

Chapter 1: Introduction

In late winter of 1864, Charles Darwin received two folio volumes on radiolarians, a group of one-celled marine organisms that secreted skeletons of silica having unusual geometries. The author, the young German biologist Ernst Haeckel, had himself drawn the figures for the extraordinary copper-etched illustrations that filled the second volume.¹ The gothic beauty of the plates astonished Darwin (see, for instance, plate 1), but he must also have been drawn to passages that applied his theory to construct the descent relations of these little-known creatures. He replied to Haeckel that the volumes "were the most magnificent works which I have ever seen, & I am proud to possess a copy from the author."² A few days later, emboldened by his own initiative in contacting the famous scientist, Haeckel sent Darwin a newspaper clipping that described a meeting of the Society of German Naturalists and Physicians at Stettin, which had occurred the previous autumn. The article gave an extended and laudatory account of Haeckel's lecture defending Darwin's theory.³ Darwin immediately replied in

¹Ernst Haeckel, *Die Radiolarien. (Rhizopoda Radiaria.) Eine Monographie*, 2 vols. (Berlin: Georg Reimer, 1862).

²Charles Darwin to Ernst Haeckel (3 March 1864), in Correspondence of Ernst Haeckel, in the Haeckel Papers, Institut für Geschichte der Medizin, Naturwissenschaft und Technik, Ernst-Haeckel-Haus, Friedrich-Schiller-Universität, Jena. The letter has recently been published in *The Correspondence of Charles Darwin*: vol. 12: 1864, ed. Frederick Burkhardt et al (Cambridge: Cambridge University Press, 2001), p. 61. For a calendar of Haeckel's correspondence, see Uwe Hoßfeld and Olaf Breidbach (eds.), *Haeckel-Korrespondenz: Übersicht über den Briefbestand des Ernst-Haeckel-Archivs* (Berlin: Verlag für Wissenschaft und Bildung, 2005).

³[Anonymous], "Vorträge Ernst Haeckels," *Stettiner Zeitung* (nr. 439), Sept. 20, 1863. The author began: "The first speaker [Haeckel] stepped up to the podium and delivered to rapt attention a lecture on Darwin's theory of creation. The lecture captivated the auditorium because of its illuminatingly clear presentation and extremely elegant form." The author then gave an extensive précis of the contents of the entire lecture. He concluded by reporting that "a huge applause followed this exciting lecture."

a second letter: "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."⁴ Darwin recognized in the young Haeckel a biologist of exquisite aesthetic sense and impressive research ability, and, moreover, a thinker who obviously appreciated his theory.

Haeckel would become the foremost champion of Darwinism not only in Germany but throughout the world. Prior to the First World War, more people learned of evolutionary theory through his voluminous publications than through any other source. His *Natürliche Schöpfungsgeschichte* (Natural history of creation, 1868) went through twelve German editions (1868-1920) and appeared in two English translations as *The History of Creation*. Erik Nordenskiöld, in the first decades of the twentieth century, judged it "the chief source of the world's knowledge of Darwinism."⁵ The crumbling detritus of this synthetic work can still be found scattered along the shelves of most used-book stores. *Die Welträttsel* (The world puzzles, 1899), which placed evolutionary ideas in a broader philosophical and social context, sold over 40,000 copies in the first year of its publication and well over fifteen times that during the next quarter century—and this just in the German editions.⁶ (By contrast, during the three

⁴Charles Darwin to Ernst Haeckel (9 March 1864), Haeckel Correspondence, Haeckel-Haus, Jena; *Correspondence of Charles Darwin*, 12: 63.

⁵Erik Nordenskiöld, *The History of Biology* (New York: Tudor Publishing, [1920-1924] 1936), p. 515.

⁶See the introduction to a modern edition of Haeckel's *Die Welträttsel*, ed. Olof Klohr (Berlin: Akademie Verlag, 1961), pp. vii-viii. See also, Erika Krausse, "Wege zum Bestseller, Haeckels Werk im Lichte der Verlegerkorrespondenz: Die Korrespondenz mit Emil Strauss," *Der Brief als wissenschaftshistorische Quelle*, ed. Erika Krausse (Berlin: Verlag für Wissenschaft und Bildung, 2005), pp. 145-70 (publication details on pp. 165-66).

decades between 1859 and 1890, Darwin's *Origin of Species* sold only some thirty-nine thousand copies in the six English editions.)⁷ By 1912, *Die Weltr thsel* had been translated, according to Haeckel's own meticulous tabulations, into twenty-four languages, including Armenian, Chinese, Hebrew, Sanskrit, and Esperanto.⁸ The young Mohandas Gandhi had requested permission to render it into Gujarati; he believed it the scientific antidote to the deadly wars of religion plaguing India.⁹

