Kant's Organicism

Epigenesis and the Development of Critical Philosophy

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The University of Chicago Press Chicago and London

Systems seem to be formed in the manner of lowly organisms, through a *generatio aequivoca* from the mere confluence of assembled concepts, at first imperfect, and only gradually attaining to completeness, although they have one and all had their schema, as the original germ, in the sheer self-development of reason. Hence, not only is each system articulated in accordance with an idea, but they are one and all organically united in a system of human knowledge, as members of one whole, and so as admitting of an architectonic of all human knowledge.

CRITIQUE OF PURE REASON, A835/B863

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Preface

Immanuel Kant has maintained an enduring intellectual presence through his works on morality, reason, history, and art. He created the first university courses on physical geography and anthropology, and throughout his career he taught logic and metaphysics alongside courses discussing everything from taste to table etiquette. It is estimated that by the time Kant died there were already well over three thousand published pieces devoted to his work, and even as Kant's general influence waned toward the end of the nineteenth century, new currents emerged such that "Neo-Kantianism" came to describe a number of schools in philosophy. Kant's moral theory remains to this day a pillar of classical ethics and a centerpiece in contemporary bioethical discussions of autonomy and patients' rights, and he continues to hold interdisciplinary appeal across various fields of law, science, and the humanities. In recent times, Kant has attracted added attention from historians of science and critical race theorists for his work in natural history and, as some have it, for his invention of the concept of race. It is such long-standing and widespread interest in Kant's work, interest stemming from all manner of intellectual backgrounds and any number of investigatory goals, that has made Kant one of the most widely discussed authors in the history of ideas.

Given the very breadth of Kant scholarship, it is perhaps useful to locate this book, at least in a topographical vein, within its appropriate region. *Kant's Organicism* starts by tracing the history of the life sciences as Kant would have come to know them, focusing especially on those

INTRODUCTION

Kant's Organicism

This book is oriented by the conviction that Kant should be fitted into a framework that has begun to take shape in a number of fields when it comes to thinking about the mid- to late eighteenth century, a framework that can be called something like "organic thinking" or, better yet, "organicism." Organicism can be defined by its view of nature as something that cannot be reduced to a set of mechanical operations. The stage for organicism was historically set by investigations into the connected concerns of natural history and embryogenesis, investigations leading to inevitable conclusions regarding nature's vitality and power. And while historians of science have long understood the centrality of these investigations to the late eighteenth century as a whole, it is increasingly the case that disciplines outside of science are now producing studies of the period along similar lines. At this point there are numerous accounts of "epigenesist poetry" and "epigenesist literature"; there are political theorists who speak of "Enlightenment vitalism," and the utopian literature of the period is said to employ "the language of epigenesis" when describing the ideal society. Indeed, in light of all this activity one cannot help but reach the conclusion that the latter half of the long eighteenth century is a period best defined by its organicism. For organicism, used interchangeably with "epigenesis," a term borrowed from embryological theory, seems best to describe the response by science and art, in politics and literature, when grasping the problems and possibilities of an irreducibly living nature.[1]

Now it has become customary for literary critics and historians alike to pay passing tribute to Kant's role in this narrative, a tribute paid almost without exception to Kant's third *Critique*, the *Critique of Judgment*, a book devoted to an investigation of nature and art. Kant's language of "reflective judgment" and his appeal to transcendental principles as heuristic guides for "orientation" were modes of epistemic caution that were for the most part ignored as the possibilities for connecting teleology and mechanism and for discovering freedom within nature and art were taken up instead by Kant's successors. There are in fact numerous points of contact between the *Critique of Judgment* and the Romantic science that would follow, but I want to investigate the degree to which Kant—and not just Kant as he was appropriated through the third *Critique*—can be located within a period defined by its organicism in order to discover in what manner Kant too would be attracted to the model offered up by "epigenesis" for thinking about questions of origin and generative processes in general. For it is my sense that epigenesist models had a significant role to play for Kant's theory of cognition, for what one might even go so far as to describe as his epigenesist philosophy of mind. And I believe that it is in fact only through attention to this influence, to seeing Kant's organicism as it were, that we can both make sense of the transcendental deduction at the heart of Kant's theory of cognition and discover the means by which his work in natural history can be meaningfully integrated into the critical system as a central part of the whole.

Before turning to Kant, however, it is worth pausing briefly to rehearse the general state of the life sciences as Kant would have first come to appreciate them in the 1750s and 1760s. By 1772 Thomas Ramsay could write that "natural history is, at present, the favourite science over all Europe, and the progress which has been made in it will distinguish and characterize the eighteenth century in the annals of literature."[2] Answering the question as to why natural history would achieve the kind of popularity it would enjoy well into the nineteenth century would take us too far afield, but at least a few of the contributing points can be made so far as these set the stage for organicism. By midcentury, for example, serious challenges had been laid down against the reigning theory of generation and indeed the general portrait of organic life as a whole. For much of the century before this, those working in the life sciences could be roughly divided into experimenters and systematists. This division is important to notice, since it is precisely the convergence of what had been parallel tracks, of experimentation with organic processes on the one hand and of the systematic classification of individual organisms on the other, that both established natural history as something that Ramsay would have recognized and became a basis for challenging the received view.

Until the 1740s, theories of generation, and of embryogenesis in particular, were oriented by a belief in the preexistence of all biological organisms. The position sounds fantastic today, but at the time, there were good reasons for its central role in biological theory. The notion that God had created every individual at the beginning of history relieved naturalists of the need to explain the means by which organisms might manage the imposition of form and force on an otherwise lifeless matter; that material being was indeed lifeless apart from God's agency had firm support from post-Reformationist schools of thought. Preexistence made room, moreover, for the increasingly secluded mechanical philosophy when it came to the explanation of organic generation. No one had been convinced by the Cartesian analysis of generation as a form of fermentation, and thus there was almost a sense of relief when mechanism assumed once more an important role to play for explaining the processes of nutrition and growth in the expansion of the previously formed yet submicroscopic individual. It was in fact the microscope that, more than anything else, lent credibility to the theory once experimenters discovered what they took to be miniature homunculi encapsulated in the "spermatic worms" seen by Leeuwenhoek in the late 1670s. Finally, it was a matter of particular convenience for the systematists to endorse preexistence so far as it ensured that for all the difficulties facing taxonomy the objects of that science would remain stable. As Linnaeus suggested, it might be tricky to determine whether the mulberry belonged with the nettles, but at least one could be sure that mulberries as a species were fixed.

The tide began to turn against preexistence theories in the 1740s, starting with Abraham Trembley's spectacular discovery of the freshwater hydra. This polyp appeared to be infinitely plastic with respect to its possibilities for regeneration. It could be sliced, severed, turned entirely inside out: in every case the hydra either regenerated the lost part, generated a second individual, or, in the last instance, simply grew a new outside altogether. The impact of this discovery cannot be overestimated for its revolutionizing effect on the life sciences. Questions poured out as a consequence of this discovery: How could preexistence theory explain this capacity? How, in this instance, could one insist on the lifelessness of the animal-machine? It hardly helped matters to note the problem of categorizing the polyp altogether, so far as it seemed to be essentially a plant with a stomach. Problems in classification had in fact begun to multiply as botanists in particular complained of the difficulty in fitting their observations to Linnaeus's system, and categories assigned to indeterminate species thus slowly began to overshadow the so-called pure lines. In the late 1740s, Pierre Louis Maupertuis, the newly elected president of the Berlin Academy of Sciences, began to collect records that he would publish on a family known for its many cases of polydactylity. If, as those records indicated, a trait could be passed on by both female and male members of the family, the basic tenets of preexistence theory had to be wrong: generation must be an active process, one clearly requiring the contribution of both mother and father in the production of an embryo. Against this kind of evidence, it almost seemed beside the point to wonder what God would have had in mind when preforming deformities such as those experienced by the family of polydactyls.

Hybrids, hydras, "monsters": these were all certainly on Georges Buffon's mind as he sat down to begin composing what would eventually grow to be some three dozen volumes on natural history. The first three volumes, appearing together in 1749, were almost immediately translated into German, and Buffon's significance in laying the groundwork for the organic view and the German strain of organicism in particular is clear. Buffon had correctly assessed the central problem facing the taxonomical system as one based on a fundamentally inaccurate view of both nature and knowledge. Nature was not rigidly demarcated along the lines proposed by the taxonomists, nor should one ever hope to completely grasp its manifold principles and operating causes when assessing its effects; at best, according to Buffon, one could adopt the strategy of a kind of game theory, using probabilities as a guide when determining the contours of our species maps. Buffon understood the consequences of his position. If research into organic processes revealed natural agency, then natural history would have to redefine itself as a discipline devoted to the *histories* of living things; it would need to commit itself, in other words, to the principle that nature was susceptible to change. And the first site of this capacity for change was embryogenesis. Devoting almost the entirety of volume 2 to the problem of generation, Buffon made development the basic biological process, the key to understanding natural history as a science of living nature. For it was here, during the composition of the embryo, that change could be affected by environmental factors such as food and climate. Change produced variation, or "degeneration" in Buffon's terms, and it both explained the experience of affinities when viewing varieties and grounded a historical sequence capable of linking, to use

one of Buffon's favorite examples, the "proud mouflon" on the mountaintop and the pathetic sheep in the field. It is Buffon, then, who best marks the moment of convergence necessary for the establishment of natural history: the previously parallel investigations into system and process converged in Buffon's natural history to produce both a new view of organic life and the basis for redefining taxonomy as a form of genealogy.

