MIT engineer Drew Endy's conscious rejection of the word "create" in favor of "construct" to describe his work with the T7 bacteriophage (24). It is through such connections that Roosth eventually declares that "this approach to making and knowing life that was inaugurated by synthetic biology inhabits a different sort of epistemic space than other methods typical of the life sciences" (175). The lack of historical argument makes this assertion difficult to accept, but Roosth has shown multiple ways in which synthetic biologists embody their particular contemporary moment, and will be a good source for future historians of the field.

CONCLUSION: RETHINKING THE POWER OF CONTROL

Together, these books should give us pause in assuming a Loeb-ian ideal of control and engineering has permeated the twentieth and twenty-first century biosciences. Scientists certainly have been manipulating, tinkering, constructing, and building life in a myriad of ways since Loeb, but invoking his ghost can inadvertently obscure some of the important details that need to be accentuated. The ways in which Roosth draws from a wider contemporary pool of meaning to deconstruct the discourses of synthetic biology reinforces Campos's and Curry's larger arguments. The concepts of control and manipulation that they develop are deeply representative of a particular time and place. Saying, of course, that context matters, may sound trite as it is one of the bedrocks of the historical profession. However, the influence of the historiography of biotechnology has pushed historians to look for longer histories of control and engineering. Jean-Paul Gaudillière categorized this

7. Pauly, *Controlling Life* (ref. 1), 7–8; as quoted in Roosth, *Synthetic*, 6.

as the "continuity" narrative, and there is much to be said for understanding the historical threads at work in the late-twentieth century biosciences.[8]

Yet the work of Campos, Curry, and Roosth should encourage us to be more self-conscious about the ways in which we employ the analytical power of control in the biosciences. Interestingly, both Curry and Campos provide stories that have not simply become obscured, but faded in relevance. The technological systems for which plant breeders became intertwined no longer dominate the landscape as they did in the middle of the twentieth century, and the half-life of radium ran its course. Articulating the ways in which these scientists tried to manipulate the biological world allowed Campos and Curry to understand aspects of that time and place that historians had previously overlooked, and they did not have to make it a part of a long history of control to do so.

In this self-described postgenomic age, ideas of control can perhaps be more powerful if we use them to uncover stories about the specific contexts in which they emerged and the people who employ them rather than using them to gesture to a long-standing past and assume their power to be long-standing in the future. Pauly's work has been one of the most inspirational books for me as a young scholar. Over time, however, my appreciation of it has come to mirror much of the initial praise that reviewers had for *Controlling Life*: that is, as an invaluable contribution to the understanding of late-nineteenth and early-twentieth century biology in America rather than seeing it as The Beginning of a monolithic idea of control over life.

8. Jean-Paul Gaudillière, "New Wine in Old Bottles? The Biotechnology Problem in the History of Molecular Biology," *Studies in History and Philosophy of Biological and Biomedical Sciences* 40, no. 1 (March 2009): 21.