Haeckel achieved many other popular successes, and, as well, produced more than twenty large, technical monographs on various aspects of systematic biology and evolutionary history. His studies of radiolarians, medusae, sponges, and siphonophores remain standard references today. These works not only informed a public, they drew to Haeckel's small university in Jena the largest share of Europe's great biologists of the next generation, among whom were the "golden" brothers Richard and Oscar Hertwig, Anton Dohrn, Hermann Fol, Eduard Strasburger, Wladimir Kovalevsky, Nikolai Miklucho-Maclay, Arnold Lang, Richard Semon, Wilhelm Roux, and Hans Driesch. Haeckel's influence stretched far into succeeding generations of biologists. Ernst Mayr, one of the architects of the modern synthesis of genetics and Darwinism in the 1940s, confessed

⁷See the introduction to *The Origin of Species by Charles Darwin: a Variorum Text*, ed. Morse Peckham (Philadelphia: University of Pennsylvania Press, 1959), p. 24.

⁸Haeckel's charting is in an unnumbered document in the Haeckel Papers, Haeckel-Haus, Jena.

⁹Joseph McCabe to Ernst Haeckel (July, 1909), in Correspondence of Ernst Haeckel, in the Haeckel Papers, Institut f r Geschichte der Medizin, Naturwissenschaft und Technik, Ernst-Haeckel-Haus, Friedrich-Schiller-Universit t, Jena. McCabe, Haeckel's English translator, met Gandhi in London. In his book *Ethical Religion*, which was originally published as articles in early 1907, Gandhi looked to the evolutionary account of morality as demonstrating its ubiquity in nature and its supreme value. See Mahatma Gandhi, *Ethical Religion*, trans. A. Rama Lyer, 2nd ed. (Madras: S. Ganesan, 1922), pp. 49-56.

that Haeckel's books introduced him to the attractive dangers of evolutionary theory.¹⁰

Richard Goldschmidt, the great Berlin geneticist who migrated to Berkley under the treacherous shadow of the Nazis in the 1930s, later recalled the revelatory impact reading Haeckel had made on his adolescent self:

I found Haeckel's history of creation one day and read it with burning eyes and soul. It seemed that all problems of heaven and earth were solved simply and convincingly; there was an answer to every question which troubled the young mind. Evolution was the key to everything and could replace all the beliefs and creeds which one was discarding. There were no creation, no God, no heaven and hell, only evolution and the wonderful law of recapitulation which demonstrated the fact of evolution to the most stubborn believer in creation.¹¹

Haeckel gave currency to the idea of the "missing link" between apes and man; and in the early 1890s, Eugene Dubois, inspired by Haeckel's ideas, actually found its remains where the great evolutionist had predicted, in the Dutch East Indies.¹² Haeckel formulated the concept of ecology; identified thousands of new animal species;

¹⁰Ernst Mayr, personal communication.

¹¹Richard Goldschmidt, *Portraits from Memory: Recollections of a Zoologist* (Seattle: University of Washington Press, 1956), p. 35.

¹²Haeckel speculated that the transition from ape to man via "pithecanthropus alalus" (ape-man without speech) took place in the area of Borneo, Sumatra, and Java. Inspired by Haeckel, Eugene Dubois searched these regions while stationed there as a physician in the Dutch Army. Amazingly, in 1890 and 1891, he discovered in Java the remains of what became known as Homo erectus, certainly the best candidate for the missing link. See Eugene Dubois, *Pithecanthropus erectus, eine menschenähnliche Übergangsform aus Java* (Batavia: Landesdruckerei, 1894); and "Pithecanthropus Erectus--A Form from the Ancestral Stock of Mankind," *Annual Report, Smithsonian Institution* (1898): 445-59.

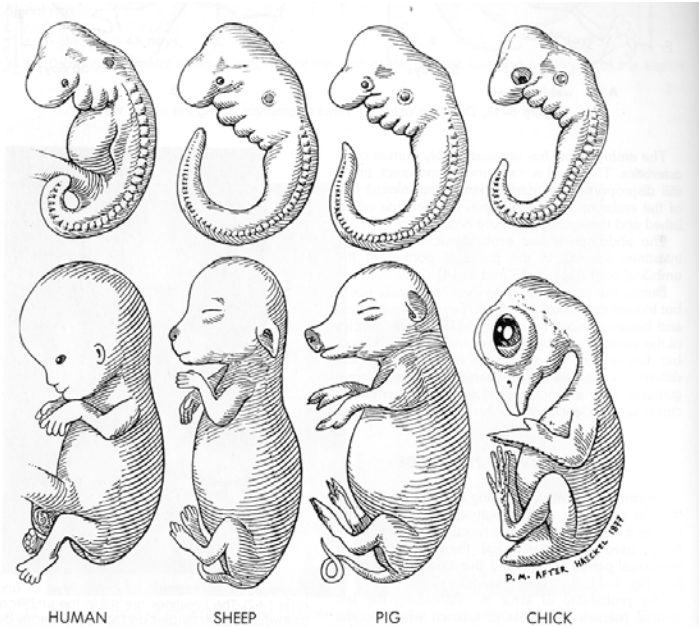


Figure 6–16. Drawings of embryos of four species showing how their early characteristics are similar. By the eighth week, human embryos have distinctive characteristics.