When it came to describing embryogenesis, Buffon relied on something he called an "internal mold"; it marked Buffon's attempt to provide a pseudomechanical explanation of the means by which form could be conveyed to the organic material of an embryo. Sometimes described as "mechanical epigenesis" to distinguish it from its more vitalistic conception, the term "epigenesis" was rapidly appropriated beyond any one theory to represent all positions counter to preexistence.[3] Epigenesis was, however, an old idea. Aristotle had considered the process by which the male imparted the soul—as source of both information and animation—to material provided by the female in terms that would suggest epigenesis to his later readers.[4] Thus in 1651 Harvey understood himself to be following Aristotle when using epigenesis to describe the progressive development of a chicken embryo from homogeneous mass to heterogeneously structured organism.[5] Harvey refrained from speculation regarding the basis of this organizational drive, as did Caspar Wolff, who published experimental results that he took, in 1759, to be evidence of a nutritive life force, a force that he called *vis essentialis*.[6] Wolff's observations suggested a dialectical logic underlying generation, an incessant motion that, in the case of plants, explained development as a back-and-forth motion between fluidity and solids. Epigenesis thus met a need to grasp the power and vitality of nature, but without recourse to the soul or devices such as Buffon's interior molds, it faced an impossible task with respect to the problem of form. As one critic complained, the epigenesist "needs a force which has foresight, which can make a choice, which has a goal, which, against all the laws of blind combination, always and unfailingly brings about the same end."[7] Despite this concern, epigenesis would soon become the common denominator of organicism: a model for literature and politics as much as for Romantic science itself.

Turning to Kant now, one discovers that within two years of Kant's passing the requirements that would allow him to teach, he received special permission to offer a new course, a course that Kant called "Physical Geography," which in outline carefully followed the path taken by Buffon in the first volume of his natural history. It was 1757, and Kant had already established his interest in the problem of origin. His most important works had so far been devoted to questions regarding cosmological origin, with numerous small pieces devoted to geological formation and natural processes associated with the workings of wind, fire, and earthquakes. So it comes as no surprise to learn that Kant kept abreast of debates regarding organic generation as well. On the whole, he took the prospects for any genuine advance in the life sciences to be gloomy. Physics was easily reducible to a set of mechanical causes, but, Kant asked, "Can we claim such advantages about the most insignificant plant or insect? Are we in a position to say: *Give me matter and I will show you how a caterpillar can be created*? Do we not get stuck at the first step due to ignorance about the true inner nature of the object and the complexity of the diversity contained in it?" (1:230).[8] The problem of generation was simply closed off from examination, at least so far as Kant was concerned.

It stands, therefore, as a tribute to the rising prominence of debates over preformation and the epigenesist alternative that the by then well-regarded Magister Kant took the opportunity to review the options as he saw them in 1763. The problem with preformation was that it relied on an essentially supernatural explanation, and recourses to God at this juncture in the history of science were simply no longer compelling. That said, Kant thought that "it would be absurd to regard the initial generation of a plant or an animal as a mechanical effect incidentally arising from the universal laws of nature" (2:114). What was needed was something different, a means of avoiding the supernatural solution even if all of the mechanical accounts of generation had so far failed. Mindful of the need to provide form, Kant emended the epigenesist alternative. Is it possible, Kant asked, that "some individual members of the plant and animal kingdoms, whose origin is indeed directly divine, nonetheless possess the capacity, which we cannot understand, to actually generate [*erzeugen*] their own kind in accordance with a regular law of nature, and not merely to unfold [*auszuwickeln*] them?" (2:114).[9] Kant's suggestion, in other words, proposed a compromise. Form was indeed supernaturally conceived, but while this generically maintained the stability of the species lines, the work of generating individuals actively belonged to nature. And the distance epigenesis had come from Buffon's account was clear not only from Kant's direct dismissal of that position as an "entirely arbitrary invention" but from the emphasis placed on a specifically nonmechanical account of organization.[10]

At this point in history there were a number of ways in which the term "epigenesis" was used. Above all, epigenesis referred to the production, the actual generation, of something new. And it was in this sense that detractors could link the notion to older, discredited claims regarding the spontaneous generation of flies and so on. Epigenesis, so far as it was identified with a theory like Buffon's, emphasized the fact of joint inheritance and so was associated with an account of "blending." Also in play were the two earlier accounts: Harvey's observationally based definition of epigenesis as the development of increasingly heterogeneous structures from out of an initially homogeneous mass and Aristotle's discussion of the imparted soul.

Kant was familiar with all of these uses. In his lecture course on metaphysics he contrasted the relative advantages offered by a preformation theory compared to epigenesis for couples, so far as epigenesis would require careful consideration of what the blended progeny might be like (17:416). Kant also regularly found opportunity to criticize Aristotle's account as fundamentally absurd given the impossibility of dividing or sharing a simple substance like the soul (17:672, 18:190, 18:429, 28:684, 23:106–107). And although he considered the possibility that biological epigenesis might offer a real alternative to mechanical models of generation (17:591), Kant worried over the difficulty of finding a principle that would be capable of explaining the stability of epigenetic development against potentially altering sources presented by the environment (18:574). Kant's final position regarding organic embryogenesis would sound close to the position that he had first outlined in 1763. Thus in 1790 Kant would describe epigenesis as akin to a system of "generic preformation" according to which "the form of the species [is] preformed *virtualiter* in the intrinsic purposive predispositions [*Anlagen*] imparted to the stock" (5:423), a position to be preferred so far as "it minimizes appeal to the supernatural, and after the first beginning leaves everything to nature" (5:424).[11] Two senses of epigenesis remain: the sense of it as a type of spontaneous generation and Harvey's technical description of development as a movement from undifferentiated unity to an interconnected whole of diversely functioning parts. It was these two models of biological epigenesis that would prove to be most influential for Kant's *metaphysical* account of cognition, an influence that would in turn clarify Kant's subsequent investigations into natural history.[12]

Starting in the mid-1760s Kant's attention began to turn away from concerns regarding cosmological and biological origin and toward a constellation of problems surrounding the basis of knowledge and, in particular, the origin of ideas. The problems were pressing. In metaphysics and natural science alike confusion reigned, according to Kant, as the result of insufficient attention to the bases upon which claims were being made and the careless, free-flowing use of vocabularies across the sciences. It was simply wrong to take concepts borrowed from physics, concepts like attractive and repulsive forces for example, and apply them uncritically when attempting to explain something like the metaphysical connection between body and soul. And the attempt in the life sciences to establish something like Wolff's *vis essentialis* as an actual "principle of life" or soul within matter was no different (28:275, 283). In each case a force was asserted to explain an effect that might very well be acknowledged to exist but that resisted all mechanical attempts at explanation nonetheless (2:331). Mechanical explanation, as Kant came increasingly to believe, was the only kind available with respect to determinate knowledge of nature. Thus while Kant ultimately took generic preformation to offer the most defensible response to the problem of generation, this was an endorsement with a caveat. So long as the keys to organic processes resisted mechanical reduction, they simply could not be known with the kind of certainty afforded the nonbiological sciences of mechanics and physics. Biology could not, therefore, be realized as a complete science, and all hypotheses regarding organic formation and natural history at large would have to remain heuristic at best.

This was not the case, however, for investigations into the cognitive processes underlying the generation of knowledge. Once Kant declared metaphysics to be henceforth known as a science of the extent and limits of knowledge, the first task was to examine the basis of its claims. Taking stock of his options, Kant considered the alternatives offered by Leibniz and Locke. Leibniz, no less than the preformationists, on Kant's view, relied on a supernatural explanation when it came to the origin of ideas. Locke's insistence on a sensible basis, however, failed to appreciate the role played by mental reflection when generating concepts that were irreducible to sense data (28:233). In contrast to either of these positions, Kant was ready by 1771 to describe his own position as "epigenetic." The "real principle of reason," Kant now argued, rests "on the basis of *epigenesis* from the use of the natural laws of reason" (17:492). Only one year before, Kant had had to content himself with tracing intellectual concepts back to what he had then described as their "original acquisition" via attention to the lawful workings of the mind. While this had allowed Kant to avoid the alternatives of concepts that were either sensible or innate, the explanation of just what was meant by "original acquisition" was missing. By subsequently identifying epigenesis as the model for cognition, Kant seems, to borrow Darwin's phrase, to have at last found "a theory by which to work."[13]

When Kant began work in earnest on the series of investigations that would lead to the publication of the *Critique of Pure Reason* in 1781, he stopped publishing entirely in the subject matter of the *Critique*. It is thus a matter of special significance to see that Kant's main publications during this period were in natural history, for only these could be conceptually linked to the somewhat parallel investigations into the bases of cognition. Kant's single appearance in print between 1770 and 1775 was the review of an Italian anatomist's discussion of the structural similarities between humans and animals, similarities that, in the anatomist's view, led to the conclusion that all manner of ailments resulted from humanity's "unnatural" state of two-footedness (2:421–425). In his response, Kant deferred to the medical expertise of the anatomist, but suggested, nonetheless, that a fundamental difference remained so far as humans alone contained "a germ of reason" (*ein Keim von Vernunft*), which if developed (*entwickelt*) would destine them for society; it was a point that Kant would continue to raise against Moscati, named or not, in subsequent lectures on physical geography and anthropology. During the remainder of the decade Kant would gradually come to realize the full consequences of what it might mean to have an epigenesist conception of mind, a mind that, like the organism itself, would have to be viewed as operating according to a kind of reflexive or organic logic according to which its unity must be viewed as both cause and effect of itself.

