The Foundations of Archetype Theory in Evolutionary Biology: Kant, Goethe, and Carus

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Charles Darwin (1809–82) was not only a creative thinker but also a creative rethinker. Darwin perceived connections among well-established concepts in biology and reconstructed them into a coherent theory of the evolution of organisms. Even the principle of natural selection had its foundation in earlier ideas, especially those concerning domestic breeding; and, of course, Thomas Malthus (1766–1834) suggested a way of conceiving how population pressure under environmental constraints might perform a function similar to that of the breeder's "picking." Even before he formulated the principle of natural selection, however, Darwin was convinced of the transmutation of species. That conviction had its proximate origins in the jolt he received in the spring of 1837 when he began sorting the specimens he had collected during his *Beagle* voyage (1831–36). John Gould (1804–81), the chief ornithologist at the British Museum, explained to the young naturalist that the Galapagos mocking birds, which Darwin had assumed to be varieties of a single species, were actually good, independent species.[1] That correction tripped a mind at the ready. Darwin, of course, was aware of the evolutionary proposals of his grandfather Erasmus Darwin (1731–1802) and of John Baptiste de Lamarck (1744–1829). But two ideas in particular seem to have prepared him for drawing the transmutation inference: the idea of the morphological unity of type and that of embryological recapitulation. Without these two notions warming the possibility, Gould's correction would not likely have struck Darwin as it did.

These two ideas were highlighted in the *Origin of Species*. In chapter 13, Darwin asked: "What can be more curious than that the hand of man, formed for grasping, that of a mole for

1 Frank Sulloway originally made this argument about Gould's intervention in "Darwin's Conversion: The *Beagle* Voyage and Its Aftermath," *Journal of the History of Biology* 15 (1982): 325–96.

digging, the leg of the horse, the paddle of the porpoise, and the wing of the bat, should all be constructed on the same pattern, and should include the same bones, in the same relative positions?"[2] This curious pattern would make sense, Darwin urged, if it derived from the limb structure of the remote ancestor of these creatures: "If we suppose that the ancient progenitor, the archetype as it may be called, of all mammals, had its limbs constructed on the existing general pattern, for whatever purpose they served, we can at once perceive the signification of the homologous construction of the limbs throughout the whole class."[3] Darwin was indebted to Richard Owen (1804–92) for the explicit notion of homology, but he had already recognized at the very beginning of his theorizing the implications of similar patterns of morphology.[4] In an early notebook, when he first speculated on the possibility of species transformation, he made use of the kind of evidence that fell under the category "unity of type." In March 1837, when he first entertained the distinct possibility of species change, he speculated on the transformation of the common rhea (ostrich) into the petite rhea and the extinct giant llama into the contemporary llama—each pair thus reflected its common type.[5] And then, of course, there were those three varieties of Galapagos mocking birds, which initially seemed subtypes of the mainland species, till Gould declared them independent species.

The second and related idea that prepared Darwin for accepting the idea of species alteration was embryological recapitulation, the notion that the embryological development of a given species retraced the morphological stages of creatures lower in classification, from the more primitive to the more advanced. For earlier naturalists, it was the idea that the human embryo, for instance, began as a simple, amoeba-like creature, then passed to something morphologically like an invertebrate, then a fish, a primitive mammal, and a primate. Darwin turned these classificatory relationships into historical relationships. This meant, as he expressed it in the *Origin of Species*, that the embryo was left "as a picture, more or less obscured, of the common parent-form of each great class of animals."[6] This notion that embryonic stages recapitulated the evolutionary stages of the phylum appeared on the first page of Darwin's first notebook devoted to his ideas on species alteration. Following his grandfather's distinction, he recognized two kinds of propagation: one in which the generated individuals were all virtually identical (budding of plants or bisection of planarians) and the other, sexual generation, during which "the new individuals pass[ed] through several stages (typical or shortened repetition of what the original molecule has done)."[7] That original molecule was Erasmus Darwin's postulation of a very simple creature that gave rise to the host of subsequent organisms in an evolutionary descent. The grandson thus adopted the model suggested by his grandfather that the development of the individual passed through the same morphological stages, though abbreviated, characterizing the history of the phylum.

2 Charles Darwin, *On the Origin of Species* (London: Murray, 1859), 434.

3 Ibid., 435.

4 Darwin explicitly mentions (ibid.) Richard Owen's *Nature of Limbs*, in which Owen examines limb patterns and denominates these as homologous, that is, having the same "meaning." Owen, as I'll indicate more fully below, formulated his notion of homology in light of Carl Gustav Carus's anatomical illustrations, though with scant reference to his source. See Richard Owen, *On the Nature of Limbs* (London: Van Voorst, 1849). Rupke details Owen's reluctant and gradual admission of his debt to Carus. See Nicolaas Rupke, *Richard Owen: Biology without Darwin*, 2nd ed. (Chicago: University of Chicago Press, 2009), 124–25.

5 Charles Darwin, "Red Notebook," MS 129–30, in *Charles Darwin's Notebooks, 1836–1844*, ed. Paul Barrett et al. (Ithaca, NY: Cornell University Press, 1987), 62–63.

6 Darwin, *Origin of Species*, 450.

7 Darwin, "Notebook B," MS 1, in *Charles Darwin's Notebooks*, 170.

These two ideas—that of unity of type and of embryological recapitulation—can be traced back to the turn of the nineteenth century and the works of Immanuel Kant (1724–1804), Johann Wolfgang von Goethe (1749–1832), and Carl Gustav Carus (1789–1869). These ideas brought all three individuals to the brink of accepting species descent, where they hovered. In what follows, I'll sketch out the views of Kant and Goethe but spend the bulk of my considerations on Carus since he gave the most detailed articulation of what became known as the theory of the archetype and provided compelling empirical evidence for the theory. It was Carus who led Owen, and ultimately Darwin, to the conception of homology.