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Figure 1.1: Depiction of different embryos at two stages of development “after Haeckel.” (From Keith Moore’s *Before We Are Born*, 1989.)

established an entire kingdom of creatures, the *Protista*; worked out the complicated reproductive cycles of many marine invertebrates; identified the cell nucleus as the carrier of hereditary material; described the process of gastrulation; and performed experiments and devised theories in embryology that set the stage for the

ground-breaking research of his students Roux and Driesch. His "biogenetic law"—i.e., that ontogeny recapitulates phylogeny¹³—dominated biological research for some fifty years, serving as a powerful research tool that joined new areas into a common field for the application of evolutionary theory. The "law," rendered in sepia tones, can still be found nostalgically connecting contemporary embryology texts to their history (figs. 1.1 and 8.18).¹⁴

Haeckel, however, has not been well loved—or, more to the point, well

¹³Specifically the principle states that the developing embryo of an advanced species passes through the morphological stages of its more primitive evolutionary ancestors—that, for instance, the human embryo begins as a one celled creature, just as our progenitor presumably did hundreds of millions of years ago, and then passes through stages similar to that of an early invertebrate, of a primitive vertebrate (e.g., a fish), of a primate, and finally of a human being.

¹⁴Richardson and Keuck have listed about a dozen text books from the 1980s to the present that have used Haeckel’s embryo illustrations. See Michael Richardson and Gerhard Keuck, “Haeckel’s ABC of Evolution and Development,” *Biological Review* 77 (2002): 493-528; the list is on p. 515.

understood—by historians of science. E. S. Russell, whose judgment may usually be trusted, regarded Haeckel's principal theoretical work, *Generelle Morphologie der Organismen* (General morphology of organisms, 1866), as "representative not so much of Darwinian as of pre-Darwinian thought." "It was," he declared, "a medley of dogmatic materialism, idealistic morphology, and evolutionary theory"¹⁵ Gavin De Beer, a leading embryologist of the first half of the twentieth century, blamed Haeckel for putting embryology in "a mental strait-jacket which has had lamentable effects on biological progress."¹⁶ Peter Bowler endorses these evaluations, and further judges that the biogenetic law "illustrates the non-Darwinian character of Haeckel's evolutionism."¹⁷ Bowler believes Haeckel's theory of evolution ideologically posited a linear and progressive trajectory toward man. Haeckel, he assumes, did not take seriously Darwin's conception of branching descent. Daniel Gasman has argued that Haeckel's "social Darwinism became one of the most important formative causes for the rise of the Nazi movement."¹⁸ Stephen Jay Gould concurred, maintaining that Haeckel's biological theories, supported by an "irrational mysticism" and a penchant for casting all into

¹⁵E. S. Russell, *Form and Function: a Contribution to the History of Animal Morphology* (Chicago: University of Chicago Press, 1982 [1916]), pp. 247-48.

¹⁶G. R. De Beer, *Embryos and Ancestors* (Oxford: Clarendon Press, 1940), p. 97.

¹⁷Peter Bowler, *The Non-Darwinian Revolution* (Baltimore: Johns Hopkins, 1988), p. 83-84. I have argued, on the contrary, that the recapitulational thesis forms the heart of Darwin's own theory of evolution. See Robert J. Richards, *The Meaning of Evolution: the Morphological Construction and Ideological Reconstruction of Darwin's Theory* (Chicago: University of Chicago Press, 1992), pp. 91-166. See also the exchange: Peter Bowler, "A Bridge Too Far," *Biology and Philosophy* 8 (1993): 98-102; and Robert J. Richards, "Ideology and the History of Science," *Biology and Philosophy* 8 (1993): 103-108.