Until the middle of the 1770s Kant took the generation of representations to be something requiring a juggling of factors directly parallel to those in play when considering organic generation. There had to be something regular, like a set of rules, guaranteeing uniformity of production. There had to be material content, and there had to be some kind of force, something capable of putting the parts together according to the rules. Finally, there had to be something capable of maintaining the unity, if not the identity, of the whole—a simple enough set of requirements perhaps, but the work, as usual, lay in the details. The immediate challenge concerned the specific connections between the various mental faculties in play—the faculty of understanding as home to the rules, sensibility as provider of material content, and *eine bildende Kraft*,[14] a formative power capable of connecting the material to the rules—a challenge exacerbated by Kant's commitment to a solution relying on neither supernaturally preformed ideas nor the empiricists' appeal to sense. The intellectual intuition of innate ideas simply smacked of "lazy philosophy," according to Kant, while the empiricists invited a skepticism that could only damage sciences grown increasingly reliant on induction.

By 1775 Kant had made good progress. Intellectual concepts—concepts like "substance" and "causality"—were now said to be based on rules for the logical positioning of sense data. Logical positioning explained how judgments were formed; indeed it defined cognition as a whole so far as cognition was now said to "consist in judgments" (17:620). Experience would be lawful and skepticism thereby avoided to the extent that cognition predetermined it according to the rules of logical positioning. Kant had in fact already been clear since 1770 on the fact that truth could be won so far as attention was paid to the rules for constructing appearances, rules that amounted to determining the logical connection between predicates in a judgment. The advance since then was to identify *concepts* with the rules for logical connection (17:614). It was from these rules that Kant could understand the epigenesis of concepts from the use of the natural laws of reason. But what was the status of these laws and rules? Were they in fact as preformed as the *supernaturally* preformed germs generically maintaining the species lines? Kant's notes during this period concentrate on the process of judgment formation itself, with page upon page devoted to working out the steps between a "principle of disposition" (*Disposition*) or "aptitude" (*aptitudo*) for organization (17:656) and the "exposition" (*exposition*) of this organization as a kind of exhibition, expounding, or realization of the rules themselves (17:643, 644, 648, 656, 660, 662).[15] This exposition of the rule, a representation of logical connection, generated unity, according to Kant, since the connecting of predicates in a judgment was precisely what unified an aggregate of sensation into a meaningful system of representation.

It was at precisely this stage in Kant's reflections that he took up the option of attaching a short essay to his regular set of course announcements for the 1775–1776 school year. It would be the last time Kant would publish this kind of advertisement, this time to announce that the course on physical geography would be taking up a question of increasing interest in natural history, namely, the explanation of race. Polygenesists had been maintaining that races represented distinct lines of creation, that they were in fact so many different kinds or species. Kant, following Buffon's adoption of interfertility as the only suitable criterion for determining species, argued instead for monogenesis. The job for naturalists interested in explaining the grounds of racial difference was therefore twofold, explaining the causal basis of such adaptation—for Kant took the generation of racial characteristics to have originally been an adaptive response to environmental conditions—and explaining the patterns of geographic isolation with respect to these adaptations, explaining, in other words, why similar occasioning causes like high heat and aridity did not seem to have produced similar races in all such locations with those characteristics.

Our interest concerns Kant's explanation of adaptation so far as it returns us to the language of germs and dispositions. By this point preexistence theorists had had to respond to discoveries like those regarding the regenerative possibilities of the hydra. And the most successful response, by far, had been put together by the Swiss naturalist Charles Bonnet. Bonnet had argued that organisms contained innumerable germs, germs containing the imprint of the species, and Kant seems to have had a similar strategy in mind when discussing the basis of biological adaptation.[16] According to Kant, the only way to explain environmental adaptation was to suppose the preexistence within species lines of "germs" for new parts and "natural predispositions" for proportional changes to existing parts. Kant took the case of birds as his first example in the course announcement. As he explained it, "In birds of the same kind which yet are supposed to live in different climates there lie germs for the unfolding of a new layer of feathers if they live in a cold climate, which, however, are held back if they should reside in a temperate one" (2:434). But how was one to understand the existence of such spectacular provisions for adaptation? Surely neither chance nor mechanical laws could explain the existence of germs purposed for the possibility of an organism's adaptive needs. "The human being," Kant continued, "was destined for all climates and for every soil; consequently, various germs and natural predispositions had to lie ready in him to be on occasion either unfolded or restrained, so that he would become suited to his place in the world and over the course of the generations would appear to be, as it were, native to and made for that place" (2:435). What Kant wanted was a lawful basis for adaptation. The existence of germs purposed for human survival across climate and geography seemed to explain both the fact of adaptation and its inheritance. Like Harvey's definition of epigenesis as the movement from homogeneous unity to increasingly distinct parts, the natural history of the human species could be viewed similarly with monogenetic unity securing phyletic connection and germs providing the rules for subsequent differentiation. But this kind of conclusion, as always with biological explanations, carried a caveat. So long as the actual histories of species remained unknown, natural history as a genealogical enterprise would fail to offer precisely that set of laws required for its establishment as a science. The "physical system for the understanding" (2:434), as Kant called it in 1775, would never be realized as an empirical science.

Returning to his work on the *Critique of Pure Reason*, Kant was ready to make a distinction, one that would prove to have a deep conceptual impact on the critical project as a whole. There had to be different grounds for unity in cognition: the rule-based unity of judgments at the heart of representation, and the unity of reason itself—in Kant's words, a "unity of experience" on the one hand and the "unity of *the self-determination of reason* with regard to the manifold of the unity of rules or principles" on the other (17:707–709, italics mine). By describing the unity of reason as a case of "self-determination" Kant had finally located an epigenetic beginning, an origin that was neither supernatural nor empirical but spontaneous. And it was only in the vein of something that could be metaphysically conceived as *self-born* that the unity of apperception could be subsequently referred to as "pure spontaneity" or as "transcendentally free." The rules and intellectual concepts responsible for generating a unified experience would subsequently be described as having been themselves generated, as a set of diversely functioning parts, from out of reason itself. Rather than lying like preformed germs and dispositions, the rules would operate, therefore, like *emergent* properties,[17] constructing experience at the same time that they gave definition to spontaneity itself, realizing or "perfecting" it through their lawful operation. Thus while the unity of reason could be conceptually distinguished from the unity of rules for constructing experience, like an organism, cognition functioned as a set of parts whose thoroughgoing connection realized unity even as the grounds of that unity preceded it. This was a different logic at work than that driving the discursive logic of judgment formation; it was a reflexive logic according to which the unity of apperception was both cause and effect of itself, or, as Kant would put it in another context, both author of and subject to its own laws.

The *Critique of Pure Reason* finally appeared in 1781. It was a book whose energies were divided between attention to the positive account of rules for coherent experience and the negative work of outlining reason's capacity for illusion in its desire to push past the boundaries it had itself set as the ground of experience. The necessity ascribed to the rules for experience became a matter of *genealogy*, as Kant now described

the connection between unity of rule and unity of apperception on the basis of their organic affinity. "How," Kant asked, "are we to make comprehensible to ourselves the thoroughgoing affinity of appearances, whereby they stand and *must* stand under unchanging laws?" (A113). Kant's answer lay in neither the kind of "special affinity" affirmed by Leibniz and responsible for connecting innate ideas and intellectual intuition nor the "natural affinity" thought by Hume to form the basis of laws for imaginative association.[18] Organic affinity, in contrast to either of these accounts, secured necessity or lawfulness in experience so far as the rules for connection had their "birthplace" in apperception (A66/B90). "The objective ground of all association of appearances," Kant now declared, "I entitle their *affinity*. It is nowhere to be found save in the principle of the unity of apperception, in respect of all knowledge which is to belong to me" (A122). This was Kant's response to skepticism: rules guaranteed the coherence of experience, and the unity of apperception secured the origin and thereby the legitimacy of the rules. "Our skeptical philosopher," Kant explained, ignored the genealogy of our concepts or rules and thus "proceeded to treat the self-increment of concepts [*diese Vermehrung der Begriffe aus sich selbst*], and, as we may say, this self-birth [*die Selbstgebärung*] on the part of our understanding (the same as of our reason), without impregnation by experience [*ohne durch Erfahrung geschwängert zu sein*], to be impossible" (A765/B793). Only the "self-birth" of reason or, as Kant would later add, the "epigenesis of reason" (B167) could finally secure the coherence of experience. Kant's transcendental deduction, where "deduction" represents a term borrowed from the legal work to determine rightful *inheritance*, could not, therefore, have been more aptly named given the vocabularies of origin and birthright at play.

With the *Critique of Pure Reason* in place, Kant was able to return with greater clarity to natural history. Reviewing Johann Herder's attempt to avoid both preexistence and mechanism in his appeal to a "genetic force" at the basis of adaptations, Kant was ready to agree,

> only with this reservation, that if the cause organizing itself *from within* were limited by its nature only perhaps to a certain number and degree of differences in the formation of a creature . . . then one could call this natural vocation of the forming nature also "germs" or "original predispositions" without thereby regarding the former as primordially implanted machines and buds that unfold themselves only when occasioned as in the system of evolution, but merely as limitations, not further explicable, of a self-forming faculty, which latter we can just as little explain or make comprehensible. (8:62–63)[19]

In 1775, Kant's effort to discover the means for lawful adaptation had stopped with the supposition of germs purposed toward the adaptive needs of an organism. By 1784 Kant was prepared to heuristically mirror the language of cognition such that heritable traits, no less than the rules for experience, emerged to limit and therefore realize, constrain and thereby form, a freely exercised power of life.