KANT AND GOETHE ON THE VERGE OF AN EVOLUTIONARY CONCEPTION

Kant

The second part of Kant's Third Critique, the *Kritik der Urteilskraft* (Critique of the power of judgment, 1790), is devoted to teleological judgment in biology; it was a complement to the first part of the work, which dealt with the teleological character of aesthetic judgment. Kant (fig. 1) maintained that anything that would count as a *Wissenschaft* (science) would have to be mechanistic in character; that is, the parts of the whole entity would completely account for its structure and actions. Newton's physics provided the standard for Kant of what would count as a *Naturwissenschaft*, a natural science. Some features of organisms, he believed, could be understood mechanistically—for example, the light-bending action of the lens and other media of the vertebrate eye, which obeyed the Snell-Descartes law of refraction. But some aspects had to be understood as purposive structures—for example, the placement of the aqueous humor, the lens, and the vitreous humor of the eye seem to have the *purpose* of focusing a coherent image on the retina. The vertebrate eye itself also had a purpose in the economy of the organism, namely, to allow the animal to survive in its environment. Thus, the naturalist, in order to comprehend the activities of biological organisms, had to postulate a plan in terms of which one could understand the purposive traits of creatures. Such postulation, in Kant's view, was entirely regulative, that is, heuristic. By assuming that organisms were created according to a plan or idea, one could better comprehend their behavior and perhaps find a way to reduce some of their activities to mechanistic law. In the Third Critique, Kant took this heuristic approach a step further. If an idea were the cause of the structuring of an organism, then only an intellect could ultimately be the creative cause of the idea and of the organism embodying the idea. Kant designated such an intellect as an *intellectus archetypus*, an archetypal intellect. Unlike our intellect, the sensory intuitions of which depended on the existence of objects, an archetypal intellect would know its objects through an intellectual intuition, the very act of which would have simultaneously created those objects.[8] Kant postulated archetypal ideas and an intuitive intellect, however, only as a heuristic, a way of dealing with the problem of teleology and in the hope of finally bringing all the features of organisms under mechanistic law.

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8 Immanuel Kant, *Kritik der Urteilskraft* (A346–47, B289–93), in *Werke*, ed. Wilhelm Weischedel, 6 vols. (Wiesbaden: Insel Verlag, 1956–64), 5:526. By "intuition" Kant simply meant the appearance of an object to consciousness. Our intellects require sensory experience to bring an empirical object to conscious awareness. Kant drew on a medieval conception of God's intellect to make the distinction from our kind of intellect. He had introduced the conception of an archetypal intellect in a letter to a former student. See Kant to Marcus Herz, 21 February 1772, in *Briefwechsel von Immanuel Kant in drei Bänden*, ed. H. F. Fischer, 3 vols. (Munich: Georg Müller, 1912), 1:119.

FIGURE 1. Immanuel Kant (1724–1804), engraving by J. L. Raab, after a painting (1791) by Gottlieb Doebler.

Though Kant was convinced that no Newton of the grass blade would arrive—that is, no genius who might show how all the distinctive features of living beings could be understood mechanistically—he did venture to think about the conditions of that possibility. One could imagine a mechanical deformation of basic vertebrate bone structures "through shortening of one bone and a lengthening of another, through a folding back of this part and a development of that," such that "the great plethora of species might be brought forth" from a single basic pattern. It was thus conceivable that over time, "creatures initially of a less purposive form would give birth to others better fitted to their native environments and adjusted to their relationships with other creatures."[9] Kant construed that possibility in terms of the unity of type and postulated that such unity might be generated through propagation from an original archetype: "Despite all these different forms [of organisms], they seem to have been produced according to a common archetype [*Urbilde*]. This analogy of forms strengthens the suspicion of a real relationship, in light of the stage-like approach of one sort of animal to another, through generation from a common primal mother."[10] This was the kind of evolutionary process later proposed by the classicist and biologist D'Arcy Thompson (1860–1948), who also conceived of a mechanistic deformation of basic skeletal structures as causing an evolution of species.[11]

Kant was thus brought to the edge of an evolutionary conception, but he pulled back. Two considerations restrained him. First was the problem of reconciling a mechanistic conception with a teleological conception. Even with a possible mechanistic explanation for species change, there was the undeniable recognition of the goal-driven processes of biological organisms. Hence, even if a mechanistic derivation were permitted, it would still have to be governed, Kant believed, by an overall teleological process; yet an ultimate reconciliation of mechanism and teleology

9 Kant, *Kritik der Urteilskraft* (A364–66, B369–71), in *Werke*, 2:538–39.

10 Ibid. (A364, B368–69), 2:538.

11 D'Arcy Wentworth Thompson, *On Growth and Form*, 2nd ed. (Cambridge: Cambridge University Press, 1942), see especially the figures on 1062–63. I discuss Thompson's view in relation to Kant in "Objectivity and the Theory of the Archetype," in *What Reason Promises*, ed. Wendy Doniger (Berlin: DeGruyter, 2016), 26–37.

seemed impossible for our mundane intelligence. We could not consistently comprehend such reconciliation as a possibility. The second difficulty in endorsing this "daring adventure of reason," as Kant called it, was that nature provided no experiential evidence of a generation of one kind of organism from another.[12] Kant thus hesitated, but Goethe seems not to have.

Goethe

The same year, 1790, that Kant produced his *Kritik der Urteilskraft*, Goethe (fig. 2) saw published his *Versuch die Metamorphose der Pflanzen zu erklären* (Essay to explain the metamorphosis of plants). This little work was the result of Goethe's own botanical observations, especially those made during his first trip to Italy and Sicily (1786–88). The observations were coupled with some speculative conceptions drawn from Spinoza, particularly the latter's notion of an *adequate idea*, that is, an idea that would provide a direct understanding of the essence of some object.[13] In the *Metamorphose*, Goethe argued that detailed observations confirmed that one feature of a plant could be transformed into another, the stem leaves into the calix, the calix into the petals, and the petals into the stamens and pistil (the male and female organs), etc. He assumed that an underlying structure, which he denominated the *ideal leaf*, could be transformed through the forces of contraction and expansion into all the manifest parts of a plant. Kant would have called this underlying structure a botanical archetype; Goethe referred to it simply as the *Urpflanze*, the primal plant.[14]

Shortly after the publication of the *Metamorphose*, Goethe made a second trip to Italy (spring 1790), where he had an epiphany, at least concerning morphological theory. As Goethe later told the story, while walking along the Lido in Venice near a Jewish cemetery, his amanuensis, Paul Götze, tossed him a broken sheep's skull. Goethe recalled that when he had examined the skull, it struck him that the bony plates forming the face and braincase "had arisen from transformed

FIGURE 2. Johann Wolfgang von Goethe (1749–1832), portrait (1791) by Johann Heinrich Lips, Archive für Kunst und Geschichte.