¹⁸Daniel Gasman, *The Scientific Origins of National Socialism* (New York: Science History Publications, 1971), p. xxii. See also, Daniel Gasman, *Haeckel's Monism and the Birth of Fascist Ideology* (New York: Peter Lang, 1998).

inevitable laws, "contributed to the rise of Nazism." Like Bowler, Gould held that the biogenetic law essentially distinguishes Haeckel's thought from Darwin's.¹⁹ Adrian Desmond and James Moore divine the causes of Haeckel's mode of thinking in "his evangelical upbringing and admiration for Goethe's pantheistic philosophy [which] had led him to a mystical Nature-worship at the University of Würzburg."²⁰ German historians of recent times have treated Haeckel hardly more sympathetically. Jürgen Sandmann considers Haeckel and other Darwinists of the period to have broken with the humanitarian tradition by their biologizing of ethics.²¹ Peter Zigman, Jutta Kolkenbrock-Netz, and Gerd Rehkämper—just to name a few other German historians and philosophers who have analyzed Haeckel's various theories and arguments—these scholars have rendered judgments comparable to their American and English counterparts.²²

Could this be the same scientist whom Darwin believed to be "one of the few who

¹⁹Stephen Jay Gould, *Ontogeny and Phylogeny* (Cambridge: Harvard University Press, 1977), pp. 77-81.

²⁰Adrian Desmond and James Moore, *Darwin: the Life of a Tormented Evolutionist* (New York: Norton, 1991), pp. 538-39.

²¹Jürgen Sandmann, *Der Bruch mit der humanitären Tradition: Die Biologisierung der Ethik bei Ernst Haeckel und anderen Darwinisten seiner Zeit* (Stuttgart: Gustav Fischer Verlag, 1990). See also his "Ernst Haeckels Entwicklungslehre als Teil seiner biologistischen Weltanschauung," in Eve-Marie Engels (ed.), *Die Rezeption von Evolutionstheorien im 19. Jahrhundert* (Frankfurt a. M.: Suhrkamp, 1995).

²²See Peter Zigman, "Ernst Haeckel und Rudolf Virchow: Der Streit um den Charakter der Wissenschaft in der Auseinandersetzung um den Darwinismus," *Medizin-Historisches Journal* 35 (2000), 263-302; Jutta Kolkenbrock-Netz, "Wissenschaft als nationaler Mythos: Anmerkungen zur Haeckel-Virchow-Kontroverse auf der 50. Jahresversammlung deutscher Naturforscher und Ärzte in München (1877)," Jürgen Link and Wulf Wülfing (eds.), *Nationale Mythen und Symbole in der zweiten Hälfte des 19. Jahrhunderts* (Stuttgart: Kolett-Cotta, 1991), pp. 212-36.; and Gerd Rehkämper, "Zur frühen Rezeption von Darwins Selektionstheorie und deren Folgen für die vergleichende Morphologie heute," *Sudhoffs Archiv* 81 (1997): 171-92. Uwe Hoßfeld offers a quite different perspective in "Haeckelrezeption im Spannungsfeld von Monismus, Sozialdarwinismus und Nationalsozialismus," *History and Philosophy of the Life Sciences*, 21 (1999): 195-213.

clearly understands Natural Selection"? The same individual whom Max Verworn eulogized as "not only the last great hero from the classical era of Darwinism, but one of the greatest research naturalists of all times and as well a great and honorable man"?²³

Ernst Haeckel was a man of parts. It is not surprising that assessments of him should collide. I believe, however, that Darwin and Verworn, his colleagues, exhibited a more reliable sense of the man. This is not to suggest, though, that other of his contemporaries would not have agreed with the evaluations made by the historians I have cited. The philosophers, especially the neo-Kantians, were particularly enraged. Erich Adickes at Kiel dismissed *Die Welträthsel* as "pseudo-philosophy."²⁴ The great Berlin philosopher Friedrich Paulsen erupted in molten anger at the book and released a flood of searing invectives that would have smothered the relatively cooler judgments of the historians mentioned above. He wrote:

I have read this book with burning shame, with shame over the condition of general education and philosophic education of our people. That such a book was possible, that it could be written, printed, bought, read, wondered at, believed in by a people that produced a Kant, a Goethe, a Schopenhauer—that is painfully sad.²⁵

The Swiss zoologist Ludwig Rüttimeyer stumbled across one of Haeckel's more crucial

²³Max Verworn, "Ernst Haeckel," *Zeitschrift für allgemeine Physiologie* 19 (1921): i-xi; quotation from p. i. Verworn was a student of Haeckel and later Professor of physiology at Göttingen, director of the Physiological Institute at Bonn, and editor of *Zeitschrift für allgemeine Physiologie*.

²⁴Erich Adickes, "The Philosophical Literature of Germany in the Years 1899 and 1900," *The Philosophical Review* 10 (1901): 386-416; see especially 404-407.

