Philosophical Lessons from Scientific Biography*

Alan C. Love[†‡]

Robert J. Richards, ***The Tragic Sense of Life: Ernst Haeckel and the Struggle over Evolutionary Thought***. Chicago: University of Chicago Press (2009), 576 pp., 8 color plates, 122 halftones, $25.00 (paper).

If we set aside personal edification, what reasons remain for a philosopher of science to study the intellectual biography of a famous (or infamous) scientist? This question raises familiar and perhaps tired arguments about the relationship between history of science and philosophy of science, but it is also practical: why take the time to digest almost 600 pages devoted to the controversial German zoologist Ernst Haeckel? A preliminary answer is the author. The historical investigations of Robert Richards have been of ongoing interest to philosophers, whether it be evolutionary explanations of mind and behavior in the nineteenth century (Dennett 1989) or his contentious claims—reinvigorated in the present volume—about Darwin's commitment to embryonic recapitulation (Lennox 1994). Richards has a knack for unearthing details germane to conceptual reflection, in no small part because of his own philosophical predilections (e.g., a selection model of scientific theory development). Here I entertain three more reasons to follow the injunction *tolle lege*: the prescient synthesis exemplified in Haeckel's evolutionary theorizing, the impact of model organism choice, and the critical role of pictures in scientific reasoning accented by Haeckel's artistic proclivities.

In *The Tragic Sense of Life*, Richards elaborates on the Romantic

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†To contact the author, please write to: Department of Philosophy, 831 Heller Hall, 271 19th Ave. S., Minneapolis, MN 55455-0310; e-mail: aclove@umn.edu.

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biology he has described more broadly (Richards 2002) within the concrete context of Ernst Haeckel's life (1834–1919). Haeckel's character formation, psychological drama, and scientific achievement compose a seamless garment that embodies Romantic biology's transformation through the nineteenth century. Richards follows Haeckel through his formative years (influenced by luminaries such as Goethe, Humboldt, and Darwin) into medical school, when he began to investigate the marine invertebrates that would establish his reputation as a zoologist. Though tempted by a bohemian life in the face of unrivaled and maddening biological diversity ("not only was he delivered of unusual species and genera, but of whole families, orders, and classes never before described" [63]), Haeckel's workhorse mentality took the upper hand and focused him like a laser on radiolarians (single-celled marine organisms with secreted silica skeletons; fig. 1). An 1860 article, his 1861 *Habilitationschrift*, and then an award-winning two-volume monograph all followed in short succession. This work launched Haeckel's meteoric academic trajectory at Jena, where he blended scientific and aesthetic sensibilities (inspired in part by Kant's *Critique of Judgment*) into an attractive and inspiring concoction for students that also included intermittent exotic travel to collect new specimens.

Inspired to demonstrate Darwin's argument for common descent empirically with marine invertebrates, Haeckel integrated evolutionary and developmental themes in his biological theorizing. In particular, he combined the *functional* reasoning of Darwin's explanation of adaptation in terms of natural selection with *structural* (or form) reasoning that utilized comparative anatomy and embryology to establish relationships of homology and demonstrate lawlike, evolutionary transformations of morphology. Although Haeckel was often criticized as a mere popularizer peddling a bastardized version of Darwinism, his marine invertebrate research remains a touchstone for contemporary biologists, and Darwin himself affirmed Haeckel's perspective: "I am delighted that so distinguished a naturalist should confirm & expound my views; and I can clearly see that you are one of the few who clearly understands Natural Selection" (Darwin to E. P. A. Haeckel, March 9, 1864, http://www.darwinproject.ac.uk/entry-4422). Haeckel undertook experiments in which he artificially cultured embryos, modified their environmental conditions, and physically divided cells to assess their potential for regeneration. He also used geometrical considerations to hypothesize morphological transitions in spherical radiolarians (an approach that would become famous in the hands of D'Arcy Thompson). Although Haeckel's theoretical framework was tinged with commitments to progress and racial hierarchy, ubiquitous in the nineteenth century, its synthesis of form and function is an exemplar with continuing relevance for integrating disciplinary approaches in evolutionary biology (Laubichler and Maienschein 2009).

