ROBERT J. RICHARDS

The Tragic Sense of Ernst Haeckel: His Scientific and Artistic Struggles

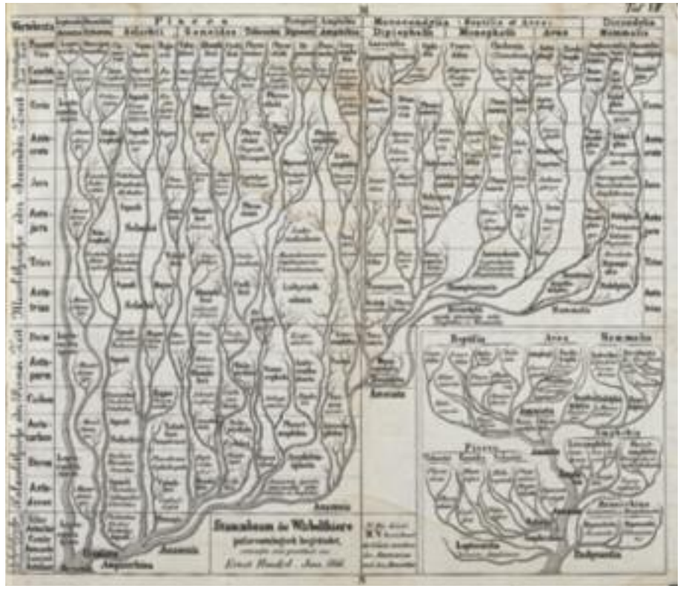
1. Ernst Haeckel (standing) with his assistant Nikolaus Miclucho-Maclay on the island of Lanzarote, 1866, photograph, 18 x 23.8 cm (4¼ x 4¾ in.), Ernst-Haeckel-Archiv, Friedrich-Schiller-Universität Jena

Ernst Haeckel (FIG. 1) was Darwin's foremost champion, not only in Germany but throughout the world. In the first decades of the twentieth century, the great historian of biology Erik Nordenskiöld judged that Haeckel's *Natürliche Schöpfungsgeschichte* (*The History of Creation,* 1868) was "the chief source of the world's knowledge of Darwinism."[1] Haeckel's *Die Welträtsel (The Riddle of the Universe),* published in 1899, sold more than 400,000 copies prior to the First World War and was translated into most of the major languages and several of the more esoteric ones (including Esperanto).[2] Despite his impact on the field of biology—or perhaps because of it—Haeckel provoked a hostile reaction in his own time, especially from the religiously minded; and that opposition has been sustained in the present day by those committed to fundamentalist religious thought.

Haeckel's reputation as researcher, evolutionist, and polemicist brought the kind of fame to his small university in Jena that it had not enjoyed since Goethe administered its affairs a half century earlier. Haeckel drew to Jena the best biologists of the next generation, including the "golden brothers" Oscar and Richard Hertwig, Wilhelm Roux, and Hans Driesch, all of whom made their marks on science by the end of the century.

Haeckel's students responded not only to his iconoclastic attitudes and aggressive intelligence but also to his unflagging energy and bold creativity. He introduced into biology many concepts that remain viable today, including the idea that the nucleus of the cell contains the hereditary material as well as the concepts of phylogeny, ontogeny, and ecology. He was among the first to use the graphic device of the evolutionary tree (see FIG. 2), and he made it a fixture of biological literature. He introduced the idea of the missing link between man and the lower animals, and his speculations led his protégé Eugène Dubois to search for its remains in the Dutch East Indies, where he discovered the first *Homo erectus* fossils. Haeckel made central to his evolutionary analyses the biogenetic law: that is, the principle that ontogeny recapitulates phylogeny. The law states that the embryo goes through the same morphological stages in its development as the phylum had gone through in its evolutionary descent. According to this law, the human embryo, for example, begins as a one-celled creature, just as we suppose life began in the sea as a single reproducing cell; the embryo then takes on the form of an invertebrate and, subsequently, something like a fish, then a mammal, then a primate, and finally, a specific human being. The biogenetic law implies that at the earliest stages of embryogenesis, embryos of a particular order or family ought to be similar in morphology, since their species stemmed from a common ancestor. And this is what Haeckel depicted in his many monographs and essays (see FIG. 3).