²⁵Friedrich Paulsen, *Philosophia militans: Gegen Klerikalismus und Naturalismus* (Berlin: Reuther & Reichard, 1901), p. 187.

lapses of judgment and instigated a charge of scientific dishonesty that would hound him for decades.²⁶ And, of course, Haeckel's continued baiting of the preachers evoked from them an enraged howl of warning about "the depth of degradation and despair into which the teaching of Haeckel will plunge mankind."²⁷ Contemporary creationists and those advocating Intelligent Design have heeded the warning; they have ignited thousands of websites in an electronic auto de fé in which Ernst Haeckel's reputation is sacrificed to appease an angry God.

Haeckel's evolutionary convictions, fused together by the deep fires of his combative passions, kept the human questions of evolution ever burning before the public, European and American, through the last half of the nineteenth century and well into ours. The controverted implications of evolutionary theory for human life—for man's nature, for ethics, and for religion—would not have the same urgency they still hold today had Haeckel not written.

The measure of Haeckel is usually taken, I believe, using a one-dimensional scale. His acute scientific intelligence, however, moved through many diverse areas of inquiry—morphology, paleontology, embryology, anatomy, systematics, marine biology, and his newly defined fields of phylogeny, ecology, chorology (biogeography)²⁸—and to

²⁶Ludwig Rüttimeyer, reviews of "E. Haeckel, `Ueber die Entstehung und den Stammbaum des Menschengeschlechts" and "E. Haeckel, `Natürliche Schöpfungsgeschichte," *Archiv für Anthropologie* 3 (1868): 301-302. I will discuss the charges below.

²⁷R. F. Horton, "Ernst Haeckel's `Riddle of the Universe,'" *The Christian World Pulpit* 63 (10 June 1903): 353-356; quotation from p. 353.

²⁸Haeckel was notorious for formulating jaw-breaking terms to define new or reconceived areas of research—"phylogeny," "ontogeny," "gastrulation," and "ecology," being those that have stuck the tightest to contemporary theory. He defined ecology as "the entire science of the relationships of the organism to its surrounding external world, wherein we understand all 'existence-relationships' in the wider sense." Chorology was the "entire science of spatial dispersion of organisms, of their geographical and

all of these he made important contributions. But more significantly, through a deft construction of evolutionary processes, he reshaped these several disciplines into an integrated whole, which arched up as a sign of the times and a portent for the advancement of biological science. He anchored this evolutionary synthesis in novel and powerful demonstrations of the simple truth of the descent and modification of species. Haeckel supplied exactly what the critics of Darwin demanded, namely a way to transform a *possible* history of life into the *actual* history of life on this planet. Certainly he merited Darwin's accolade, and was, I believe, the English scientist's authentic intellectual heir. But Haeckel, needless to say, was not Darwin. His accomplishments must be understood as occupying a different scientific, social, and psychological terrain, through which passed a singular intellectual current that flowed powerfully even into the second half of the nineteenth century, namely, Romanticism.²⁹

Both by intellectual persuasion and temperament Haeckel was a Romantic. His ideas pulsed to the rhythms orchestrated particularly by Johann Wolfgang von Goethe, Alexander von Humboldt, and Matthias Jakob Schleiden. They, and other similarly disposed figures from the first half of the century, inspired Haeckel in the construction of his evolutionary morphology. They had proposed that archetypal unities ramified through the wild diversity of the plant and animal kingdoms. Such Urtypes focused consideration on the whole of the creature in order to explain the features of its

topographical spread over the earth's surface." Haeckel conceived chorology as part biogeography, part the morphology of populations (much in the manner of Alexander von Humboldt). See Ernst Haeckel, *Generelle Morphologie der Organismen*, 2 vols. (Berlin: Reimer, 1866): 2: 286-87.

²⁹For a discussion of the ways the Romantic movement shaped biological thought in the first half of the nineteenth century, see Robert J. Richards, *The Romantic Conception of Life: Science and Philosophy in the Age of Goethe* (Chicago: University of Chicago Press, 2002).

individual parts. When the theory of the archetype became historicized in evolutionary theory it yielded the biogenetic law, the lever by which Haeckel attempted to lift biological science to a new plane of understanding. The Romantic thinkers to whom Haeckel owed much regarded nature as displaying the attributes of the God now in hiding; for them, and Haeckel as well, it was *Deus sive natura*—God and nature were one. This metaphysical persuasion required that the sterile mechanisms described by low-grade Newtonians be replaced by a fecund nature from whose creative depths greatly disparate forms could arise. Nature, under their conception, feigned no indifference to moral concerns or to beauty. Darwin himself, as I have shown elsewhere, shared this Romantic conception of nature.³⁰ These earlier Romantic scientists insisted that the understanding of organic forms, whether manifested in the individual or in the population, required not only theoretic consideration but aesthetic evaluation as well. The artistic features of organic forms had to be included in the proper assessment of their development and function; and for this purpose, Haeckel's talent with the artist's brush served him no less than his dexterity with the scientist's microscope. And just as Goethe sought the concrete realization of his theory of types in an aesthetically imagined primitive plant, the *Urpflanze*, so Haeckel pictured a polymorphous organism—a perverse sponge artfully conceived—that seemed to bring an ideal evolutionary theory into actual history.