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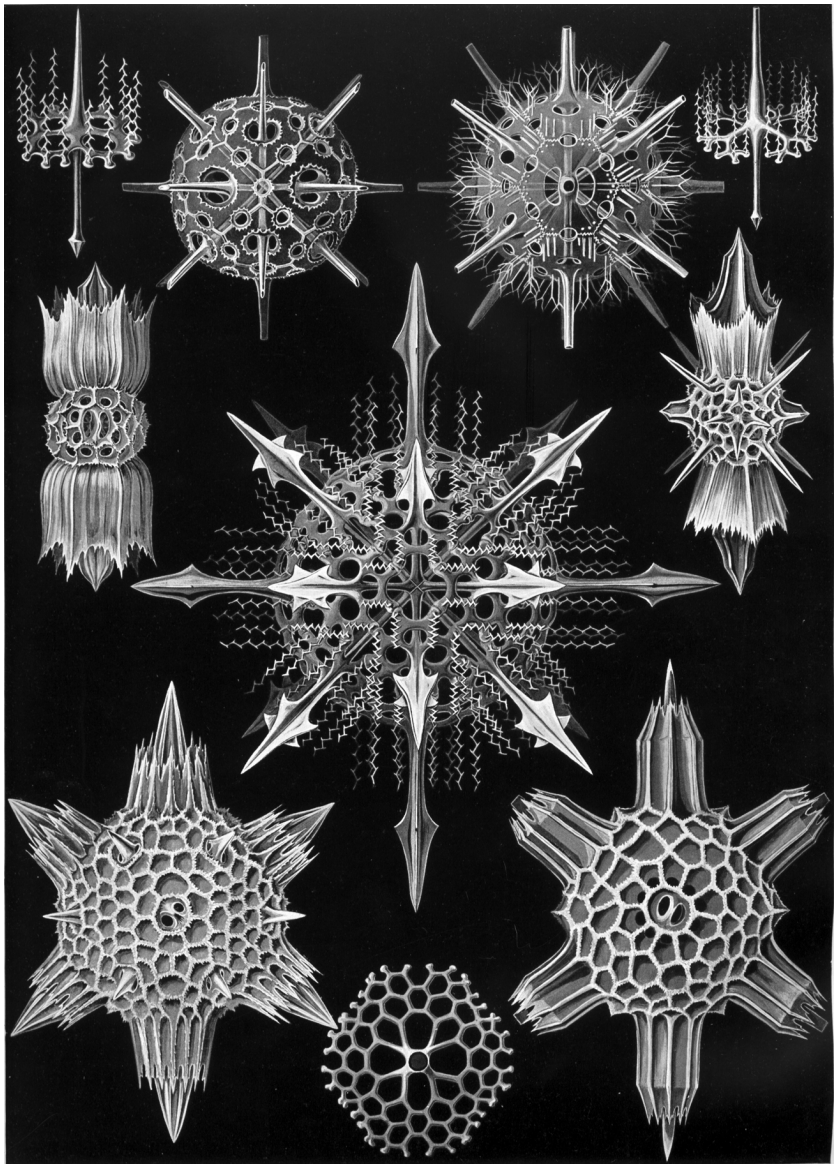


Figure 1. Acanthophracta radiolarians. Plate 41 from Haeckel's *Kunstformen der Natur* (1904); http://commons.wikimedia.org/wiki/File:Haeckel_Acanthophracta.jpg.

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A second philosophical issue, closely related to Haeckel's integrative methodology, is the epistemic impact of model organism choice in biological investigation. The marine invertebrate diversity that nearly paralyzed Haeckel metamorphosed into his signature strength. (All 4,000 HMS *Challenger* species of radiolarians were turned over to Haeckel; he analyzed them in almost 2,000 pages of text and figures, solidifying a classification system still in use today.) Marine invertebrates exhibit a variety of features that encourage a developmental perspective on evolutionary change, such as complex life histories with baroque larval forms, asexual propagation, colonial organization, and amazing regenerative potential. Haeckel was on a 'first-name' basis with these taxa, in part because he was the first to give them names. Throughout the twentieth century, marine invertebrate organisms fell out of favor in evolutionary research, which partially explains why the modern evolutionary synthesis had little interest in morphology and development (Love 2009). The epistemic impact of marine invertebrate models ranges further because it connects to current debates about the nature of biological individuality, especially heterogeneous, nested, and interspecific functional arrangements. Haeckel canvassed these in detail when investigating siphonophores (e.g., the Portuguese man-of-war) and distinguished three kinds of individuality: morphological, physiological, and genealogical.

Skillfully interwoven among the descriptions of Haeckel's research are the details of a physically vigorous (mountain climbing, gymnastics) and larger-than-life personality (with suicidal tendencies) that was driven to defend a Darwinian worldview in the face of personal tragedy—the premature death of his first wife and soul mate, Anna Sethe (on his thirtieth birthday when he received word of the award for his radiolarian monograph). He drowned his sorrow with 18-hour workdays for a year to produce his massive, two-volume evolutionary paradigm: *Generelle Morphologie der Organismen* (1866). Although Haeckel was a recognized expert on marine invertebrates and master wordsmith (coining terms such as 'ecology', 'phylogeny', 'gastrulation', and 'ontogeny'), the acidic and antireligious tone of *Generelle Morphologie*—the one thing Darwin complained about in Haeckel's work—found its way into more popular writings, such as *Natural History of Creation* (1868), and launched him into the public sphere as *the* defender of 'Darwinian' materialism and atheism.