Ernst Haeckel, Desmonema annasethe, in *System der Medusen*, Jena 1879, Staatsbibliothek zu Berlin – Preußischer Kulturbesitz



2. Ernst Haeckel, Stem-tree of the vertebrates, in *Generelle Morphologie der Organismen*, Berlin 1866, Staatsbibliothek zu Berlin – Preußischer Kulturbesitz, Abteilung historische Drucke

3. Ernst Haeckel, illustration of the biogenetic law: comparison of bat, gibbon, and human embryos at three stages of development, in *Das Menschen-Problem und die Herrentiere von Linné*, Frankfurt/Main 1907, Staatsbibliothek zu Berlin – Preußischer Kulturbesitz

Haeckel was not only a scientist of extraordinary ability but an artist. He supplied the illustrations that would serve for the crafting of woodblocks, copper etchings, and lithographs used in the production of his twenty or so technical monographs and numerous articles. In 1864 he sent to Charles Darwin, by way of introduction, his massive work *Die Radiolarien,* a seven-pound treatise on creatures no bigger than the head of a pin.[3] The book was the result of his habilitation research in Italy and Sicily. The illustrations (as, for example, in FIG. 4) astonished Darwin. When Haeckel would travel to the Italian cities of Rome and Naples, or to the Canary Islands, or Ceylon, or Java—or to the more than thirty other research sites he visited during the half century of his scientific life—he would not only carry sketch pads for depicting the variety of creatures he pulled from the seas but would also bring canvases to capture the landscapes of the countries visited or the vistas of native life. His artistic impulses flowed as deeply as his scientific impulses.

In this essay, I will focus on two central and closely related aspects of Haeckel's accomplishment: first, the way in which his artistic renderings intersected with his science, giving a distinctive cast to that science and involving him in many disputes; and second, the manner in which both his art and science were driven by an overwhelming tragedy. Let me briefly sketch the course of his life to put these considerations into proper perspective.

THE TRAJECTORY OF HAECKEL'S LIFE[4]

Ernst Heinrich Philipp August Haeckel (1834–1919) was born into an upper-middle-class family. His father, Karl, was a jurist and a minister in the Prussian Court; his mother, Charlotte (née Sethe), came from a family of lawyers. His older brother, also named Karl, followed in the family tradition and entered the legal profession. Haeckel, however, inclined toward natural history. Karl Haeckel, with fatherly concern, insisted that his younger son obtain a professional degree. The adolescent Haeckel obediently matriculated at the medical school in Würzburg, where he studied with Albert Kölliker and Rudolf Virchow, two of the most eminent biological and medical researchers of the period. He also worked in the laboratory of the great Berlin zoologist Johannes Müller, with whom he intended to do his habilitation after receiving his medical degree in 1858. Müller's suicide, however, disrupted Haeckel's plans. Shortly thereafter, Carl Gegenbaur, at Jena, offered to guide his young friend's investigations. Haeckel's travels to southern Italy and Sicily for his habilitation research yielded the work that initiated his correspondence with Darwin. The two became good friends, with a stream of letters passing between them over the next twenty years. During the course of their friendship, which terminated only with Darwin's death in 1882, the English sage entertained Haeckel three times at his country home in the village of Downe.

4. Ernst Haeckel, Radiolaria of the subfamily Eucyrtidium, in *Die Radiolarien. Eine Monographie*, Berlin 1862–88, Staatsbibliothek zu Berlin – Preußischer Kulturbesitz, Abteilung historische Drucke

Haeckel's monograph on radiolaria—along with Gegenbaur's support—secured a position for him as *extraordinarius* professor at Jena. It also made possible marriage, in 1862, to his cousin Anna Sethe, with whom he was engaged during his Italian sojourn. Their deliriously happy life came to an abrupt end eighteen months later, when on the very day Haeckel was to celebrate his thirtieth birthday, Anna suddenly died of what was likely a burst appendix. Her death completely devastated Haeckel; his family feared he might commit suicide in his desperate grief. Even in his elder years, on the anniversary of Anna's death, he seriously contemplated taking his own life. Her death decisively moved him away from religion and led him to adopt a doctrine that promised less but was demonstrably more reliable—Darwinian theory. He wrote to his parents from Nice, where they had sent him to recover:

> The last eight days have passed painfully. The Mediterranean, which I so love, has effected at least a part of the healing cure for which I hoped. I have become much quieter and begin to find myself in an unchanging pain, though I don't know how I shall bear it in the long run. … You conclude that man is destined for a higher godlike development, while I hold that from so deficient and contradictory a creation as man, a personal, progressive development after death is not probable, but more likely is a progressive development of the species on the whole, as Darwinian theory already has proposed it. … Mephisto has it right: "Everything that arises and has value comes to nothing."[5]

While walking along the Mediterranean in a miserable state, Haeckel happened to notice a medusa—that is, a jellyfish—in a tidal pool. That crea-

ture with is delicate yellow tendrils reminded him of Anna's golden braids, and in his later publication on medusae, he named it in memory of his wife. But a few years after, he received from a colleague a specimen he thought even more beautiful, and this would become *Desmonema annasethe*.