12 Kant, *Kritik der Urteilskraft* (A366, B371 note), in *Werke*, 5:539.

13 Goethe explained to Jacobi that Spinoza's notion of adequate ideas gave him hope that his interaction with things would yield adequate—that is, essential—ideas. See Goethe's letter to Friedrich Jacobi, 3 May 1786, in *Goethes Briefe*, 4th ed., ed. Karl Robert Mandelkow, 4 vols. (Munich: C. H. Beck, 1988), 1:508–9.

14 I have discussed the argument of Goethe's *Metamorphose* in *The Romantic Conception of Life: Science and Philosophy in the Age of Goethe* (Chicago: University of Chicago Press, 2002), 416–19.

vertebrae," much as the plant consisted of transformations of the ideal leaf.[15] The play with the sheep's skull would be used as evidence by Goethe in his priority dispute with Lorenz Oken (1779–1851) about who first formulated the theory that the vertebrate skull consisted of transformed vertebrae. The dispute over the "vertebral theory of the skull" is complex, though a path through the charges and countercharges can be found, but not here.[16] Rather, I wish to highlight Goethe's argument for the extension of his morphological ideas to the vertebrates.

That application to the vertebrates comes into clear focus in his 1794 "Versuch einer allgemeinen Vergleichungslehre" (Essay on a general theory of comparison). By that time, Goethe had absorbed the message of Kant's Third Critique, namely, that organisms, even if they exhibit an internal teleology, should not be regarded as products of an external teleology, that is, as having a role in a larger cosmological scheme. The relationship of an organism to its environment, Goethe maintained, had to be regarded as nonintentional, that is, not part of a larger plan; rather, he argued that the environment of an organism modified that organism in distinctive ways. The external body of a seal, for instance, had been altered by its aquatic environment through impinging physical forces. By contrast, the seal's internal skeletal structure indicated a general pattern, an "inner kernel" (*innerer Kern*), comparable to the bone formation of land mammals.[17] Both Lamarck and the young Darwin likewise would assume that a common pattern of bones in vertebrates had been deformed to operate in a particular environment, a reconfiguration that would be heritable. Without being explicit about the transmutation of species, Goethe all but drew the conclusion.

By the first decade of the nineteenth century, Lamarckian evolutionary ideas had become notorious throughout Europe. But even before Lamarck had advanced his transmutational hypothesis, Erasmus Darwin had proposed a comparable evolutionary theory. In his *Zoonomia* (1794; 2nd ed., 1796), Darwin proclaimed: "All warm-blooded animals have arisen from one living filament, which THE GREAT FIRST CAUSE endued with animality, with power of acquiring new parts, attended with new propensities, directed by irritations, sensations, volitions, and associations; and thus possessing the faculty of continuing to improve by its own inherent activity, and of delivering down those improvements by generation to its posterity, world without end!"[18] Darwin's two-volume treatise was quickly translated into German (1795–98), and it fell into Goethe's hands.[19] He wrote Schiller in January 1798 that "I first got the book [Darwin's

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15 Goethe had made some kind of discovery in 1790 relevant to morphology, at least he so maintained to friends at the time; but he didn't specify what that discovery was. Only in his later collection, *Zur Morphologie* (1817–24), did he claim that the play with the sheep skull led to his vertebral theory. The quotation comes from his essay "Bedeutende Fördernis durch ein einzigges geistreiches Wort," *Zur Morphologie*, 2.1 (1823), in *Sämtliche Werke nach Epochen seines Schaffens* (Münchner Ausgabe), ed. Karl Richter et al., 21 vols. (Munich: Carl Hanser Verlag, 1985–98), 12:308. Goethe first publicly mentioned his conviction that the vertebrate skull was composed of six transformed vertebrae in the conclusion to his essay "Dem Menschen wie den Tieren ist ein Zwischenknochen der obern Kinnlade zuzuschreiben," *Zur Morphologie*, 1.2 (1820), in *Sämtliche Werke*, 12:190.

16 Most scholars believe that Goethe had the priority and that Oken got wind of his theory, which inspired a like view. I think there is strong evidence that the usual assumption is incorrect. I believe that both Goethe and Oken came independently to the idea and that Goethe's own construction was retrospective. I have discussed this in *Romantic Conception of Life*, 497–502.

17 Goethe, "Versuch einer allgemeinen Vergleichungslehre," in *Sämtliche Werke*, 4.2:182.

18 Erasmus Darwin, *Zoonomia; or the Laws of Organic Life*, 2nd ed., 2 vols. (London: Johnson, 1796), 1:509. (The second edition does not differ essentially from the first.)

19 Erasmus Darwin, *Zoonomie, oder Gesetze des organischen Lebens*, trans. J. D. Brandis, 3 vols. in 5 (Hannover: Gebrüder Hahn, 1795–99).