Without a mechanical explanation of necessary inheritance, Kant turned to a basic tenet of the first *Critique*, namely, that all necessity without exception must have a transcendental ground (A106). The unity of apperception was the transcendental ground guaranteeing the necessary coherence of experience. But in the natural history of the human species no such ground could ever be discovered. It could only be asserted therefore as a transcendental principle: a principle serving as a condition—not for the construction of experience but for the possibility of orientation within it. How can we understand natural history as a genealogical exercise, one capable of providing, in Kant's words, a genuine "archaeology of nature" (5:419)? In the case of the human species it is by asserting the monogenesis of our kind, a phyletic unity requiring the possibility of differentiation from the start given the vagaries of climate and geography (8:99).[20] But the *lawfulness* of original adaptation, the *necessity* of subsequent inheritance, these can therefore only rest on a transcendental principle regarding the unity of our species, a principle we supply as a unifying law of reason, a law that reason gives to *itself* in its investigation of nature as seen through the lens of teleology. This was Kant's solution to the complaint he had first voiced in 1763 regarding the need for recourse to some kind of explanatory principle besides mechanism or God. It was a solution that could yield a productive means for the investigation of nature while still remaining faithful to the limits of our claims.

By setting limits on the use of transcendental principles regarding nature's unity and purposiveness, Kant expressed a note of epistemic caution that would go unheard by his successors. Convinced of nature's vitality, naturalists and philosophers would make use of Kant's work as they saw fit. The most significant transformation of Kant's work concerned the use of transcendental principles themselves, since these tools for *thinking* about nature would be subsequently ascribed to nature itself. This so-called constitutive use of what was meant to be only a transcendental principle for reflective judgment betrayed its lineage as more than an epistemic device, as something that was indeed itself forged out of Kant's synthesis of biological and epistemic concerns. Thus when Goethe described "intuitive perception" as the

ability to "see the ideas" at work in nature, he was identifying the archetype as something that functioned both epistemically *and* as the biologically active ground of metamorphosis.[21] This would be the case for Darwin's appeal to "common descent" as well. Descent with modification, the guiding idea behind the theory of natural selection, represented a claim meant not only to orient our investigation of nature but to ground the interconnection of nature itself. Common descent functioned like a transcendental principle so far as it oriented classification toward the search for nature's unity via phyletic lineage between organisms. But it was also more than a mere heuristic by which one could think nature's interconnection; it was the organically real ground of biological affinity, the only basis upon which Darwin could declare comparative anatomy to be "the soul of natural history."[22]

In the end, while Kant's real role in natural history might have operated through the manner in which he was appropriated, his place in the organicism of his time is best secured by his account of the epigenesis of reason, an epigenesis that was far more radical than the one Kant was willing to accord natural organisms via "transcendental principles," and one that locates Kant as a genuine forerunner of investigations into "epigenetics" and the "emergent properties" of genes that are central to discussions of embryogenesis today.

EPILOGUE

A Daring Adventure of Reason

It is easy to miss the epigraph Kant chose for the second edition of the *Critique of Pure Reason*. A long quotation in Latin, the passage was taken from Francis Bacon's preface to the *Instauratio Magna*, or "Great Renewal," an unfinished collection of philosophical writings by Bacon including the *New Organon*. In quoting Bacon, Kant must have appreciated Bacon's hope that the *Instauratio* be seen as "the foundation of human utility and dignity" and even more Bacon's claim to have put forth in his work "nothing infinite, and nothing beyond what is mortal, for in truth it [the *Instauratio*] prescribes only the end of infinite errors" (Bii). Apart from such sentiments, however, it also made sense that Kant would choose an epigraph from Bacon for the first *Critique*, given the particular nature of Kant's project. Bacon's *New Organon* had dealt with inductive logic, a logic he intended to be a replacement for the deductive logic of Aristotle's *Organon*. Kant's *Critique of Pure Reason* was meant to provide a new logic as well, a transcendental logic capable of moving beyond the merely analytic conclusions of syllogistic reasoning and capable, thereby, of securing the claims reached by way of induction. For these reasons Bacon made for an obvious choice. But what exactly were the means by which Kant had finally secured Bacon's inductive practices? The answer to this question immediately revealed to Kant's readers that the choice of Bacon—father of the "New Science"—was in fact a case of subversive appropriation on Kant's part and that what it

announced, more than anything else, was his specific intention with respect to a redefinition of empirical science altogether.

Consider the cover of the *New Organon*. It portrays a ship returning to the Mediterranean through the pillars of Hercules with the motto "Many will travel and knowledge will be increased" emblazoned below. There are sea monsters on either side of the ship, a second tribute to the mythical power of Hercules, slayer of monsters and protector of mankind. According to legend, the pillars astride the Straits of Gibraltar were remnants from the time Hercules had pulled apart the mountains in order to connect the two seas, the Atlantic and the Mediterranean. Renaissance tradition held that the pillars bore the warning "*nec plus ultra*," nothing further beyond—though Plato had long before suggested that the lost city of Atlantis might indeed be located beyond them—so ships remained within the confines of the Mediterranean as a result. The *New Organon*'s image of a ship returning in full sail from the Atlantic, unharmed by the sea monsters surrounding it and passing like Hercules through the boundaries separating the known from the new, was perfect for capturing Bacon's goals for the New Science. For it demonstrated that knowledge and discovery were possible if only one was willing to leave familiar shores, a point to be visited by Bacon again in the *New Atlantis* only a few years later.

Compare now the language by which Kant took leave of the sections devoted to the achievements of transcendental logic as he turned toward the uncharted and dangerous waters of the "transcendental dialectic." Explaining that he had finished exploring the territory of the pure understanding—an exploration that had entailed a complete survey of its parts and a measurement of its extent—Kant summarized the results of his survey: "this domain is an island, enclosed by nature itself within unalterable limits. It is the land of truth—enchanting name!—surrounded by a wide and stormy ocean, the native home of illusion, where many a fog bank and many a swiftly melting iceberg give the deceptive appearance of farther shores, deluding the adventurous seafarer ever anew with empty hopes" (A235/B294).[291] In Kant's lexicon here the "adventurous seafarer" was reason. The practices of inductive science could be performed only in the land of truth and, indeed, as Kant saw it, Bacon's ships would require mooring altogether if there were to be any hope for the empirical sciences at all. This domain, this "land of truth," might be only an island, but according to Kant it was a land containing everything required for science to succeed against dogmatism and skepticism both. The physical sciences could rest secure in the knowledge that transcendental logic had undergirded the

FIGURE 1. A ship of discovery returning through the pillars of Hercules, frontispiece to Francis Bacon's *New Organon* included in his fragmentary *Instauratio Magna* (1620). The inscription reads: "Many will travel and knowledge will be increased" (Daniel 12:4).

world of experience, a landscape wherein cognition gave the law to nature (A159/B198). It was, contra Bacon, the attempt to leave the land of truth, to book passage with the "adventurous seafarer" in search of objects whose possession were forbidden to the human mind, that caused difficulties for the investigator of nature. It was no accident, therefore, that Kant had chosen to quote Persius in the opening pages of the *Critique*: "Dwell in your own house and you will know how simple your possessions are" (Axx).

These were, of course, all words that went unheeded by an "adventurous and self-reliant reason" (A850/B878), an adventurer who was naturally disposed, indeed fated (Avii) to move beyond the boundaries of experience when looking for something more than a mechanical explanation of nature's unity. From reason's vantage point, the observation of morphological similarities between organic forms suggested that lines of natural affinities connected the web of organic life. It was an irresistible conclusion and the basis for just the sort of investigation that reason was disposed to follow. Kant took the task of the transcendental dialectic, therefore, to be the exposure of such conclusions for what they were: ideas that had been projected by reason onto nature in the first place. Thus with respect to the question of natural affinity, Kant explained that while it was a principle of general logic that the "various species must be regarded merely as different determinations of a few genera, and these, in turn of still higher genera" (A651/B680), it was only after reason had projected this principle onto nature that its genealogical investigation at the empirical level had in fact begun. Reason's idea or "transcendental principle" regarding genera was not inherent to nature; its source was reason itself, and it rose out of the unity of reason in its search for a correlative unity in nature, in reason's search, in other words, for a mirroring of its *own* organic affinity such that "even amidst the utmost manifoldness" of nature it could "observe homogeneity in the gradual transition from one species to another, and thus recognize a relationship of the different branches, as all springing from the same stem" (A660/B688). It was Kant's task, in light of this, to repeatedly remind reason that it was the author of such principles and to protect it, as in this instance, from believing that it had discovered the basis of nature's unity in nature itself. This kind of belief was indeed the hallmark of what Kant took to be a "transcendental illusion" on reason's part, and it was the history of such illusions, so far as Kant saw it, that had made it impossible to establish metaphysics as a science up until the *Critique of Pure Reason* had appeared (A663/B691, A669/B697–A671/B699).