In 1867, three years after Anna's death, Haeckel remarried. His bride was the twenty-four-year-old Agnes Huschke. Their marriage was hardly successful, except in the biological sense: they had a son, who became a decent painter, and two daughters, one of whom, like her mother, suffered from the nineteenth-century malady of neurasthenia. Through the years in his oppressive household, Haeckel felt his psychic energy gradually wearing away. This left him falling into the arms of another woman in the late 1890s, a story that also ends in tragedy.

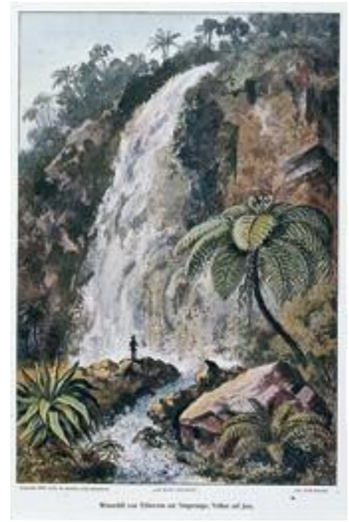
HAECKEL'S DARWINIAN SCIENCE AND ART

After Haeckel's major theoretical work on evolutionary theory—*Generelle Morphologie der Organismen* (1866)—failed to excite even the zealots who opposed Darwinian theory, he gave, between 1867 and 1868, a series of popular lectures based on the book in which he sought to make evolutionary theory more accessible to a general audience. He quickly redacted the lectures to produce a wildly successful introduction to the theory, his *Natürliche Schöpfungsgeschichte*. The book went through twelve editions between 1868 and the time of Haeckel's death in 1919. In this work, Haeckel made the argument that human beings should be brought under the aegis of Darwinian theory; he made this claim even before Darwin himself had written on human evolution. Through its several editions, the book became ever more replete with illustrations that reduced the complexities of argument to comprehensible and compelling expressions of the various aspects of the evolutionary process. It was also quite polemical. Haeckel rejected with a sneer the kind of religiously oriented biology that had been the standard prior to Darwin's *Origin of Species*. But the book was mild in its dismissal of the ingressions of religion into science compared with his *Welträtsel* in 1899. This latter work was a phenomenal best seller and was translated into at least thirty languages. A reviewer of the English edition for the *New York Times* encapsulated the message of the book in this way:

> One of the objects of Dr. Haeckel—it would not be unfair to say the chief object—is to prove that the immortality of the human soul and the existence of a creator, designer, and ruler of the universe are simply impossible. He is not at all an agnostic. Far from it. He knows that there can be no immortality and no God.[6]

In addition to his popular works, Haeckel authored some twenty or so large technical monographs on various marine organisms: sponges, siphonophores, medusae, radiolaria, and other creatures. All of these works included illustrations by his own hand, often reproduced as color lithographs. Haeckel also composed two significant art books: his *Kunstformen der Natur (Art Forms in Nature)*, initially published in ten fascicles of ten

plates each from 1899 to 1904, and then in book form (1904) as well as in box form with prints unbound and suitable for framing;[7] and his *Wanderbilder* of 1905, also with unbound prints.[8] The *Kunstformen* reproduced many of the plates from his monographs on marine biology, added new illustrations of more advanced animals, and set them as artistic pieces. Many of the illustrations were newly colored and replicated in lithograph or in autotype (a monochromatic, nonfading print). The printing work was done by Adolph Giltsch, who was also responsible for reproducing the illustrations of most of Haeckel's many monographs. The *Kunstformen* had a decided impact on the artistic movement of Jugendstil, which flourished at the beginning of the twentieth century.[9] The *Wanderbilder* gathered together landscapes that Haeckel painted on his two trips to the tropics, the first in 1881–1882, when he traveled to Ceylon (now Sri Lanka), and the other in 1900–1901, when he journeyed to Sumatra and Java. The printing of these landscapes required another hand; it was undertaken by the natural-history publishing house of Eugen Koehler and his son Woldemar Koehler. Though the plates included photographs of some scenes, especially those of individuals in native dress, the purpose was to induce in the reader a deeper feeling for nature, which Haeckel believed could only be inspired by vivid illustration in oil or watercolor. Photography simply could not produce the desired effect.