Zoonomia] at home yesterday and find it has met my expectations; indeed, basically I am favorably disposed to Darwin."[20] Further evidence of Goethe's disposition toward the transmutational hypothesis is provided by Goethe's friend the satirical writer Johannes Daniel Falk. In March 1813 Falk put the question to Goethe "whether it did not seem likely to him that all the many different animals have arisen from one another through a metamorphosis similar to that by which the butterfly has arisen from the grub." Goethe, according to Falk, was rather gnomic in his response, but he did point out: "I have given in my *Metamorphosis of Plants* the law whereby everything in nature is built up (this occurs through polarity, through generation). According to this law, things move into ever more splendidly and progressively higher syntheses."[21]

The clearest evidence of Goethe's endorsement of species transmutation comes in his response to a work by Christian Pander and Eduard d'Alton, *Das Riesen-Faultier Bradypus Giganteus* (The giant sloth, *Bradypus giganteus*, 1821). The authors commented on the giant megatherium, the fossil remains of which had been dug up in South America several years before (fig. 3). Georges Cuvier (1769–1832) had described this creature, the size of a rhinoceros, as having the same skull structure as that of the modern sloth.[22] Pander and d'Alton, in the introduction to their essay, argued that the resemblance of this ancient giant to the modern sloth was the result of a historical process of species transformation, similar to, as Goethe had shown, the transformation of the leaf into the various parts of a plant. The authors then generalized their argument: "The differences in formation of fossil bones in comparison with those of still-living animals are greater the older the rock formations in which they are found (with the fossil remains of the most recent formations quite similar to the structures of living animals). This common observation supports the assumption of an unbroken train of descent [*eine ununterbrockenen Folge der Abstammung*] as well as of the progressive transformation of animals in relation to different external conditions."[23]

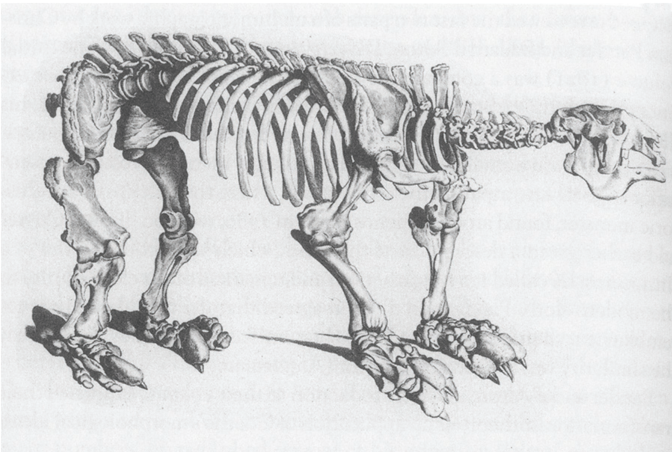

FIGURE 3. Megatherium drawn by d'Alton, in Christian Pander and Eduard d'Alton's *Das Riesen-Faultier Bradypus Giganteus* (1821).

20 Goethe to Friedrich Schiller, 26 January 1798, in *Sämtliche Werke*, 8.1:509. "Ich bin Darwin im Grunde günstig."

21 Johannes Daniel Falk, 15 March 1813, in *Goethes Gespräche*, ed. Flodoard von Biedermann, expanded by Wolfgang Herwig, 5 vols. (Munich: Deutscher Taschenbuch Verlag, 1998), 2:786.

22 Georges Cuvier, "Notice sur le squelette d'une très-grande espèce de quadrupè inconnue jusqu'à present," *Magasin encyclopédique*, 2d anée, 1:303–10.

23 Christian Pander and Eduard d'Alton, *Das Riesen-Faultier Bradypus Giganteus* (Bronn: Weber, 1821), [p. 6].

In his collection of essays *Zur Morphologie* (1822), Goethe aligned himself with Pander and d'Alton's expansion of his theory of plant morphology into a theory of historical transmutation. He wrote: "We are in perfect agreement with the authors as concerns the introduction"—the introduction being the section in which the authors identified Goethe's theory with a more general theory of transmutation.[24] Without a doubt, Goethe came to advance the hypothesis of the transmutation of species. But among the early nineteenth-century naturalists, perhaps the most interesting and significant for the further development of evolutionary considerations is Carl Gustav Carus, who did the most to construct the theory of the archetype as a stable notion in natural history.

CARL GUSTAV CARUS AND THE THEORY OF THE ARCHETYPE

Carl Gustav Carus (fig. 4) was born in 1789 and grew up in Leipzig, where he attended university. Initially he followed his father's request to study chemistry, which would be useful for the family wool-dyeing business. However, he drifted into natural-historical studies, which led him to enter the medical curriculum in 1806. His considerable artistic talent (fig. 5) directed his focus on the human body and the intricacies of its anatomy; he recalled the impetus in one of his autobiographical essays: "it was particularly the secret of the human, indeed, its animal structure, that pulled me on with strong cords."[25] While in medical school his study of the human became enveloped in the distinctively Romantic metaphysics of such writers as Lorenz Oken and Joseph Friedrich Schelling (1775–1854). Schelling convinced him not only that biological organisms manifest a teleological unity but that the entire cosmos displayed levels of a higher integrated unity—a "World-Soul" in Schelling's terms. Oken introduced him to the idea of "development" (*Entwicklung*), especially the parallel development of the human embryo and the hierarchical stages represented in the animal kingdom: "the parallel between human development from the microscopic egg, through the delicate, pliable embryo, to its perfected form as a mature human and the stages of the animal kingdom from the microscopic infusorium, through the delicate, pliable mollusk, to the anthropoid animals."[26]

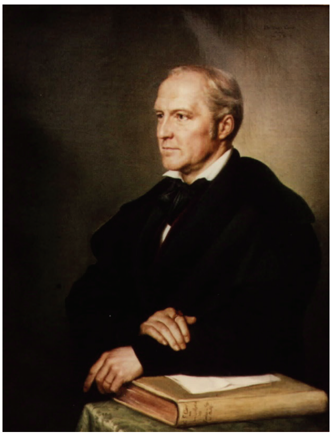

FIGURE 4. Carl Gustav Carus (1789–1869), oil painting (1844) by Julius Hübner, Frankfurt Goethe Museum. Carus's arm rests on his famous book, *Von den Ur-Theilen des Knochen- und Schalengerüstes* (1828).

FIGURE 5. *Carl Gustav Carus* (1822), self-portrait, Dresden Museum of Fine Arts.

24 Johann Wolfgang von Goethe, "Die Fautiere und die Dickhäutigen," *Zur Morphologie*, 1.4 (1822), in *Sämtliche Werke*, 12:245.