Kant returned once more to the topic of natural unity in the *Critique of Judgment* and his account showed that he had continued, in the intervening years, to keep abreast of the latest developments in natural history. In the *Critique of Judgment* Kant acknowledged the attractiveness of particular scientific hypotheses while insisting again that these hypotheses be recognized as arising out of reason for reason's own use in its investigation of nature. Kant could readily appreciate the attraction of comparative anatomy for natural historians, remarking that it was right to look with the "archaeologist" of nature for the means by which "a common archetype" could have connected the parts of nature through a principle of affinity. The idea of an archetype could be reasonably maintained insofar as "so many genera of animals share a certain common schema on which not only their bone structure but also the arrangement of their other parts seems to be based; the basic outline is admirably simple but yet was able to produce this great diversity of species, by shortening some parts and lengthening others, by the enfolding [*Einwickelung*] of some and the unfolding [*Auswickelung*] of others" (5:418). It was reasonable for naturalists to suspect that all species were "actually akin, produced by a common original mother," a position that Kant in fact considered more plausible than counterefforts to explain the emergence of species "by the mechanics of crude, unorganized matter." Indeed, by locating the origin of species in an organic "mother," naturalists were simply demonstrating reason's own need to suppose an organized basis for the production of organized beings. It was in this manner, as Kant put it, that the archaeologist of nature made

> mother earth (like a large animal) emerge from her state of chaos and make her lap promptly give birth to creatures of initially a less purposive form, with these then giving birth to others that became better adapted to their place of origin and their relations to one another, until in the end this womb itself rigidified, ossified, and confined itself to bearing definite species that would no longer degenerate [*ausarten*], so that the diversity remained as it had turned out when that fertile formative force [*fruchtbaren Bildungskraft*] ceased to operate. (5:419)

The naturalist proposing this scheme, according to Kant, was employing a teleological lens when viewing the history of the species lines, an idea of natural affinity that had been born out of a "daring adventure of reason." It was reason that had sought out the original point from which species had emerged and begun their gradual process of differentiation and it was reason that had demanded that the archaeologist

"attribute to this universal mother an organization that purposively aimed at these creatures, since otherwise it is quite inconceivable how the purposive form is possible that we find in the products of the animal and plant kingdoms" (5:419). The search for final causes could not be eliminated from the study of nature, Kant argued, but it was a search that both began and ended with a principle rooted in reason alone.

Kant's stipulations regarding the heuristic as opposed to the constitutive use of principles supplied by reason would be unheeded by the majority of his philosophical and scientific contemporaries and successors. But the historical significance of reason's principle of natural affinity is particularly worth tracing, since it reveals the peculiar legacy of Kant's own turn to biological investigations when accounting for reason. What Kant had written regarding the natural history of reason—a system describing the means for approaching reason both as an individual and as a species with a history of transformations in its wake—was exactly the kind of account contemporary naturalists sought in their own investigations of organic life. And while the story of how Kant's synthesis of biological and epistemic considerations would be subsequently taken up and transformed by naturalists is too lengthy to be included at the end of a history of Kant's own development, one aspect of this legacy seems to require at least a brief remark.

One of the more striking aspects of Kant's appropriation by the life sciences was the way biological and epistemic considerations were fused in the use Goethe and Darwin would each make of Kant's transcendental principle of affinity. Goethe referred to Kant on numerous occasions throughout his various scientific studies and reflections. And he had been influenced by the *Critique of Judgment* in particular, even characterizing his own search for nature's archetypal forms as a case of having embarked on a deliberate "adventure of reason."[292] Darwin, by contrast, rarely mentioned Kant apart from passing references to his theory of race, but Kant's influence on Darwin by way of Goethe and the transcendental morphologists after him was still evident. For a principle of affinity worked within the systems of both of these naturalists not only as an epistemic principle for interpreting nature but as indeed a biological principle for connecting nature itself.

For Goethe, it was the archetype and its metamorphosis that would be responsible for both explaining the parts of nature and physically uniting nature as a whole. In his account of the archetype, Goethe described a point of orientation by which the naturalist could see the universal made individual insofar as the idea of the whole was always contained in the part. The archetype referred to an idea that was meant to retrain the eye, to teach it to search for the identity of the ideal and the real on view everywhere within nature. But unlike Kant's account of the principle of affinity, Goethe's approach to the archetype was not simply a matter of reflective judgments regarding the unity of nature. The metamorphosis of the archetype described the biological means by which the *actual* affinity of nature had been generated.

It was a move that would be strikingly similar to the one Darwin would make in the *Origin of Species* some half century later. Darwin's idea regarding the "common descent" of all species from one origin—Kant's womb of nature, so to speak—opened up an epistemic framework for interpreting nature on all its levels. It taught naturalists the proper approach to comparative anatomy, for example, one revealing this demonstration of affinity to be the true "soul of natural history."[293] But the idea of common descent was meant to do more than operate as the key concept for Darwin's so-called hypothetico-deductive approach. Descent with modification, as an idea for interpreting the interconnection of nature, was also intended as a description of the organic means by which such interconnection had occurred. The idea of common descent thus functioned like Goethe's archetype, as an epistemic means for the investigation of natural affinity at the same time that it was the biologically real ground of that affinity.

What these naturalists had done, from Kant's perspective, was to take reason's transcendental principle of affinity and force it into double service as a constitutive principle as well. It was perhaps easier to remember with Goethe that the archetypal ideas served as the means for teaching the scientist to see the identity of the real and the ideal, an act Goethe termed "intuitive perception," but when reading Darwin one had to be continually reminded that the idea of natural affinity was something that had been added by the investigator as a means for connecting a merely accumulated set of empirical facts. As Darwin himself would repeatedly remind readers of the *Origin of Species*, the idea of common descent simply put the facts together in a more satisfying manner than did the reigning theory regarding God's special creation of the species lines.

The main point to keep in mind when considering these appropriations of Kant's transcendental principle of affinity, however, is not the technical issue of a constitutive versus heuristic employment of the ideas of reason. What should instead be kept in view are the noticeably different agendas of Kant and the actual practitioners of natural history. They might well have inherited Kant's model of biological and epistemic synthesis from his treatment of reason, but the internal

direction of the synthesis was reversed: where the naturalists began with reason's interpretation of nature, Kant had in fact used nature as a model by which to interpret reason. In its most radical form, epigenesis offered a theory of generation that Kant found compelling as a model for interpreting reason, for approaching reason as an agent that was both cause and effect of itself. But it was precisely the radicality of this model that led investigators in Kant's day to ultimately decide that this form of epigenesis was untenable as an explanation of nature. The most plausible versions of biological epigenesis, on their view, required the introduction of a formative capacity, some explanation of the means by which form could be conveyed beyond the models of simple replication presented by either crystal formation or a "vegetative force." This was the impulse behind Maupertuis's addition of psychic characteristics to his organic molecules, it was the reason Buffon had appealed to internal molds, and it had caused Blumenbach to put a formative drive at the seat of all life.

Kant understood all of this perfectly well. But he also saw the opportunities presented for a metaphysical interpretation of reason according to the most radical, and supposedly least tenable, version of physical epigenesis. This version allowed Kant to think of reason as a creature of its own making, as something self-born yet containing germs and predispositions for the possibility of its completion within an organic system that had been generated by itself. Germs and predispositions were not physical things for Kant in this case, nor did they lie in reason in the manner of preformed ideas. They existed merely as potentialities, susceptibilities, a virtual set of possibilities that, given the right environment—a school such as the Philanthropinum perhaps—could be realized. But until that moment of realization, a moment in no way predictable within the life of the individual, the model of epigenesis allowed the openness of reason's possibilities to be maintained. Only epigenesis, for Kant, could ground the description of a human being as a being with "an aptitude for purposes generally, i.e., in a way that leaves that being free" (5:431). Kant's vision regarding moral teleology may have been well in line with traditional notions of the constraints required for the perfection of freedom, but Kant in fact conceived of such constraints as laws that had been issued from out of freedom itself. Only the most radical model of biological epigenesis could allow Kant to imagine the heart of the critical system as he did, to maintain the organic identity of freedom and law in reason, and to describe the subsequent emergence of lawful constraints—be they categories for understanding nature or postulates for determining freedom—as laws that had been generated by reason solely for the sake of its own needs and purposes.

In light of this, it is hard to imagine that Kant would not have appreciated the possibilities for thought opened up by today's discussions of "epigenetics" and "emergent properties" in the life sciences when describing the fluid processes of organic life. The least tenable model has at last become the most plausible one for imagining the irreducible quality of the organism, one demanding our amazement not because of the intricate operations of its parts but because it has forced us to acknowledge the primacy of the living organic context within which such parts can emerge to mechanically function at all. This was precisely the kind of organic model that Kant had in mind when trying to grasp reason, and it is what locates him as a genuine forerunner of the organicism of both his day and our own.