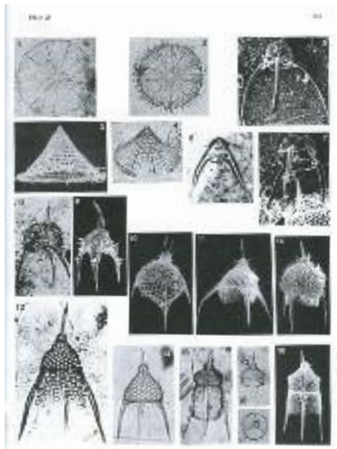


5. Ernst Haeckel, Waterfall at Tjiburrum at the foot of the volcano Pangerango, in the highlands of Java, in *Wanderbilder*, Gera-Untermhaus 1905, Staatsbibliothek zu Berlin – Preußischer Kulturbesitz

An example of Haeckel's effort to lead his readers to the deeper attractions of nature can be found in his illustration in the *Wanderbilder* of a waterfall on the island of Java (FIG. 5). Haeckel admitted that he was "no accomplished artist, but only an enthusiastic dilettante whose moderate talent, through extensive practice and heartfelt dedication, has been directed usefully to nature."[10] This modest evaluation belies his aesthetic talent, honed by study and unremitting effort. The waterfall scene evokes Kant's notion of the sublime—that is, a feeling of individual insignificance in view of the power of nature, yet with a recognition of human mental power that rises above nature. It is also reminiscent of Caspar David Friedrich's famous *Der Wanderer über dem Nebelmeer* (The Wanderer above the Sea of Fog, 1818).

AESTHETICS AND SCIENCE

Haeckel's artistic efforts and scientific practice were intimately connected along several dimensions. One might first consider the supposed stylized character of his scientific illustrations. Stephen Jay Gould, whose first book, *Ontogeny and Phylogeny* (1977), took as its theme Haeckel's principle of recapitulation, both its historical fortunes and its then-contemporary status, maintained that his predecessor (of whom he was no friend) made his drawings too symmetrical, too stylized, and thus they did not represent the real character of the organisms depicted. Gould had particularly in mind Haeckel's illustrations of radiolaria (as for example, those pictured in FIG. 4, above). More recently, Lorraine Daston and Peter Galison, in their book *Objectivity*, have leveled a comparable charge, suggesting that Haeckel remained mired in an older tradition while more empirically inclined naturalists had taken up the camera to render nature with photo-



6. Micrographs of the subfamilies Plectopyramidinae and Eucyrtidinae, in Kozo Takahashi and Susumu Honio's *Radiolaria: Flux, Ecology, and Taxonomy in the Pacific and Atlantic*, 1991

graphic realism and precision.[11] Peter Bowler has argued that Haeckel's artistic representations reveal his non-Darwinian approach. He contends that Darwin emphasized the variability of organisms, the very material of evolutionary adaptation and development, while Haeckel showed no interest in variable traits.[12] I believe these criticisms are unfounded and neglect the intended purpose of Haeckel's science and his art.

Haeckel's depictions of radiolaria do show them as quite symmetrical, because, as a matter of fact, they are—notoriously so (see FIG. 6). Haeckel's intention in constructing his atlas of radiolaria—as well as the many other atlases accompanying his volumes on the systematic description of medusae, siphonophores, sponges, and other creatures—was to provide a *standard* representation of a given species. Had he included a depiction of a particular individual deviating from the species norm, instead of one exhibiting the essential structure of the species, the illustrations would be quite defective for the purposes of identifying species members. Moreover, Haeckel understood quite well the advantages of the watercolor or oil painting over the photograph:

> I have been convinced that colored images (even of a mediocre production) are much more valuable for a vivid intuitive awareness of nature than the photograph or the simple black-and-white illustration. Indeed, a crude color sketch (if it conveys the landscape in a vivid fashion) has a deeper and more stimulating effect than the best black-and-white illustration or photographic representation. This distinction lies not only in the effect of color itself—since different individuals are sensitive in different measures—but also because the painter, as thoughtful artist, reproduces in his subjective image the conceptually articulated character of the landscape and emphasizes its essential features. The objective image of the photograph, by contrast, reproduces equally all parts of the view, the interesting and the mundane, the essential and the inessential. Thus the colored photograph, if it should be brought to perfection, will indeed never be able to replace the individually conceived and deeply felt image of the painter.[13]

Haeckel understood that when depicting botanical objects, as well as birds, fish, hydrozoa, and most other animals, the color of the subjects was quite crucial. Of course, color photography, which Haeckel presciently foresaw, would not be perfected until the 1930s. During the nineteenth century, the usual mode of color reproduction was the copper etched plate or the lithograph, both of which depended on the artist's illustration. Further, the accidental and unrepresentative aspects of creatures, as opposed to their essential features, had to be excluded. Many of the specimens that Haeckel had at his disposal—and would render into striking images, being careful to get color and essential features exact—were damaged or defective in some way. They had to be rectified through the experience of the naturalist and the imagination of the artist. For example, the medusa that Haeckel named after his first wife—*Desmonema annasethe*—originally came to him as a compressed and crumpled brown mass. It was sent to him preserved in spirits of wine and shipped in a soldered tin by his cousin in Africa, the linguist Wilhelm Bleek. Bleek, significantly, was also the cousin of Anna Sethe. Haeckel's initial illustration of this organism (P. 93), while structurally correct, lacked the vividness of the original, a quality it would later acquire in Haeckel's inspired hands. I will come back to this image.

A final reason why photography would not and could not substitute for the artist's brush has to do with light, something Haeckel understood quite well. While in the highlands of Java in 1900, he meditated on the subject of light and the disadvantage of photography in dealing with its difficulties. He wrote:

> In the colorful confusion produced by the mass of tangled plants, the eye vainly seeks a resting place. Either the light is reduced and distorts the thousand crisscrossed branches, twigs, and leaf surfaces … or the light of the overhead sun … produces on the mirrored surface of the leather-like leaves thousands of glancing reflections and harsh lights, which allow no unified impression to be gathered. In the depths of the primitive forest, the various complexes of light are extraordinary and cannot be simply reproduced by means of photographs. … A good landscape painter—especially when he possesses botanical knowledge—is able in a larger oil painting to place before the eye of the viewer the fantastic magical world of the primeval forest in a realistic way.[14]

Haeckel intended to represent not only the essential geometrical structures of radiolaria but their beauty as well, which he was able to portray through the use of color and the balanced arrangement of creatures in his atlas plates. Haeckel had been convinced by his mentors Goethe and Alexander von Humboldt that to depict the wonders of nature accurately was not only to discover "the laws of their origin and evolution but also to press into the secret parts of their beauty by sketching and painting."[15] Humboldt's *Kosmos* (1845–62) was predicated on this aspect of the naturalist's representations of nature. Yet both Humboldt and Haeckel had an even more radical intention: they wished the observer of their volumes to have an experience comparable to that of the naturalist who first encounters the seductive displays of nature.[16] As Haeckel expressed his intent in *Kunstformen der Natur*: "Nature generates from her womb an inexhaustible cornucopia of wonderful forms, the beauty and variety of which far exceed the crafted art forms produced by human beings." But nature's wondrous structures often lay hidden in the jungles of tropical lands or in the depths of the oceans beyond the reach of the ordinary reader. By his artistic efforts Haeckel sought to "bring those forms into the light and to make them accessible to the greater circle of the friends of art and nature."[17] To accomplish this, the artist-naturalist had to create depictions that would give the reader a partial experience of nature's extraordinary beauty; the naturalist had to allow the reader to share the experience he once had of such extraordinary sights.

Haeckel's conviction about the astounding structures of life hidden from ordinary view was shared by René Binet, the chief architect of the

René Binet, *La porte monumentale d'entrée à l'Exposition de 1900*, c. 1900 | CAT. 72

Paris World Exposition of 1900. Binet thought such extraordinary forms should be displayed as a main attraction of the fair. To that end, he used Haeckel's work on radiolaria as motifs for the various exhibits, including the entranceway to the fair, the Porte Monumentale (FIGS. 7, 8).