25 Carl Gustav Carus, *Mnemosyne: Blätter aus Gedenk- und Tagebüchern* (Pforzheim: Flammer und Hoffmann, 1848), 414.

26 Ibid., 422.

The young medical student felt relaxed enough to interrupt his curriculum to spend a year studying painting with Johann Friedrich August Tischbein (1750–1812), the cousin of Goethe's companion in Italy, Johann Heinrich Wilhelm Tischbein (1751–1829). Later, in 1816, he made the acquaintance of Caspar David Friedrich (1774–1840) and they became fast friends, often going out into the countryside for painting jaunts. Friedrich's Romantic landscapes, with diminished human figures, had a marked impact on Carus's own style (see fig. 6). The craft of precise representation would serve Carus well in his depictions of the structures of animals and humans that would fill his many monographs in anatomy and physiology.

For several years Carus had been working on a fully illustrated text on comparative anatomy, which was finally published in 1818 as *Lehrbuch der Zootomie*, a seven-hundred-page comparative anatomical and physiological study of the organs and structures of animals, from zoophytes and insects through fish, amphibians, birds, and mammals. Carus composed most of the drawings for the twenty copper plates of the atlas from original dissections, though he also borrowed a few from other anatomists. In the book, Carus detailed the development of comparable organ systems across various classes of animals—organs of sensation, digestion, respiration, secretion, and sexual reproduction. He also argued that the fetus of higher animals would develop through morphological stages of those lower in the hierarchy: "Just as only by progressive stages [*stufenweise*] the particular forms of the animal kingdom reach a higher perfection, so must the individual unfold in a certain progressive series."[27] However, Carus cautioned that the parallelism would not be perfect, and that the hierarchical series that was repeated in fetal development would be confined to the nature (*Bedeutung*) of its type. Carus's theory of recapitulation was hardly original with him. Other German anatomists—Lorenz Oken, Johann Friedrich Meckel (1781–1833), Gottfried Reinhold Treviranus (1776–1837), and Friedrich Tiedemann (1781–1861)—endorsed the theory.[28]

Carus's *Zootomie* surpassed all competitors in extent and detail, and its value was recognized relatively quickly with a two-volume English translation. In England, the book was used by Joseph Henry Green (1791–1863) as a text for a series of lectures (1828 and after) on comparative

FIGURE 6. *View of Dresden at Sunset* (1822), by Carl Gustav Carus, Chemnitz Museum of Art.

[27] Carl Gustav Carus, *Lehrbuch der Zootomie* (Leipzig: Gerhard Fleischer dem Jügern, 1818), 669.

[28] I have traced out the origins of the theory in *The Meaning of Evolution: The Morphological Construction and Ideological Reconstruction of Darwin's Theory* (Chicago: University of Chicago Press, 1992), chap. 3.

anatomy at the Royal College of Surgeons—a series that Richard Owen attended. For Carus, however, the book had a more personal value: it served as a gift for and an introduction to Goethe.

Carus sent the *Zootomie* to the poet in February 1818, with a note indicating that the book represented what united them and for which he revered Goethe: the close connection between art and science. The motto from Goethe that graced the title page already suggested their mutual interest: "all forms are similar and none is like the other; that chorus indicates a secret law."[29] Goethe quickly replied enthusiastically, indicating that he immediately read Carus's work and discussed it with friends. He sent Carus his own gift, the first number (1817) of his collection of essays, *Zur Morphologie* (1817–24). And so was initiated a correspondence and frequent exchange of books and articles, as well as gifts of some of Carus's paintings and illustrations, that lasted till Goethe's death in 1832.[30]

Carus first met Goethe on 21 July 1821 in Weimar, where he stopped while traveling from Dresden to Genoa, Italy. He arrived at 11:00 A.M. that morning at Goethe's house on Der Frauenplan. As he recalled, he sat nervously waiting in the parlor of the large house, surrounded by classical statuary lining the walls. "Finally, a lively step through the adjoining room announced the esteemed man himself. He was outfitted in a simple blue frock coat, boots, and displaying short, lightly powdered hair and the well-known, deeply lined face, from smoking. With a strong bearing, he stepped up to me and led me to the sofa. His seventy-two years have made little impression on him." Carus began to describe to the older man his new anatomical work on the vertebrate skeleton, which would confirm for Goethe "his earlier supposition that the head consisted of six vertebrae." When Carus sketched for him the structure of the head of a fish, "he interrupted me with an approving exclamation and joyful nods of the head: 'Yes, yes, the matter is in good hands.'"[31] A few months after Carus returned from Italy, he sent Goethe two prints from the copperplates of the book that was still being composed. Goethe quickly responded that the all-too-brief visit left him with the deep desire to have further opportunity to discuss the impending work with the young anatomist. He said he was "convinced we could expect beautiful fruit not in a while but rather quickly, since you know how to gather, secure, and order [your materials].[32] The publication, however, took more time than expected. During the next six years, Carus would keep Goethe informed as to his progress and send him several more plates of illustrations. Goethe, in turn, informed a larger public of Carus's progress by including brief summaries of the state of the young anatomist's research in subsequent numbers of his essay series *Zur Morphologie*.[33] Finally, in 1828, Carus sent Goethe a copy of his great, folio-sized *Von den Ur-Theilen des Knochen- und Schalengerüstes* (On primitive parts of the bones and the skeletal framework).[34]

29 The line is from Goethe's poem having the same title as his work in botany: *Die Metamorphose der Pflanzen.*

30 The correspondence between Carus and Goethe is reprinted with commentary by Stefan Grosche in his *"Zarten Seelen is gar viel gegönnt": Naturwissenschaft und Kunst in Briefwechsel zwischen C. G. Carus und Goethe* (Göttingen: Wallstein Verlag, 2001).

