



# Kant and Blumenbach on the *Bildungstrieb*: A Historical Misunderstanding

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In August 1790, just after the publication of his *Kritik der Urteilstkraft* ('*Critique of Judgment*'), Immanuel Kant (1724–1804) penned an admiring letter to Johann Friedrich Blumenbach (1752–1840), a young star in the medical faculty at Göttingen. Kant wanted to acknowledge an intellectual debt. He wrote:

I wish to extend my thanks for sending me last year your excellent work on the formative force [*Bildungstrieb*]. I have learned a great deal from your writings. Indeed, in your new work, you unite two principles—the physical-mechanical and the sheerly teleological mode of explanation of organized nature. These are modes which one would not have thought capable of being united. In this you have quite closely approached the idea with which I have been chiefly occupied—but an idea that required such confirmation [as you provide] through facts.<sup>1</sup>

Kant mentioned that he was having his bookseller send along a copy of the *Kritik der Urteilstkraft*, so that Blumenbach might see the use to which the concept of the *Bildungstrieb* had been put. In the *Kritik*, Kant introduced the notion of the *Bildungstrieb* at the beginning of a long appendix discussing the 'methodology of teleological judgment'. As with Blumenbach himself, Kant urged the idea both as a solution to the problem of the origin of organic form and as a way of comprehending how organisms achieved species-specific goals—both perennial concerns of philosophers of nature. Blumenbach was obviously flattered by the recognition given him by the great Königsberg sage, for in his subsequent works he usually added to his description of the *Bildungstrieb* a parenthesis, stemming directly from

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<sup>1</sup>Immanuel Kant to Johann Friedrich Blumenbach (5 August 1790), in *Immanuel Kant, Briefwechsel*, selected and annotated by Otto Schöndörffer (Hamburg: Felix Meiner Verlag, 1972), p. 466. Kant referred here to Blumenbach's *Über den Bildungstrieb*, 2nd ed. (Göttingen: Johann Christian Dieterich, 1789).

Kant's letter, which indicated that this force 'united the mechanistic with the purposively modifiable'.<sup>2</sup>

Kant and Blumenbach seem to have arrived at a remarkable agreement. The Göttingen biologist appears to have developed an idea that met rather strict philosophical requirements and, moreover, one that confirmed for the period's most famous philosopher a new perspective on the sciences of biology.<sup>3</sup> In turn, the biologist employed the language urged by the philosopher in light of the new understanding. This apparent agreement has been highlighted by several historians, who have interpreted the relationship as one in which the philosopher, detecting the potential of the conception of the *Bildungstrieb*, brought the biologist to adopt a general theory of *teleomechanism*. This historical reconstruction has Blumenbach and several other biologists of the period—such as Johann Christian Reil (1759–1813), Karl Friedrich Kielmeyer (1765–1844) and Karl Ernst von Baer (1792–1876)—agreeing with Kant that the idea of the *Bildungstrieb*, and like ideas, should be regarded as regulative or heuristic. As a regulative principle, the concept would allow the biologist to pursue the study of organisms *as if* they had developed under the aegis of a directive, vital force, while yet restricting the researcher to explaining organic activity by appeal only to mechanistic laws.<sup>4</sup>

I believe Kant and Blumenbach did perceive themselves as having reached a common understanding. I think, however, that it was really a common misunderstanding (albeit a rather creative and useful one) that they achieved—or, perhaps better said, they each adopted ideas of the other while ignoring the inimical implications of those ideas. Those historians who have portrayed the two as having actually found common and deep agreement also misunderstand, I will argue, the relationship, though with less productive outcome. In order to set the scene for this account, I will first relate a short history of certain embryological ideas that became pivotal for the Kant–Blumenbach interchange.

<sup>2</sup>See, for example, Johann Friedrich Blumenbach, *Handbuch der Naturgeschichte*, 12th ed. (Göttingen: Dieterich'schen Buchhandlung, 1830), p. 17.

<sup>3</sup>In light of a possible purist reaction, the term 'biology' and its various forms has to be flagged. Though the word itself was not used before the beginning of the nineteenth century, there is no other term that so conveniently refers to all the theoretical disciplines dealing with life. Further, its application to Blumenbach's work is hardly anachronistic. The word itself was coined by Karl Friedrich Burdach in 1800 to refer to the study of man from a zoological perspective. Gottfried Reinhold Treviranus, two years later, employed the term to designate those disciplines we retrospectively place under the rubric. See Gottfried Reinhold Treviranus, *Biologie, oder Philosophie der lebenden Natur*, 6 vols (Göttingen: Johann Friedrich Röwer, 1802–22). Jean-Baptiste de Lamarck, also in 1802, made a similar application of the term. See the discussion in Robert J. Richards, *The Meaning of Evolution: The Morphological Construction and Ideological Reconstruction of Darwin's Theory* (Chicago: University of Chicago Press, 1992), pp. 17–18.