Notes

INTRODUCTION

1. Schiller's description of the ideal society, for example, was of a political organization "which is formed by itself and for itself . . . insofar as the parts have been severally attuned to the idea of the whole," a state where "every individual enjoyed an independent existence, but could, when need arose, grow into the whole organism," *On the Aesthetic Education of Man*, trans. Reginald Snell (Mineola, NY: Dover, 2004), 33, 40. Herder was equally indebted to organic models: "Thus, as natural history can only observe a plant completely if it knows how it goes from seed, bud, bloom to decay, so would Greek history be for us such a plant." "General Reflections on the History of Greece," in Herder, *On World History: An Anthology*, ed. Hans Alder, trans. Ernest Menze (Armonk, NY: M. E. Sharpe, 1997), 288. Schlegel was also indebted to such models when arguing, for example, that "just as the organic seed [*Keim*]—thanks to the constant development [*Evolution*] of the formative drive [*Bildungstrieb*]—completes its cycle, grows vigorously, blossoms copiously, matures quickly, and wilts suddenly: so it is with every type of poetry, every age, every school of poetry." *On the Study of Greek Poetry*, trans. Stuart Barnett (Albany: SUNY Press, 2001), 65. And finally, in a vein similar to Schiller's, there is of course Kant's own remark on the body politic as analogous to the natural purposiveness of the organism. For in what seems to have been an allusion to the American Revolution, Kant wrote that "in speaking of the complete transformation of a large people into a state, which took place recently, the word *organization* was frequently and very aptly applied to the establishment of legal authori-

ties, etc., and even to the entire body politic. For each member in such a whole should indeed be not merely a means but also a purpose; and while each member contributes to making the whole possible, the idea of that whole should in turn determine the member's position and function." *Critique of Judgment*, 5:375. All citations from Kant will henceforth be to *Kants gesammelte Schriften* (Berlin: Walter de Gruyter, 1902–), except references to the *Critique of Pure Reason*, which will follow standard citation practice in referring to the A edition of 1781 and the B edition of 1787 when providing academy-edition page numbers.

2. Thomas Ramsay in praise of the naturalist Thomas Pennant, "To the Lovers of Natural History," *Scots Magazine* 34 (1774): 174.
3. The terms "preexistence" and "preformation" are frequently used interchangeably by commentators to capture the difference between a description of embryological formation where the problem of form is "solved" and a description, as in the case of epigenesis, where it is not. Jacques Roger, and Peter Bowler after him, have argued for the need to clearly distinguish between these terms. "Preexistence," as Roger sees it, should strictly refer to those theories proposing that all individual embryos were made by God at the moment of creation, so that all embryos thereby "preexist" their moment of specific temporal development. Malebranche, the earliest proponent of this view, argued that all future generations of the human race existed as fully formed miniscule beings whose embryological development was nothing more—so far as form was concerned—than their enlargement. Because Malebranche believed that future generations were contained in the sexual reservoirs of current ones, his position is referred to as *emboîtement*, the "Russian doll" theory, "encasement theory," and even "individual preformation." Initially, these miniscule "homunculi" were thought to be contained in the female, a position called "ovism"; once Leeuwenhoek discovered what he called "spermatic animalcules" under the microscope in 1674, the testes were thought instead to be the storage site, a determination that was referred to as "spermism." As positions like Malebranche's began to suffer under the pressure of discoveries such as Trembley's polyp, preexistence theories were adjusted until they became by the mid-eighteenth century, with Bonnet, arguments for the preexistence of only preformed germs for the species lines. "Preformation," according to Roger's distinction, should be reserved for a position like Buffon's. In this case, the parts of the embryo are formed by the parents (who contain molds for the parts, and whose molds were originally made for the species by God), with embryological development thus akin to the assembly of preformed parts. This account was disdained by preexistence theorists as affording too much power to nature, for even granting nature the capacity for the assembly of premade parts—Buffon thought this capacity was due to a "penetrating force"—was suspicious. Buffon insisted that generation was a mechanical process and has been since identified as a "mechanical epigenesist." The position that would be cautiously endorsed by Kant, proposed the nonmechanical (i.e., organic) epigenesis of individuals according to an internalized plan for their species as a whole, a plan that was therefore only "generic" for the species line. On the argument for severing preexistence and preformation, see Jacques Roger, *The Life Sciences in Eighteenth-Century French Thought*, trans. Robert Ellrich (Stanford, CA: Stanford University Press, 1997), 259–260; and Peter J. Bowler, "Preexistence and Preformation in the Seventeenth Century: A Brief Analysis," *Journal of the History of Biology* 4 (1971): 221–244. Against this distinction, see J. S. Wilkie, "Preformation and Epigenesis: A New Historical Treatment," *History of Science* 6 (1967): 138–150.
4. Aristotle, *Generation of Animals*, trans. A. L. Peck (Cambridge, MA: Harvard University Press, 1963), 733b23–735a29. Anthony Preus explicitly identifies Aristotle's account with epigenesis when discussing these passages. *Science and Philosophy in Aristotle's Biological Works* (Hildesheim: G. Olms, 1975), 66–69, 285n6.
5. William Harvey, *Disputations Touching the Generation of Animals* (1651), trans. Gweneth Witteridge (Oxford: Blackwell Scientific, 1981). For Aristotle's influence on Harvey see James Lennox, "The Comparative Study of Animal Development: William Harvey's Aristotelianism," in *The Problem of Animal Generation in Early Modern Philosophy*, ed. Justin E. H. Smith (Cambridge: Cambridge University Press, 2006), 21–46.
6. Caspar Friedrich Wolff, *Theoria generationis* (1759) and *Theorie von der Generation in zwo Abhandlungen erklärt und beweisen* (1764), facsimile reprints (Hildesheim: G. Olms, 1966). See Wolff (1759), §§ 43–53, §168, §242 and (1764), 160. The most thorough discussion of Wolff remains Shirley Roe's *Matter, Life, and Generation: Eighteenth-Century Embryology and the Haller-Wolff Debate* (Cambridge: Cambridge University Press, 1981). Karen Detlefsen challenges some of Roe's conclusions in "Explanation and Demonstration in the Haller-Wolff Debate," in Smith, *Problem of Animal Generation in Early Modern Philosophy*, 235–261.
7. Albrecht von Haller, "Reflections on the Theory of Generation of Mr. Buffon," in *From Natural History to the History of Nature: Readings from Buffon and His Critics*, ed. and trans. Phillip Sloan and John Lyon (Notre Dame, IN: University of Notre Dame Press, 1981), 322.
8. *Universal Natural History and Theory of the Heavens* (1755), 1:215–368.
9. *The Only Possible Basis for a Demonstration of the Existence of God* (1763), 2:63–164.
10. As Kant put the point three years later, "I am convinced that *Stahl*, who is disposed to explain animal processes in organic terms, was frequently closer to the truth than *Hoffman* or *Boerhaave*, to name but a few. These latter, ignoring immaterial forces, adhere to mechanical causes." *Dreams of a Spirit-Seer Elucidated by Dreams of Metaphysics* (1766), 2:331. The spirit of Kant's compromise between preformed species lines and organically

generated individuals can easily be compared to Ernst Mayr's own summary of the way genes work. As Mayr described it in 1997, "The genotype is the preformed element. But by directing the epigenetic development of the seemingly formless mass of the egg, it also played the role of the *vis essentialis* of epigenesis. . . . [The concept of a genetic program] was thus, in a way, a synthesis of epigenesis and preformation. The process of development, the unfolding phenotype, is epigenetic. However, development is also preformationist because the zygote contains an inherited genetic program that largely determines the phenotype." *This Is Biology: The Science of the Living World* (Cambridge: Cambridge University Press, 1997), 157–158. Mayr's formulation is nicely critiqued by Jason Robert, but this is a critique that Kant's sense of the *metaphysical* epigenesis of reason ultimately avoids given its affinity with Robert's understanding of epigenesis as entailing emergent properties. See Robert, *Embryology, Epigenesis, and Evolution: Taking Development Seriously* (Cambridge: Cambridge University Press, 2004), 38–41.

11. *Critique of Judgment* (1790), 5:165–486.
12. Kant is explicit regarding the spontaneous generation or "self-birth" (*Selbstgebärung*) of reason (A765/B793; cf. 18:273–275), but Harvey's model must be inferred when considering the relationship between the various faculties and apperception or reason as their undifferentiated ground (e.g., A119, B150–154).
13. Darwin famously described his response to reading the economist Thomas Malthus's *Essay on the Principle of Population* (1798) when developing the theory of natural selection with the comment, "Here, then, I had at last got a theory by which to work." *The Autobiography of Charles Darwin, 1809–1882, with Original Omissions Restored*, ed. Nora Barlow (London: Collins, 1958), 120. For Kant's use of epigenesis in this specific sense, see also 17:554, 18:8, 18:12, 18:273–275, B167. Compared to many of the issues under discussion in Kant scholarship, there has not been a great deal of work on Kant's appeal to epigenesis in connection with his account of reason; indeed the number of commentators can be counted on two hands. The best short essays remain Günter Zöller's "Kant on the Generation of Metaphysical Knowledge," in *Kant: Analysen-Probleme-Kritik*, ed. H. Oberer and G. Seel (Wurzburg: Königshausen and Neumann, 1988): 71–90; and Claude Piché's "The Precritical Use of the Metaphor of Epigenesis," in *New Essays on the Precritical Kant*, ed. Tom Rockmore (New York: Humanity Books, 2001), 182–200. Similarly significant for their attention to the distinctive philosophical requirements of the transcendental account are Hans Ingensiep's "Die biologischen Analogien und die enkenntnistheoretischen Alternativen in Kants Kritik der reinen Vernunft B §27," *Kant-Studien* 85, no. 4 (1994): 381–393; and Brandon W. Shaw's "Function and Epigenesis in Kant's *Critique of Pure Reason*" (master's thesis, University of Georgia, 2003). The most thorough discussion is provided by Thomas Haffner in