31 Carl Gustav Carus, *Lebenserinnerungen und Denkwürdigkeiten*, 4 vols. (Leipzig: Brockhaus, 1865–66), 3:10–11.

32 Goethe to Carus, 13 January 1822, in Grosche, *"Zarten Seelen,"* 19.

33 Goethe, *Zur Morphologie*, 1.4 (1822), 2.1 (1823), 2.2 (1824), in *Sämtliche Werke*, 12:250–52, 285–94, 359–60. The first two summaries were provided by Carus himself. The last mention of Carus's work came in Goethe's essay "Das Schädelgerüst aus sechs Wirbelknochen Auferbaut." In this essay, Goethe said he had from Carus "a test-print of the plates, including a wonderful table of the whole organic structure of the more perfect animals, and especially the genetic development [*genetische Entwicklung*] of the skull" (359).

34 Carl Gustav Carus, *Von den Ur-Theilen des Knochen- und Schalengerüstes* (Leipzig: Gerhard Fleischer, 1828).

In the *Ur-Theilen*, Carus credited Goethe with clarifying what had been a vague presentiment of many previous naturalists: "the idea of a metamorphosis of the bony structure, that is, awareness that the different particular structures are more or less modifications of one and the same original formation [*Ur-Gestaltung*]."[35] Carus affirmed that Goethe had initially expressed this principle of the archetype in his essay on comparative osteology (1796) and then applied it to his earlier discovery of the vertebral composition of the skull. Carus took Goethe at his word that the poet had made the discovery during his second trip to Italy in 1790 but that he revealed it to the public only in his *Zur Morphologie* in 1819. Being tactful, Carus mentioned in the *Ur-Theilen* that though Goethe had the priority, the first individual to announce publicly the vertebral theory of the skull was Oken, a man "equipped with greater intellectual power and more illuminating insight over the realm of nature . . . than his contemporaries."[36] After Oken, many French and German anatomists (Étienne Geoffroy Saint-Hilaire, Henri Dutrochet, Johann Spix, Ludwig Bojanus, and others) began to recognize the general principle of the archetype and its specific application in understanding the development of the vertebrate skeleton. Yet, the work of these contemporary researchers, in Carus's estimation, lacked the kind of systematic approach that bespoke a flexible imagination, one that considered its object with a sharp eye and mental acuity. He wished to provide that more systematic approach in his new work.

Every organic individual, Carus declared in the *Ur-Theilen*, forms a unity governing its parts; and each individual, in its turn, can be regarded as a part of its type. All individuals form the ideal whole: the whole of the realm of plants is the Ur-plant; the whole of the realm of animals is the Ur-animal. The main feature of plant life is generation (*Zeugung*): the generation of the individual through assimilation and growth and the generation of the species (*Gattung*) through reproduction of similar individuals.[37] Animals exhibit through their nervous systems an inner unity, which allows awareness (*Wahrnehmung*) of the relationship of their parts and their relationship to an external world, which arises through sensibility and ultimately through reason and freedom.[38]

Carus's division of the animal realm followed conventional distinctions but designated them by unconventional names: the *sphere of egg-like animals* (protozoa and radiolarians), the *sphere of corporal animals* (having two divisions: Mollusca and Articulata), the *sphere of cephalic animals* (having four divisions: fish, amphibians, birds, mammals), and, as a separate sphere, human beings. Carus regarded the external structures of individual members of these various animal spheres as developed out of a common Ur-part, comparable to the ideal leaf in plants. He gave the name of "vertebra" (*Wirbel*) to this part, though recognizing that only the cephalic animals exhibited proper vertebrae. The term functioned symbolically to refer to that fundamental body part that was transformed into the several structures of an organism; the term semantically

35 Ibid., vii.

36 Ibid., viii. About Goethe's priority, Carus wrote: "Concerning the priority of this recognition by one or another researcher, some doubt could be raised; nonetheless, concerning his osteological views, Goethe, in 1819, expressly stated that this recognition had not been hidden from him, namely, that the head had been constructed not merely from three but rather six vertebrae" (ibid.). Thus, in the priority dispute, Carus simply took Goethe's word that he had discovered the construction of the skull thirty years earlier. Carus met Oken at the first meeting of the Gesellschaft deutscher Naturforscher und Ärzte, which Oken organized. This small meeting occurred in Leipzig in September 1822 but would continue annually, except during the two world wars, up to the present day. Oken's influence on Carus, especially on ideas of development, was considerable, as Carus admitted in his *Lebenserinnerungen* (2:181–83).

37 Carus, *Von den Ur-Theilen*, 7.

38 Ibid., 8.

distilled Carus's doctrine of the archetype much in the way that the "leaf" captured Goethe's comparable doctrine. The most powerful support for this doctrine—and the feature of Carus's grand synthesizing scheme that would survive in the later theories of Richard Owen and Charles Darwin—was the empirical demonstration of the vertebral theory of the vertebrate skull.

Carus examined the skulls and skeletons of several classes of animals: jawless fish, teleost fish, shark, tortoise, snake, several birds (eagle, chicken), mammal (dog), and human (fig. 7). In skulls of each of these kinds of animals, he focused on the three boney plates forming the braincase and on the three major plates forming the face.[39] His illustrations showed how these six plates gradually changed, from the jawless fish, where the distinction between the anterior spinal column and the skull hardly existed, through intermediate skulls, to the plates forming the braincase and face of the most advanced creature, man. He also furnished an illustration of the "simplest schema" of the skeleton of a cephalic animal, which consisted of a vertebral column and riblike processes off the vertebrae (see fig. 7, top right). In scanning Carus's illustrations, a reader could see the gradual transformational process by which anterior vertebrae became incrementally restructured in passing through the series of lower skulls up to that of the human. But were these transformations only ideal, or did Carus have in mind historical transformations of the kind Lamarck, Erasmus Darwin, and Goethe proposed?