Even if the one-celled radiolaria in fact show a deep symmetry, what about the metazoans, the many-celled creatures that Haeckel also portrayed? Perhaps here the objection might well lodge in the creative channels of Haeckel's art. His depictions of metazoans are rather symmetrical and idealized. The individual creatures that Haeckel pulled up from the sea would have lacked the perfection of form exemplified by his illustrations. Take, for example, the beautiful *Physophora magnifica*, flanked by juvenile specimens, that graced his prize-winning monograph on siphonophores (FIG. 9).[18] It is obvious that at one level what Haeckel portrayed was not an individual carrying all the marks of particularity but an ideal, an archetype of the species. While Gould's protest that Haeckel's images were too symmetrical fails in regard to the simple radiolaria, it might well be appropriate in regard to more advanced creatures, like the siphonophores.

8. René Binet, *Exposition Universelle de 1900: La Porte Monumentale, de R. Binet*, c. 1900 | CAT. 74

To understand Haeckel's artistic and scientific justification of his practice, one must consider the assumptions and principles that guided his hand—and still guide the hands of biological illustrators today. These assumptions and principles, in Haeckel's case, had three sources: first, the morphological tradition in which he was schooled; second, what he came to understand as the object of biological and, indeed, artistic comprehension; and, finally, his deeper evolutionary and metaphysical convictions.

First, then, there is the Goethean morphological tradition. Haeckel had been enamored of Goethe since his youth—and that passion did not wane in his later years. He wooed both Anna Sethe and later Frida von Uslar-Gleichen, his special friend, with Goethe's poetry. And it was a Goethean morphology of which he was persuaded. Goethe held a version of Spinoza's doctrine of *adequate ideas*, that is, the notion that within nature,

which Spinoza identified with God, real ideas were to be found, counterparts of material individuals. These ideas, as Goethe construed them, were generative; they were responsible for their material manifestations. In Goethe's view, both scientist and artist had to understand these ideas—or archetypes, as they became known—in order to comprehend natural creatures in a scientific way and to render them aesthetically in artistic productions. Thus, in a given instance, the same archetypal principles would serve the scientist and artist in a complementary pursuit. For Haeckel, then, what he conveyed to his reader analytically in precise description might also be rendered intuitively in an illustration that would reveal the same underlying archetype.

Haeckel's more metaphysical considerations of the Goethean archetype became transformed into an historical scenario after he read Darwin and became convinced that what Goethe referred to as the archetype could now be understood as the derived structure of the species (or the *Bauplan* of the ancestor, in the case of the phylum). Thus the Goethean archetype became historicized in Darwinian science; and the unity of type exhibited by a variety of species (e.g., vertebrates) could be traced not to an abstract metaphysical idea but to a common ancestor of those species. Yet Haeckel retained the Goethean conception that the proper object of biological investigation was the archetypal structure of a species, which could now be traced back in evolutionary history to the common ancestor of that species and of those closely related to it. Hence, the subject of his inquiries was not this particular medusa, but the underlying structure that united it with others of its species and ultimately with the ancestor that established the phylum.

9. Ernst Haeckel, *Physophora magnifica*, flanked by two larvae at slightly different stages of development, in *Zur Entwickelungsgeschichte der Siphonophoren*, Utrecht 1869, Ernst-Haeckel-Archiv, Friedrich-Schiller-Universität Jena

Haeckel's science did not abandon a metaphysical foundation, though it had changed after the infusion of a Darwinian historical dynamic. Under the new Darwinian dispensation, however, Haeckel did not deny the reality of the species-type and its own more fundamental structure, the phylogenetic archetype. These were indeed real aspects of nature as embodied in particular individuals. There was though, another kind of metaphysical assumption to which Haeckel's biology gave expression, and it concerned the death of his first wife. That death marked a radical religious and philosophical turning point in his life. As the letter to his parents indicates, he abandoned orthodox religion and replaced it with Darwinian theory. A year after the death of his wife, Haeckel began what would become a two-volume, highly theoretical application of evolutionary theory to morphology. He set a feverish pace, and within fourteen months his thousand-page *Generelle Morphologie der Organismen* appeared in 1866. This work constituted Haeckel's fundamental position on Darwinian theory and its application to all of life. The last chapter of the book took a sharp metaphysical turn. He followed Goethe and Spinoza in identifying God with nature: it was *Deus sive natura*. And while Haeckel as scientist recognized that all individuals were mortal, the Romantic Haeckel presumed that nature preserved all of life in her bosom. He captured this attitude in the epigram from Goethe that he used as preface to his book:

There is in nature an eternal life, becoming, and movement. She alters herself eternally, and is never still. She has no conception of

stasis, and can only curse it. She is strong, her step is measured, her laws unalterable. She has thought and constantly reflects—not as a human being, but as nature. She appears to everyone in a particular form. She hides herself in a thousand names and terms, and is always the same.[19]

Haeckel seems to have felt that Anna had returned to nature and retained a presence therein. Toward the end of his life, when he produced the *Kunstformen der Natur*, that original, crumpled, brown creature, *Desmonema annasethe*, was resurrected into the beautifully transformed medusa that is now emblematic of Haeckel's accomplishments as an artist (p. 103). In the *Kunstformen*, he remarked: "The species name of this extraordinary *Discomedusa*—one of the loveliest and most interesting of all the medusa—immortalizes the memory of Anna Sethe, the highly gifted, extremely sensitive wife of the author of this work, to whom he owes the happiest years of his life."[20] He wrote these tributes while still married to his second and apparently forgettable wife, Agnes. The creature that appears in the *Kunstformen* has become more beautiful, certainly more beautiful than the brown, compressed exemplar he received from his cousin. Moreover, the composition is artfully balanced, with *Annasethe* flanked by two other species. The *Chrysaora mediterranea* at the lower right is a venomously armed companion to *Annasethe*. In nature it is about four times the size of *Annasethe*. *Floscula promethea*, in the upper left, is only a quarter of the size of *Annasethe*. Haeckel adjusted the dimensions of each of the flanking medusae to complement the magnificent creature at the center. Haeckel's first wife grew in memory more beautiful and significant over his lifetime. For Haeckel, love fled and hid her face among sea creatures

1 Erik Nordenskiöld, *The History of Biology* (New York: Tudor, 1936), 515.
2 Erika Krauße, "Weg zum Bestseller, Haeckels Werk im Licht der Verlegerkorrespondenz," in *Der Brief als Wissenschaftshistorische Quelle*, ed. Erika Krauße (Berlin: Verlag für Wissenschaft und Bildung, 2005), 145–70.
3 Ernst Haeckel, *Die Radiolarien. (Rhizopoda Radiaria). Eine Monographie*, 2 vols. (Berlin: Georg Reimer, 1862).
4 This biographical section is based on my book *The Tragic Sense of Life: Ernst Haeckel and the Struggle over Evolutionary Thought* (Chicago: University of Chicago Press, 2008).
5 Haeckel to his parents, 21 March 1864, in *Himmelhoch jauchzend: Erinnerungen und Briefe der Liebe*, ed. Heinrich Schmidt (Dresden: Carl Reissner, 1927), 318–19.
6 "A Little Riddle of the Universe," *New York Times*, 27 July 1901.
7 Ernst Haeckel, *Kunstformen der Natur* (Leipzig: Bibliographisches Institut, 1904).
8 Ernst Haeckel, *Wanderbilder: Nach eigenen Aquarellen und Oelgemälden* (Gera-Untermhaus: W. Koechler, 1905).
9 See Christoph Kockerbeck, *Ernst Haeckels 'Kunstformen der Natur' und ihr Einfluß auf die deutsche bildende Kunst der Jahrhundertwende* (Frankfurt: Peter Lang, 1986).
10 Haeckel, *Wanderbilder* [p. 3 of the unnumbered pages].
11 Lorraine Daston and Peter Galison, *Objectivity* (New York: Zone Books, 2007), 194-95.
12 Peter Bowler, *The Non-Darwinian Revolution: Reinterpreting a Historical Myth* (Baltimore: Johns Hopkins University Press, 1988), 83.
13 Haeckel, *Wanderbilder* [p. 3 of the unnumbered pages].
14 Ernst Haeckel, *Aus Insulinde: Malayische Reisebriefe* (Bonn: Emil Strauss, 1901), 106-8.
15 Haeckel, "Vorwort," in *Kunstformen der Natur* [p. 1 of the unnumbered pages].
16 See Alexander von Humboldt, *Kosmos: Entwurf einer physischen Weltbeschreibung*, 5 vols. (Stuttgart: Cotta'scher Verlag, 1845–62), 2: 73.
17 Ernst Haeckel, "Vorwort," in *Kunstformen der Natur* [p. 1 of the unnumbered pages].
18 Ernst Haeckel, *Zur Entwicklungsgeschichte der Siphonophoren* (Utrecht: C. van der Post, Jr., 1869).
19 Ernst Haeckel, *Generelle Morphologie der Organismen*, 2 vols. (Berlin: Georg Reimer, 1866), 1: iii.
20 Haeckel, *Kunstformen der Natur*, text to plate 8.