Haeckel's Romanticism reached down to the inmost feelings of his being; and so to comprehend his scientific achievement, we must also probe his character. The

³⁰Ibid., epilogue.

strategy of causally linking the theories of a scientist not only to the ideas supplied by predecessors and contemporaries but also to the deeper forces of the self—this strategy is born of a historiographic conviction, one given firm expression by Miguel de Unamuno, author of an earlier *Tragic Sense of Life*. In his *Sentimiento Trágico de la Vida* (1913), he objected:

In most of the histories of philosophy that I know, philosophic systems are presented to us as if growing out of one another spontaneously, and their authors, the philosophers, appear only as mere pretexts. The inner biography of the philosophers, of the men who philosophized, occupies a secondary place. And yet it is precisely this inner biography that explains for us most things.³¹

The historical explanation of a scientist's ideas requires as well, I believe, a descent to that inner self, without neglecting, of course, the force of evidence and the compulsion of logic.

In this book I wish to explain why Haeckel adopted Darwinian theory and why that theory came to have, in his rendering, the special features it did. I will account for his initial acceptance of evolution, in large part, by showing how his own research became illuminated and inspired by his reading of Darwin's *Origin of Species*. But, of course, many other biologists read Darwin in the 1860s but did not come away

³¹Miguel de Unamuno, *Tragic Sense of Life*, trans. J. E. Crawford Fitch (London: Macmillan, 1921), p. 2. Unamuno offers a clue, I believe, for the solution to the puzzle of Ernst Haeckel, a matter discussed briefly at the end of this chapter and in chapter 11.

evolutionists—quite the contrary. The task, therefore, must be further to situate his reading in the context of the intimate experiences and profound beliefs that allowed Darwin's message to become in Haeckel's case virtually a religious calling, which he followed throughout the rest of his life.

Haeckel first read the *Origin of Species* immediately after research on a class of animals that provided evidence that bespoke species transmutation; but, again, such evidence would bear fruit only in a mind prepared by certain other fertile conceptions—in Haeckel's case prominently among them were those Romantic notions I have mentioned, as well as the traditions of morphology in which he was schooled. Ideas will have causal efficacy because of their logical and semantic character. But this can hardly be enough. Logic and meaningful fit of ideas have potency only if invested with it by the person. To adapt Novalis's adage, logic and semantics bake no bread. Only when the fire is struck from below, in the depths of personality, will the logical and causal relations of ideas become solidified: the relations of ideas are human relations. Ideas that are logically or semantically fit to be cause and effect of one another must yet be brought into proximity and charged with causal energy through hopes and fears, desires and sufferings. Without the infusions of personality, ideas floating through the mind of a scientist will remain limp and anemic, poor effete creatures that evanesce away. Haeckel's ideas had martial force. So the study of his scientific ideas, their origin and trajectory, must be grounded in his character formation—in his *Bildung*, the Romantics would say—and in the enlarged passions of the man, in a deep need to find the truth about the world, especially a truth that would mitigate the overwhelming tragedy that touched virtually all of his work in evolutionary theory.

In the following chapters, then, I will trace the unfolding of Haeckel's thought, especially its Romantic connections, as it reaches up to the great synthesis of his early career, his *Generelle Morphologie der Organismen* (General morphology of organisms, 1866). This work, born in despair, formed the trunk whence sprang the many branches of his later science. In order to appreciate the resolving power of Haeckel's theory, I will treat in some detail his great monographs on various marine organisms that appeared in the decade and a half surrounding his *Generelle Morphologie*. Those monographs, while still known to the relevant specialist in marine biology, remain forbidding waters to most others. Yet these volumes reveal his remarkable abilities as a research scientist and display the singular discoveries by which Darwinian theory achieved concrete realization. Indeed, Haeckel's empirical accomplishments in his vast studies of marine fauna provide counterweight to the presumption of many contemporary historians that his evolutionary theory fled sound science to reside in a speculative land of gothic dreams. Haeckel's research, richly detailed and technically sophisticated even to modern eyes, reached back, admittedly, through theoretical and aesthetical attachments to the works of Goethe, Humboldt, and Schleiden. Yet this only indicates, as I will argue, that Romanticism had features attractive and fecund enough to seduce thoroughly modern science.