Carus considered the question ten years later in his *System der Physiologie*.[40] By 1838, the Lamarckian hypothesis had become well known and was essentially endorsed by several German

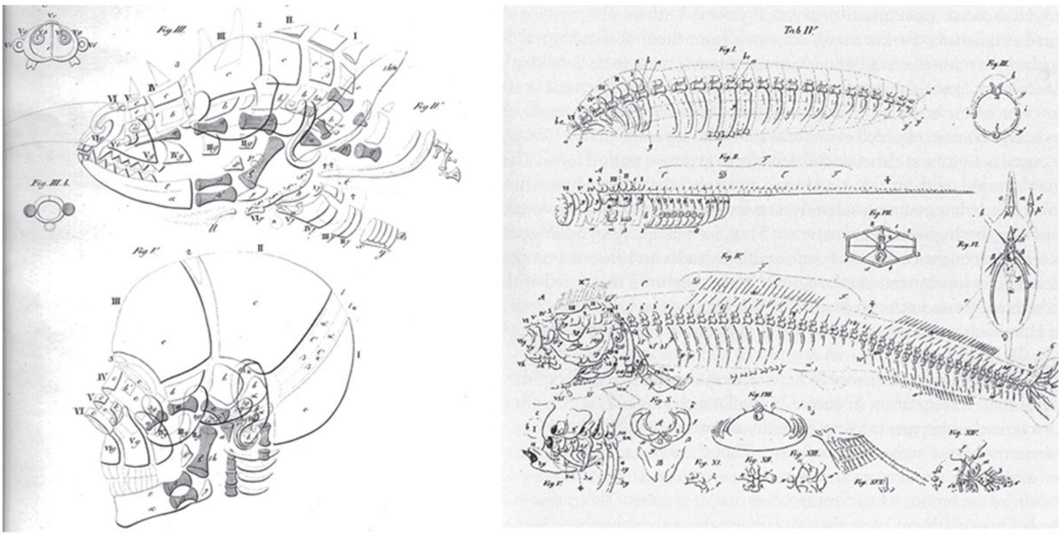

FIGURE 7. The left diagram illustrates a human skull and a dog skull, with six skull bones marked in roman numerals. The right diagram illustrates a teleost fish (fig. 4), a jawless fish (fig. 2), a vertebra (fig. 3), and the "simplest schema" (fig. 1), or the archetype, all depicting the six cephalic vertebrae. Other plates trace the six vertebrae in many other animals. From Carus's *Von den Ur-Theilen des Knochen- und Schalengerüstes* (1828).

39 A frontal plate, a parietal plate, and an occipital plate form the human braincase. In the infant skull, the frontal plate consists of two halves (left and right) joined at the metopic suture; the parietal plate consists of two halves joined at the sagittal suture. During childhood and early adolescence, these sutures fuse.

40 Carl Gustav Carus, *System der Physiologie*, 3 vols. (Dresden: Gerhard Fleischer, 1838–40).

naturalists, such as Gottfried Treviranus and Friedrich Tiedemann.[41] Carus, however, expressed reservations: "strictly speaking, we know nothing of the origin of mankind." He recognized that the geological work of such naturalists as Georges Cuvier, Alexandre Brongniart (1770–47), and William Buckland (1784–1856) indicated a period of earth's history when only plants covered the earth and a subsequent period when no-longer-existing animals, such as giant lizards, megatheriums, and mastodons, populated the earth. Only in the last period of earth's history did human beings arise, likely in the highlands of Asia, and thereafter they spread over the earth.[42] Still, "a mysterious darkness envelops the earliest evolution of humanity [*Entwickelung der Menschheit*]."[43] Despite the obscurity, Carus urged that the real evolution of humankind was mental and cultural and that the most important ability was speech, which unfolded into ideas and then into science and art. The best evidence of this kind of gradual mental evolution was provided by the varieties of mankind. Just as the individual went through periods of development, from infancy through adolescence to adulthood, so the various groups of humans displayed a comparable evolution, from the fetal stage of the Papuans to the adult stage of the Europeans. The Europeans demonstrated the greatest variability of talents, with certain individuals (e.g., Kant, Goethe) showing the great potential of humanity.

Most naturalists of the eighteenth and nineteenth centuries assumed a hierarchy of races as regards their mental and cultural standing. Charles Darwin certainly accepted a racial hierarchy, one in which some groups were more evolved than others. Only Johann Friedrich Blumenbach (1752–1840) and Friedrich Tiedemann held that any mental differences among the races were due to learning and not to intrinsic ability.[44]

During his term as president (1862–69) of the Leopoldina, the German Academy of Science, Carus read several short papers before the society on the features of the gorilla's hand and skull. He thought that those features, which were distinctively different from the human, provided evidence against the Darwinian hypothesis, even though "the gorilla in its formation stands nearer to man than it does to the other animals." But what was decisive for Carus was human mental ability, which opened up a gap (*Kluft*) that simply could not be bridged. The transition to man required, he believed, "a new act of creation."[45]

41 Gottfried Reinhold Treviranus held that the higher classes of animals arose out of lower, extinct organisms through the actions of the environment and vital forces. He also maintained that the evolution of organisms was comparable to the development of the individual. He argued this about the same time as Lamarck did. See, e.g., his *Biologie, oder Philosophie der lebenden Natur*, 6 vols. (Göttingen: Röwer, 1802–22), 3 (1805): 225: "We believe thus that the Encrinites, Pentacrinites [both fossil crinoids], Ammonites [fossil mollusks], and other zoophytes of the preworld are the original forms from which all organisms of the higher classes have arisen through a gradual evolution [*durch allmählige Entwickelung entstanden sind*]. We are of the further opinion that every species, just as every individual, has a certain period of growth, of bloom, and of death." Friedrich Tiedemann argued a similar position in *Zoologie, zu seinen Vorlesungen Entworfen*, 3 vols. (Landshut: Weber, 1808–14), 1 (1808): 73–74.

42 Carus, *System der Physiologie*, 1:107–11.

43 Ibid., 113.

44 I have discussed the racial analyses of Blumenbach and Tiedemann in "The Beautiful Skulls of Schiller and the Georgian Girl: The Quantitative and Aesthetic Scaling of the Races, 1770–1850," in *Johann Friedrich Blumenbach: Race and Natural History, 1750–1850*, ed. Nicolaas Rupke and Gerhard Lauer (Milton Park: Routledge, forthcoming).

45 Carl Gustav Carus, "Weiteres über den Gorilla und gegen die Hypothese Darwin's," *Leopoldina* 4.5 (1863): 59–61.

So Carus, like Kant, remained teetering on the edge of the evolution hypothesis. But the path to the hypothesis had already been laid in his theory of the archetype—a thoroughly developmental theory—which became, in the slippery hands of Richard Owen, the theory of homology.