"Die Epigenesisanalogie in Kants Kritik der reinen Vernunft" (Ph.D. diss., Universität des Saarlandes, 1997). An older essay concentrating mainly on an explanation of the biological vocabulary used by Kant in the B deduction is provided by J. Wubnig, "The Epigenesis of Pure Reason: A Note on the *Critique of Pure Reason*, B, sec. 27, 165–168," *Kant-Studien* 60, no. 2 (1969): 147–152. A. C. Genova discusses the epigenesis of reason in the B deduction but primarily through the lens of Kant's later remarks regarding the epigenesis of organisms in the *Critique of Judgment*. See "Kant's Epigenesis of Pure Reason," *Kant-Studien* 65, no. 3 (1974): 259–273. The assumption that Kant's attitude toward epigenesis in biological organisms is the key to interpreting his account of the epigenesis of reason, is made by the majority of commentators, including Phillip Sloan's influential essay, "Preforming the Categories: Eighteenth-Century Generation Theory and the Biological Roots of Kant's A Priori," *Journal of the History of Philosophy* 40 (2002): 229–253; and John Zammito's several discussions indebted to Sloan's interpretation on this point, including most notably " 'This Inscrutable *Principle* of an Original *Organization*': Epigenesis and 'Looseness of Fit' in Kant's Philosophy of Science," *Studies in History and Philosophy of Science* 34 (2003): 73–109. Ingensiep's response to the Sloan-Zammito interpretation is worth noting: "Organism, Epigenesis, and Life in Kant's Thinking," *Annals of the History and Philosophy of Biology* 11 (2006): esp. 70–73. Marcel Quarfood reaches different conclusions than Sloan and Zammito regarding Kant's supposed attitude toward preformation, but he follows the approach starting with Kant's biological discussions when considering the epigenesis of reason. See his *Transcendental Idealism and the Organism: Essays on Kant* (Stockholm: Almqvist and Wiksell International, 2004). This is also the case in Helmut Müller-Sievers's discussion of Kant in *Self-Generation: Biology, Philosophy, and Literature around 1800* (Stanford, CA: Stanford University Press, 1997); and in François Duchesneau's "Épigenèse de la Raison pure et analogies biologiques," in *Kant Actuel: Homage à Pierre Laberge*, ed. F. Duchesneau, G. Lafrance, and C. Piché (Montreal: Bellarmine, 2000): 233–256.

The difficulty with interpretations of the epigenesis of reason that begin with, or are at least oriented by, Kant's comments on biological generation is twofold. First, inadequate attention is typically given to the difference in status between transcendental and natural considerations, and thus to the specter of subreption regarding the latter. Second, the epistemic context of Kant's metaphysical appeal to the epigenesis of reason is frequently overlooked; that is, Kant's attempt to ground necessity in the face of Hume's challenge, on the one hand, and to locate the origin of knowledge in neither Locke's empiricism nor the innatism of Leibniz and Crusius, on the other. Ultimately Kant was a *metaphysician* with respect to reason, and because of this he was able to think about reason as something self-born even though he would have vigorously rejected the suggestion that he was thereby *naturalizing* reason in a vein similar (as he would have seen it) to the theory proposed by J. N. Tetens.

14. 17:736; cf. 28:231, 235, and 277, though this use is distinct from Kant's later identification of the transcendental imagination as a more fundamental ground of connection (23:18–20).
15. Kant later describes with approval Blumenbach's notion of a "formative impulse" (*Bildungstrieb*) so far as it refers to the capacity matter has for organization in the case of an organism (5:424). The formative impulse thus mirrors, as Kant interpreted it, the predisposition or aptitude of the mind for form.
16. In Bonnet's words, "I understand in general by the word germ every preordination, every preformation of parts capable by itself of determining the existence of a plant or of an animal." *The Contemplation of Nature* (1764), quoted by Bentley Glass in "Heredity and Variation in the Eighteenth Century Concept of the Species," in *Forerunners of Darwin, 1745–1859*, ed. Bentley Glass, Owsei Temkin, and William L. Strauss (Baltimore: Johns Hopkins Press, 1968), 167. Elizabeth Gasking offers a careful overview of Bonnet's views in *Investigations into Generation, 1651–1828* (London: Hutchinson, 1967), 117–129. For a recent reappraisal of Leibniz's influence on Bonnet's mature views, see François Duchesneau, "Charles Bonnet's Neo-Leibnizian Theory of Organic Bodies," in Smith, *Problem of Animal Generation in Early Modern Philosophy*, 285–314. While Bonnet was rightly famous for this "solution" to the problem of animal regeneration for preexistence theories, in his first essay on race Kant was more directly engaged with the work of Maupertuis and Buffon, each of whom also appealed to germs and dispositions in their discussion of the issues.
17. This term is used in current accounts of embryological development so far as the "epigenetic" response to environmental conditions understands actual ontogenesis as something that cannot be reduced to the simple unfolding of a genetic program. Emergent properties in this instance are "inexplicable from lower (or higher) hierarchical levels; for instance, cells' collective behavior during morphogenesis cannot be explained (or predicted) by examining the behavior of individual cells prior to cell division, differentiation, or (in animals) condensation—let alone by examining DNA sequences. This is because the formation of cell condensations is contingent not on genetic directives but rather on the spatiotemporal state of the organism and its component parts at multiple levels" (Robert, *Embryology, Epigenesis, and Evolution*, 97). A broad and relatively nontechnical recent assessment of emergent properties at work in cellular functioning is offered by Steve Talbott, "Getting Over the Code Delusion," *New Atlantis* 28 (2010): 3–27. Emergent properties in these discussions should not be confused with descriptions, for example, of appeals to "emergent vital forces" in late eighteenth-century German biology. In that context vital forces were understood to emerge from chemical-physical forces acting on

inorganic matter, and the question of a subsequently *directed* formation at the hands of these vital forces was either left open—as in the case of Caspar Wolff's *vis essentialis*—or included, as in Blumenbach's notion of the *Bildungstrieb*. A careful reconstruction of Wolff's position on this point is in François Duchesneau, "'Essential Force' and 'Formative Force': Models for Epigenesis in the Eighteenth Century," in *Self-Organization and Emergence in Life Sciences*, ed. B. Feltz, M. Crommelinck, and P. Goujon (Dordrecht: Springer, 2006), 171–186, esp. 173–175. Timothy Lenoir nicely describes Blumenbach's position, according to which "the *Bildungstrieb* was not a blind mechanical force of expansion which produced structure by being opposed in some way; it was not a chemical force of 'fermentation,' nor was it a soul superimposed on matter. Rather the *Bildungstrieb* was conceived as a teleological agent which had its antecedents ultimately in the inorganic realm but which was an emergent vital force." "Kant, Blumenbach, and Vital Materialism in German Biology," *Isis* 71 (1980): 83.

18. Leibniz describes this kind of special affinity in the *New Essays on Human Understanding* (1705), ed. and trans. Peter Remnant and Jonathan Bennett (Cambridge: Cambridge University Press, 1996), 80. Hume, on Kant's reading, "confounds a principle of affinity, which has its seat in the understanding and affirms necessary connection, with a rule of association, which exists only in the imitative faculty of imagination, and which can exhibit only contingent, not objective, connections" (A766/B794, cf. 4:259). See Hume, *A Treatise of Human Nature* (1739–1740), ed. L. A. Selby-Bigge, rev. ed., ed. P. H. Nidditch (Oxford: Oxford University Press, 1978), 504n71.
19. The "system of evolution" refers in this case to preexistence theory, specifically the encasement or "*emboîtement*" model of generation. For more discussion of this see n. 3.
20. An archaeology of nature attempting to link species, while not inconsistent as a judgment of reason, has no empirical evidence and therefore amounts to what Kant describes as a "daring adventure of reason" (5:419n1). Judgment regarding the unity of humanity as a result of their monogenesis has at least the evidence of interfertility in its support.
21. Johann Wolfgang von Goethe, "Fortunate Encounter" (1794), in *Scientific Studies*, trans. and ed. Douglas Miller, vol. 12 of *Goethe's Collected Works* (New York: Suhrkamp, 1983), 21. Cf. "What I had undertaken to do was nothing less than to present to the physical eye, step by step, a detailed, graphic, orderly version of what I had previously presented to the inner eye conceptually and in words alone, and to demonstrate to the exterior senses that the seed of this concept might easily and happily develop into a botanical tree of knowledge whose branches might shade the entire world." "Later Studies and Collections" (1817), in *Goethe's Botanical Writings*, trans. and ed. Bertha Mueller (Woodbridge, CT: Ox Bow, 1952), 97. Robert J. Richards highlights the shift from a heuristic to a constitutive use of Kant's

approach to nature in "Kant and Blumenbach on the *Bildungstrieb*: A Historical Misunderstanding," *Studies in the History and Philosophy of Biological and Biomedical Science* 31 (2000): 11–32. See also Richards's *The Romantic Conception of Life: Science and Philosophy in the Age of Goethe* (Chicago: University of Chicago Press, 2002), chap. 5., 216–237.

22. "This resemblance is often expressed by the term 'unity of type': or by saying that the several parts and organs in the different species of the class are homologous. The whole subject is included under the general name of Morphology. This is the most interesting department of natural history, and may be said to be its very soul." Darwin, *The Origin of Species by Means of Natural Selection; or, The Preservation of Favoured Races in the Struggle for Life* (1859) (London: Penguin Books, 1968), 415.