Ernst Haeckel, *Kunstformen der Natur*, 1899–1904

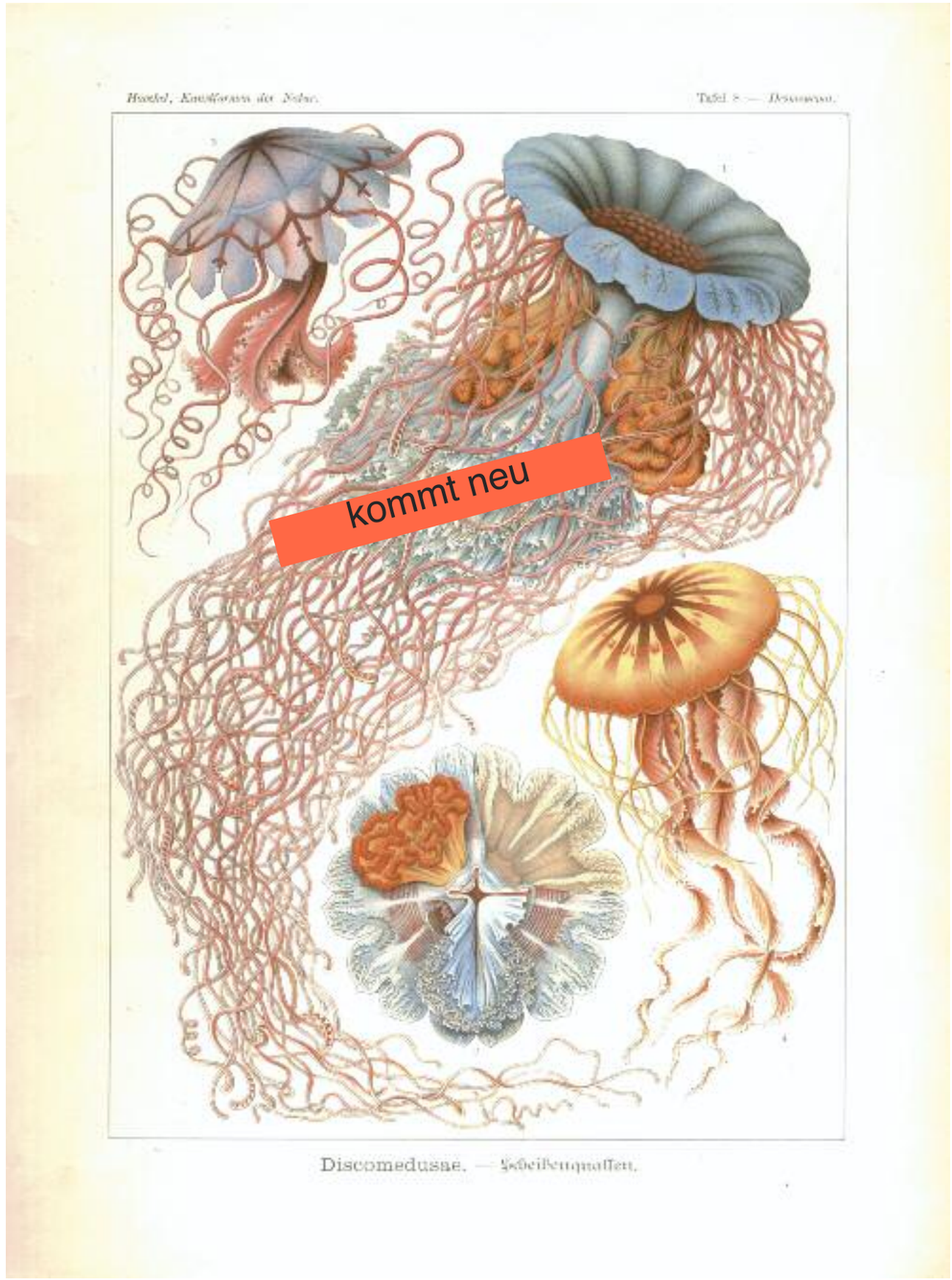


Plate 8: *Desmonema. Discomedusae.* Scheibenquallen | CAT. 66.9