CONCLUSION: THE ARCHETYPE AND THE ANCESTOR

Owen sided with Oken in the priority dispute with Goethe over the discovery of the vertebral theory of the skull. He concluded, in his "Report on the Archetype" (1846) for the British Association for the Advancement of Science, that it was Oken who not only formulated the vertebral theory but was instrumental in the spread of the idea to other anatomists, including Goethe.[46] He then generalized the findings of Oken and several subsequent anatomists into the doctrine of homology, according to which particular bones displayed the same "*Bedeutung*" (Owen's Germanophilic usage) or "nature" throughout the vertebrate phylum. He distinguished three sorts of homology: special, serial, and general. Special homology referred to the direct comparison between individual organisms: say, the plates in the skull of a human with those in the skull of an ostrich. Serial homology indicated the repetition of similar structures in an organism: say, the vertebrae or limbs of a dog. General homology characterized the relationship of certain structures to those of the ideal archetype. In his "Report on the Archetype," Owen insouciantly dismissed Carus's analysis as below the merit of his illustrations in *Von den Ur-Theilen*.[47] Yet Owen's depiction of an ideal vertebra seems modeled, without attribution, on Carus's (fig. 8), and when the "Report" was published as a small book in 1848, Owen added a plate that virtually duplicated Carus's, including a very similar depiction of the archetype (fig. 9).[48]

A significant feature of Charles Darwin's creativity was to see in the accomplishments of others what they often did not see themselves. Darwin, in his "one long argument" in the *Origin of Species*, drew components from predecessors and contemporaries and reinterpreted them. He recognized that the archetype and its more primitive derivations could be conceived of as ancestors, so that present-day creatures, like human beings and higher vertebrates, could be conceptually transformed into evolutionary descendants of the vertebrate phylum. In this way, a thoroughly Romantic conception, as Carus formulated it, became a central part of the development of modern evolutionary theory. A

46 Richard Owen, "Report on the Archetype and Homologies of the Vertebrate Skeleton," in *Report of the Sixteenth Meeting of the British Association for the Advancement of Science, September 1846* (London: Murray, 1847), 169–340.

47 Ibid., 247.

48 Richard Owen, *On the Archetype and the Homologies of the Vertebrate Skeleton* (London: Richard and John Taylor, 1848). Nicolaas Rupke explores Owen's debt to Carus in his *Richard Owen*.

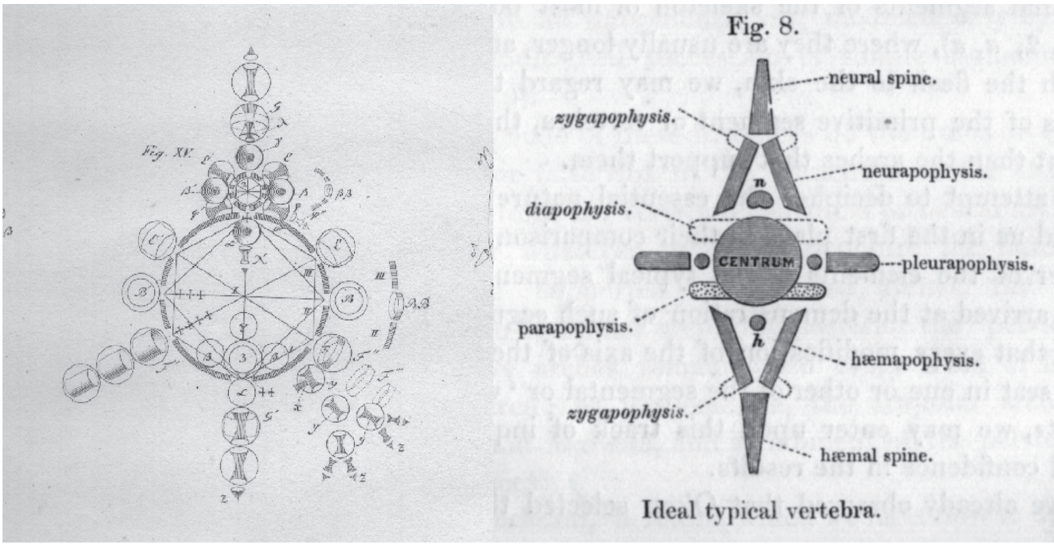

FIGURE 8. On the left, an ideal vertebra from Carus's Von den Ur-Theilen des Knochen- und Schalengerüstes (1828); on the right, an ideal vertebra from Owen's "Report on the Archetype" (1846).

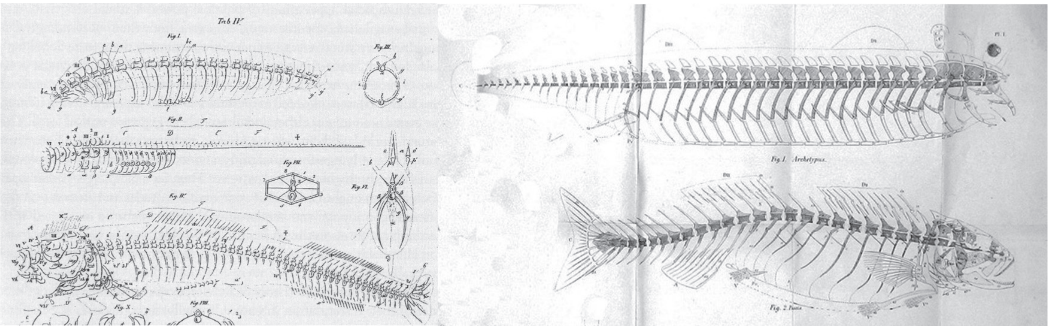

FIGURE 9. On the left, Carus's image of the archetype and two fish, from his Von den Ur-Theilen des Knochen- und Schalengerüstes (1828); on the right, Owen's image of the archetype (top) and a fish, from his On the Archetype and the Homologies of the Vertebrate Skeleton (1848).