Haeckel's colleagues objected that he indulged in speculation rather than using original research, problematically invoked teleological reasoning (the functional orientation favored by Darwin), and utilized phylogenetic (historical) factors to explain ontogeny. The latter criticism was aimed at the biogenetic law or recapitulation ('ontogeny recapitulates phylogeny') for which Haeckel is remembered today, though he did not invent the idea. The embryologist Wilhelm His took issue with this ap-

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proach, preferring to cite the proximate causal interactions of individual embryonic parts. Haeckel saw the methodological difference clearly: "I depart fundamentally from the explanatory path of His. I turn to phylogeny to clarify the historical origin of the different forms of growth and seek their completely sufficient explanatory foundation in the mutual causality of inheritance and adaptation. His holds this 'roundabout way' to be utterly superfluous and seeks to clarify ontogeny directly from itself" (299).

More damning were the accusations of outright fraud. Haeckel had accidentally replicated the same woodcut of embryos under three distinct labels and inelegantly argued that a panel of vertebrate embryos constituted evidence rather than being an illustration. Once highlighted, these accusations grew to epic proportions and remain with us today (Pennisi 1997). But Richards shows how Haeckel's aesthetic sensibility and distinct aims for different pictorial representations blunt these accusations. There was not a single set of evaluative standards because these pictures were put to diverse uses: evidential, classificatory, or illustrative. Each type of use governed decisions about the appropriate level of detail (idealizations), artistic license, source material, and size normalization (see also Hopwood 2006). Once recognized, these diverse uses underline Haeckel's introduction of other novel, visual formats, such as the stem-tree, which could encapsulate genealogical relations, temporal distance, and morphological differences in a single diagram. Distinct formats serve different ends and should be evaluated according to different sets of theoretical *and* aesthetic standards (fig. 1). The diverse roles for pictures in science, including their variable standards of evaluation, remain much less studied than the question of how they come to be representational at all (Kulvicki 2010).

Haeckel was not shocked by public dissent; he intentionally picked a fight. He imbued his discussions of evolution with a philosophical monism meant to counteract any orthodox religion, leading to totalizing claims that were inflammatory. (Haeckel endorsed a Romanticism-tinted metaphysical monism: mind and matter are manifestations of a more fundamental nonpersonal substratum, and there is no essential line between living and nonliving.) Since the majority of the world prior to the First World War learned of Darwinism from Haeckel's writings, anyone uncomfortable with its purported consequences targeted him. Haeckel's stress on human evolution, inflected with a form of eugenic thought common to the time, brought detractors out of the woodwork. Richards recounts several of these episodes, including Rudolf Virchow's hyperbolic charge that evolutionary theory was nonscientific, co-traveling with communism and socialism, and Haeckel's extended exchange with the Jesuit entomologist Erich Wasmann.

A major accomplishment of this book is a near conclusive debunking

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of the myth—promulgated by biologists, historians, and religious critics—that Haeckel provided the intellectual foundations for Nazism and its racial extermination practices. This false legacy has clouded Haeckel's significance. But Haeckel did not embrace anti-Semitism, in contrast to some contemporaries, and thought Jews were on the same level as other Europeans in his (now objectionable) hierarchical classification of races. Later, the National Socialist Party's Department of Race Politics expressly rejected an association with Haeckel's brand of monism.

The Tragic Sense of Life artfully depicts the complexity of Haeckel's scientific contributions, personal demons, and manifold duels, exposing what subsequent history has papered over and correcting egregious errors. Most impressively, Haeckel's scientific prowess shines through. As in the past, the historical explorations offered by Richards uncover a variety of conceptual issues, some of which cry out for more attention (e.g., evaluative standards for pictorial evidence and diagrams). This is not to say that every historical interpretation survives scrutiny, and Richards sometimes overreaches (Hopwood 2009); the ambition of convincingly showing the centrality of a Romantic conception of life for nineteenth-century biology will remain contested. But agreement on these matters is unnecessary to experience the philosophical provocation lodged in this riveting history. Working with ample narrative material, executed with well-crafted prose, and always delivered with impeccably wry humor (look for the prehistoric burgher family), the book provides reason enough for a philosopher of science to make the practical decision: take up and read.

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