Haeckel did not remain hidden behind the researcher's microscope. Because of a great personal tragedy, he took on Darwinian theory as a kind of theological doctrine, recasting it as the foundation for his "religion of monism." He preached this doctrine from a number of venues—the popular book, the vituperative essay, the revivalist lecture. These works brought him the admiration of a liberal, emancipated public during

the last part of the nineteenth century and allowed him to cultivate relationships with such political, intellectual, and artistic luminaries as Edward Aveling (consort of Karl Marx's daughter and translator of *Das Kapital*), David Friedrich Strauss (theologian and iconoclastic author of the *Life of Jesus*), Ernst Mach (positivist and physicist at Vienna), and Isadora Duncan (free-lover and dancer).



Figure 1.2: Isadora Duncan (1877-1927): “My writing table at Phillips Ruhe. I look upon your lovely picture. Yours in friendship, Isadora Duncan, July 1904.” (Courtesy of Haeckel-Haus, Jena.)

After his extraordinary empirical accomplishments of the 1860s and 1870s, Haeckel fought one battle after another, right through the First World War, against the enemies of his Romantic evolutionism, that is, his passionately applied Darwinism. The heated controversies in which he became engaged reflect, from a particular perspective, the course of evolutionary theory from the second half of the nineteenth century through the first part of the twentieth. These controversies

concerned internal disputes of evolutionists as well as external conflicts with religious enemies. The politics of evolution even spilled over into Haeckel's efforts to enlist scientists to ward off the coming war that would devastate Europe. I will sketch these battles and thereby offer one portrait of the course of evolutionary theory during the period. I will also attempt to develop several themes of more historiographic concern,

namely: the rhetorical structure of disputes in science, the role of graphic representation in the explanation and demonstration of particular theories, and the justification for making ethical evaluations of historical figures—this latter will occupy the second appendix.

Haeckel's greatest sin in the eyes of many historians and philosophers is that he was not Darwin. But not even Darwin was Darwin, at least as he is usually depicted in contrast to Haeckel. This study will, I hope, make it more difficult both to dismiss Haeckel's scientific accomplishments as anti-Darwinian and to denigrate his character as meretricious. I also hope that this book will expose those Romantic roots of evolutionary theory that have made it bloom with such diverting and sweetly compelling ideas.

The Tragic Source of the Anti-Religious Character of Evolutionary Theory

Had Charles Darwin or Ernst Haeckel not lived, I believe that in due course a theory of evolution by natural selection would have been formulated—Alfred Russel Wallace, after all, came very close to beating Darwin to the punch, though it may have been a punch not many people would have felt, initially at least. But in Germany prior to 1859, there were several biologists of prominence who had advanced one or another version of a theory of descent with modification; for some, the modifications were wrought by Lamarckian devices, for other by the Divine Hand. During the first half of the century the evidence accumulated: the fossil evidence, the biogeographical evidence, the anatomical evidence, the embryological evidence, the practical evidence from breeders—all of these avenues led in the same direction. Moreover, though many

different devices had been proposed to explain transmutation, the seeming analytic clarity of the principle of natural selection and the persuasive model of artificial selection could be expected, even without the *Origin of Species*, to reveal the power of the selective device, elevating it to become a leading contender for the position of chief causal source of species alteration. It is certainly not unreasonable to suppose, absent Darwin, that both of these ideas—descent with modification and natural selection—would have rather quickly become dominant in biological science during the latter part of the century. Why would they become dominant? Well, because, as the best evidence we have shows, they conform to features of the natural world.³² How else to explain the rapid spread of evolutionary theory in radically different political cultures, ethnic domains, and religious orientations in the last part of the nineteenth century—from social conservatives to liberal Marxists, from western Europeans to eastern Asians, from militant atheists to militant Jesuits?

So I reject the so-called “contingency thesis” proposed by several sociologists and historians of science.³³ The thesis itself cannot, I think, even be coherently expressed. The notion seems to be something like this: major features of science—the experimental method, for instance—need not have come to characterize a successful *modern science*; rather those features resulted simply from a collocation of chance historical events that introduced and sustained them; and thus the development of an

³²There are certain Kantian problems with the concept of “the natural world” that need not be explored at this juncture.