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23. See, for example, "De Anima," 415b, 9–30, in *The Complete Works of Aristotle*, ed. Jonathan Barnes, vol. 1 (Princeton, NJ: Princeton University Press, 1984). For some discussion of the role played by metaphysics for Aristotle's theory of sexual reproduction, see J. M. Cooper, "Metaphysics in Aristotle's Embryology," *Proceedings of the Cambridge Philological Society* 214 (1988): 14–41; A. Code, "Soul as Efficient Cause in Aristotle's Embryology," *Philosophical Topics* 15 (1986): 51–60; and D. Henry, "Understanding Aristotle's Reproductive Hylomorphism," *Apeiron: A Journal of Ancient Philosophy and Science* 39 (2006): 269–300. While the situation is more complicated when explaining the spontaneous generation of lower animals, the metaphysical models are still presupposed, and in fact synonymy is preserved. A helpful discussion of this is in D. Henry, "Themistius and Spontaneous Generation in Aristotle's Metaphysics," *Oxford Studies in Ancient Philosophy* 24 (2003): 183–208.

24. In a typical formulation Jean Calvin declares that "concerning inanimate objects, we ought to hold that, although each one has by nature been endowed with its own property, yet it does not exercise its own power except insofar as it is directed by God's ever-present hand. These are, thus, nothing but instruments to which God continually imparts as much effectiveness as he wills, and according to his own purpose bends and turns them to either one action or another." *Institutes of the Christian Religion*, ed. J. McNeil, 2 vols. (Philadelphia: Westminster, 1960), bk. 1, chap. 16, sect. 2. A well-researched discussion of the impact of Reformation theology on seventeenth-century mechanical philosophy is Gary B. Deason's "Reformation Theology and the Mechanistic Conception of Nature," in *God and Nature: Historical Essays on the Encounter between Christianity and Science*, ed. David C. Lindberg and Ronald L. Numbers (Berkeley: University of California Press, 1986): 167–191. A clear account of Boyle's work to make sense of matter in motion within the constraints set by reformers

is in Peter Anstey's *The Philosophy of Robert Boyle* (New York: Routledge, 2000), esp. 164ff.

25. The classic example of this is Borelli's *De motu animalium* (1680–1681), but Descartes's *Treatise on Man* serves just as well. A survey of contributors to the rise in mechanist anatomy is in R. S. Westfall's "Biology and the Mechanical Philosophy," in *The Construction of Modern Science: Mechanisms and Mechanics* (Cambridge: Cambridge University Press, 1977): 82–104.

26. This formative work on the part of the soul is distinct from the role played by matter with respect to individuation. On the difference see G. E. R. Lloyd, "Aristotle's Principle of Individuation," *Mind* 79 (1970): 510–529.

27. "Parts of Animals," 643b27f., in *The Complete Works of Aristotle*, ed. Barnes. See also G. E. R. Lloyd's "The Development of Aristotle's Theory of the Classification of Animals," *Phronesis* 6 (1961): 59–81. Aristotle's caution was overlooked in the face of the overwhelming practical needs facing taxonomists in the sixteenth century. The most important figure in this history was Andreas Cesalpino. Cesalpino was determined to develop botany as a proper science, but to do so he had to retrieve it from the province of medical gardeners and their chaotic classification schemes within the many *materia medica* being produced at the time. In contrast to these sorts of practical aims regarding the development of medicinal recipes, Cesalpino's interests were primarily theoretical, and he saw the development of a universal classification system to be the necessary basis for any true botanical science. Taking his lead from Aristotle, Cesalpino argued that reproduction was the essential function of a plant and that a natural system of division could therefore be established according to the parts of fructification as the most essential features of a plant. As he put it, "From the means of producing fruits many genera of plants can be distinguished. Indeed, in no other structures has nature formed such a multiplicity and distinction of organs as are seen in the fruits. . . . Therefore we shall try to investigate the genera of plants by means of the unique fructifying characters which have been provided us by the Grace of God, both in the trees and shrubs, and in other plants." *De plantis libri XVI* (Florence, 1583), bk. I, 28. Phillip R. Sloan emphasizes Cesalpino's incorporation of Aristotle in "John Locke, John Ray, and the Problem of the Natural System," *Journal of the History of Biology* 5 (1972): 1–53, esp. 9–13. For further discussion of Cesalpino see Julius von Sachs's discussion in his *History of Botany (1530–1860)*, trans. Henry Garnsey (Oxford: Clarendon, 1906), 37–66; and A. G. Morton's *History of Botanical Science: An Account of the Development of Botany from Ancient Times to the Present Day* (London: Academic, 1981), 128–148.

28. "The Origin of Forms and Qualities According to the Corpuscular Philosophy," in *Selected Philosophical Papers of Robert Boyle*, ed. M. A. Stewart (Indianapolis: Hackett, 1991), 49ff. For a lengthier discussion see Boyle's 1675 essay, "Of the Imperfection of the Chemists' Doctrine of Qualities," ibid., 120–137.

tention to the specter of subreption; it locates him among the vanguard of those concerned with the establishment of scientific practices regarding "boundary maintenance." In the mid-1770s Lavoisier ended the phlogiston debate in large part because his oxygen theory offered a new vocabulary, a new method, and above all, a severely circumscribed set of questions that the chemical scientist could ask. The model would be adopted by geology in the coming decades, and indeed all of the sciences established in the nineteenth century would eventually follow suit, with the key to their successful establishment in each case being determined by such boundary maintenance. Questions regarding (or coming out of) metaphysical speculation, religious presuppositions, or biblical interpretation—in short, questions relying on claims that were untestable and therefore unknowable—would simply lie outside of the boundaries of a given science. This is perhaps why one might say that Kant's German idealist successors were mistaken to have ignored Kant's boundaries when establishing their own systems, even if they got Kant right in taking his organic conception of reason as their starting point.

288. Kant's conclusions regarding the relationship between these modes of judgment developed directly out of his discussions of physicotheology and moral teleology in the first *Critique*, even if these were to be freshly distinguished in order demonstrate that only moral teleology was capable of yielding conviction in its proofs (5:462, 5:478).

289. Although much has been made of Kant's endorsement of Blumenbach and of questions regarding Blumenbach's influence on Kant in his discussion of epigenesis, one should not forget that, whatever influence might be claimed, Blumenbach in fact transgressed a clear boundary set by Kant between thinking about nature as purposive and claiming that nature was in fact purposive. Robert J. Richards emphasizes this difference between Kant and Blumenbach in "Kant and Blumenbach on the *Bildungstrieb*: A Historical Misunderstanding," *Studies in History and Philosophy of Biology and Biomedical Science* 31 (2000): 11–32. See also Richards's *The Romantic Conception of Life: Science and Philosophy in the Age of Goethe* (Chicago: University of Chicago Press, 2002), chap. 5., pp. 216–237. As Timothy Lenoir describes Blumenbach's position, "The *Bildungstrieb* was not a blind mechanical force of expansion which produced structure by being opposed in some way; it was not a chemical force of 'fermentation,' nor was it a soul superimposed on matter. Rather the *Bildungstrieb* was conceived as a teleological agent which had its antecedents ultimately in the inorganic realm but which was an emergent vital force." "Kant, Blumenbach, and Vital Materialism," 83. It was precisely this interpenetration of form and force—something Kant explicitly liked about Blumenbach's theory—that caused Caspar Wolff, the first author to describe vegetative growth and reproduction as a form of epigenesis, to complain about Blumenbach's position. For Wolff, force simply could not by definition also be responsible for

form. See Wolff, "Von der eigenthümlichen und wesentlichen Kraft der vegetabilischen sowohl als auch der animalischen Substanz," in *Zwo Abhandlungen über die Nutritionskraft welche von der Kayserlichen Akademie der Wissenschaft in St. Petersburg den Preis getheilt haben*. St. Petersburg: Kayserliche Akademie der Wissenschaften, 1789.

290. Kant's caution regarding the progress of the life sciences has continued relevance today. After nearly a century dominated by the genes-as-destiny model, the resistance of the organism to this kind of determination has formed the core of a recent reorganization in genetic investigations, a reframing made necessary by the discovery of the central role played by emergent, environmentally fluid switches for gene expression. The new science surrounding this discovery is called "epigenetics."

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291. Kant had played with this sort of image as early as 1772, imagining as well a difference in the inhabitants disposed to living in one or the other of the various "regions" of reason. As Kant pictured this geography in 1772, however, it was dogmatic metaphysics that formed an island of cognition, and bridges between this island and the mainland of experience were still thought to be possible: "In metaphysics, like an unknown land of which we intend to take possession, we have first assiduously investigated its situation and access to it. (It lies in the (region) hemisphere of pure reason;) we have even drawn the outline of where this island of cognition is connected by bridges to the land of experience, and where it is separated by a deep sea; we have even drawn its outline and are as it were acquainted with its geography (ichnography), be we do not know what might be found in this land, which is maintained as uninhabitable by some people and to be their real domicile by others. We will take the general history of this land of reason into account in accordance with this general geography" (17:559).

292. Goethe, "Judgment through Intuitive Perception" (1817), in *Scientific Studies*, trans. Douglas Miller (New York: Suhrkamp, 1988), 12:32. I discuss Kant in relationship to Goethe on this point more fully in "Intuition and Nature in Kant and Goethe."

293. As Darwin put it, "This resemblance is often expressed by the term 'unity of type': or by saying that the several parts and organs in the different species of the class are homologous. The whole subject is included under the general name of Morphology. This is the most interesting department of natural history, and may be said to be its very soul." *The Origin of Species*, 415.