³³Hacking discusses the various formulations and implications of the contingency thesis. See Ian Hacking, *The Social Construction of What?* (Cambridge: Harvard University Press, 1999), especially pp. 63-99. While Hacking thinks the thesis not exactly clear, he agrees with it in a limited fashion.

equally effective modern science could have occurred without the techniques of empirical experiment. If the contours of Robert Boyle's experimental profile, like Cleopatra's nose, had a different shape, then modern science would have developed in a dramatically different way—perhaps along the lines of a Hobbsian metaphysics. Yet in this scenario, which has been proffered by some contemporary historians, the contingency thesis cannot even be coherently expressed.³⁴ It cannot be intelligibly expressed because by “modern science” we mean that interconnected set of laws established by experimental procedures. No doubt, it might possibly have occurred that the Black Death was more lethal to European populations than was historically the case and that virtually the entire intellectual community was obliterated. One could imagine—though with some difficulty—that the saved remnants reverted to doctrinaire superstition that became fanatically entrenched, so that its system came to dominate what subsequently passed for intellectual thought. But simply said, that would not be science. It makes no sense to say that modern science could have developed quite nicely without modern (experimental) science. I do not think the thesis could be rationally expressed if one focused on modern biology and held that it only contingently

³⁴This is the general thesis that Shapin and Schaffer worked out in their historical analysis of the controversy between Thomas Hobbes, whom they take to reject experimental methods to establish the fundamental elements of science, and Robert Boyle, whom they represent as advancing those methods. See Steven Shapin and Simon Schaffer, *Leviathan and the Air-Pump* (Princeton: Princeton University Press, 1985). They say: “Our goal is to break down the aura of self-evidence surrounding the experimental way of producing knowledge... [W]e want to show that there was nothing self-evident or inevitable about the series of historical judgments in that context [of the Hobbes-Boyle debate] which yielded a natural philosophical consensus in favour of the experimental programme. Given other circumstances bearing upon that philosophical community, Hobbes's views might have found a different reception” (p. 13). Shapin and Shaffer further contend that the victory of Boylean experimentalism in the history of early modern science was inextricably intertwined with his political and religious ideology—a quite contingent matter—and that this connection was a principal factor in the success of his programme (pp. 80-109).

featured evolutionary theory. As Dobzhansky famously observed, nothing in biology makes sense except by reason of evolution. Thus again, without this major feature—evolutionary theory—one could not have the development of “modern biology.”

Well, these may seem like the niggling semantic objections of a paleo-positivist. I do believe, nonetheless, they go quite deep. Yet for my purposes in this history, it is not crucial that the reader accept these analytical objections to the contingency thesis. Indeed, I want to argue for an attenuated version of the thesis, a version that, I think, can be coherently stated. This version considers certain non-essential aspects of modern evolutionary theory, namely its materialistic and anti-religious features. These, I believe, are contingent cultural traits of the modern theory. As I have attempted to show elsewhere, many of the early proponents of Darwinian theory were both spiritualists—that is, they accepted a non-materialistic metaphysics—and believers—that is, they integrated their scientific views with a definite, or sometimes an indefinite, theology.³⁵ Asa Gray, William James, and Conwy Lloyd Morgan are just a few prominent examples of advocates of evolutionary theory who nevertheless rejected a stony, desiccated materialism.

During the late nineteenth and through the twentieth centuries, however, the cultural representation of the evolutionary doctrine took on a different cast: evolutionary theory became popularly understood as materialistic and a-theistic, if not atheistic. I believe this cultural understanding is principally due to the tremendous impact and polarizing influence of Ernst Haeckel. Had Haeckel not lived, evolutionary theory would

³⁵See Robert J. Richards, *Darwin and the Emergence of Evolutionary Theories of Mind and Behavior* (Chicago: University of Chicago Press, 1987), pp. 331-408.

have turned a less strident face to the general public. At least, the antagonism with religion would not have been so severe. It was Haeckel's formulations that, as I will maintain, created the texture of modern evolutionary theory as a cultural product. My thesis is even more specific, namely: had Haeckel not suffered the tragic events that caused him to dismiss orthodox religion as unmitigated superstition and to advance a militant monistic philosophy, his own version of Darwinian theory would have lost its markedly hostile features and these features would not have bled over to the face turned toward the public.



Miguel de Unamuno, in his *Del Sentimiento Trágico de la Vida*, explored what he took to be the soul-splitting experience of Western intellectuals, their tragic sense of life. He depicted the struggles of a skeptical reason, especially in philosophy and science, as courageously insisting that human striving is mortal, that its efforts end in the grave; yet such reasoning cannot, he thought, overcome the vital desire for life, for transcendence.³⁶ Ernst Haeckel experienced the passion for transcendence through a love that lifted him to ecstasy and then crushed him in despair. This experience invaded his insistently rational attitudes, even transforming his science into a means for escaping the grasping hand of mortality. My over-arching argument will be that Haeckel's science and his legacy for modern evolutionary theory display the features they do because of his tragic sense of life.

³⁶I will return to consider Unamuno's thesis in relation to Haeckel's accomplishments in the conclusion to this book.