<sup>4</sup>I have discussed this thesis in the case of Reil in Robert J. Richards, 'Rhapsodies on a Cat-Piano, or Johann Christian Reil and the Foundations of Romantic Psychiatry,' *Critical Inquiry* 24 (1998), 700–736.

## 1. Embryology and Theories of Descent in the Seventeenth and Eighteenth Centuries

From the last part of the seventeenth century and through the eighteenth, two very different theories of embryological development—each born out of distinct empirical, methodological and philosophical considerations—competed with one another for acceptance in the broader community of zoologists and physiologists.<sup>5</sup> One theory came to light in the work of the insectologist Jan Swammerdam (1637–1680). Swammerdam proposed, in his *Historia insectorum generalis* (1669), that among insects the semen of the female already contained, ‘in ideas and types according to a rational similitude’, a pre-existing adult form. The semen of the male acted, he believed, only as a stimulus to the realization of the adult type already encapsulated in the grub. Swammerdam rapidly generalized this theory, tincturing it with a Calvinistic stain: ‘the entire human race’, he concluded, ‘already existed in the loins of our first parents, Adam and Eve, and for this reason, all of human kind has been damned by their sin’.<sup>6</sup> An English reviewer of Swammerdam’s volume brought to the attention of his readership this theory, according to which embryological change consisted only ‘in a gradual and natural Evolution and Growth of the parts’.<sup>7</sup> The term ‘evolution’ thus became attached to a theory of preformation and thereafter itself would become a carrier of certain theological implications. Over the next century and a half, a conceptual linkage between embryological evolution and species evolution would gradually be laid down, and along its tracks the term itself would steadily glide.<sup>8</sup>

The rival conception to embryological evolution was much older. It originated in Aristotle’s biological theories and was confirmed, in the mid-seventeenth century, by William Harvey (1578–1657). Harvey distinguished two modes of gestation: one, *per metamorphosin*, in which all organs became immediately transformed—when, for instance, the caterpillar transmuted into a butterfly; and the other, *per epigenesin*, in which the embryo began as a formless mass and then gradually became more articulated as parts slowly started to take on definite structure—the case with vertebrates.<sup>9</sup>

During the next century, naturalists weighed the merits of the two theories, evolution and epigenesis, against careful observation and theoretical considerations. Even within the work of one thinker, the scales might dip one way then another;

<sup>5</sup>The discussion in this section is based on chapter two of my *Meaning of Evolution*.

<sup>6</sup>Jan Swammerdam, *Historia insectorum generalis*, translated from the Dutch by H. Henninius (Holland: Luchtmans, 1685), p. 45.

<sup>7</sup>Anon., ‘Review of *Historia insectorum generalis, ofte algemeine verhandel van de bloedeloose dierkens*’, *Philosophical Transactions of the Royal Society* 5 (1670), p. 2078. This is a review of the Dutch edition (1669) of the book. Note: the pagination in this volume of the *Philosophical Transactions* must have been set by a printer’s devil. There are, for instance, two sequences of pages, each containing a page numbered 2078. The quotation comes on the first of these.

<sup>8</sup>I have traced the history of the gradual change in meaning of the term ‘evolution’—as it moved from describing a theory of embryological preformation to one describing a theory of species descent—in my *Meaning of Evolution*.

<sup>9</sup>William Harvey, *Exercitationes de generatione animalium* (London: DuGaidianis, 1651), p. 121.

and indeed this is the story of the great Swiss anatomist Albrecht von Haller (1708–1777). Initially Haller endorsed preformationism, according to which ‘all the viscera, muscles, and remaining solid parts have already existed in the first beginnings of the invisible human embryo, and . . . they have at length successively become apparent in those places where they have been slowly dilated by an influxing humor and have become a visible mass’.<sup>10</sup> Two versions of the theory of evolution existed, as Haller observed: ovism, espoused by Swammerdam, according to which ‘some sort of germ or perfect human machine exists in the egg’; and spermism, advanced by his own teacher Hermann Boerhaave (1668–1738), which taught ‘that man pre-exists in the little worm and that . . . the fabric of the whole body has been delineated in the earliest embryonic stage and that it is expanded by heat and reabsorbed humor’.<sup>11</sup> When Haller offered these descriptions, he had temporarily lost faith in the evolution hypothesis. His extended observational study of fetal development and his pondering of such phenomena as limb regeneration convinced him, for a while, that epigenesis seemed the more likely process of embryogenesis. That theory, though, required the postulation of some formative force which might guide the gradual development of organs. The need for a better angel to watch over embryological formation, however, tempted Haller’s north German theology. The requirement was also out of harmony with a more sober Newtonian reluctance to have truck with metaphysical entities. In the mid 1750s, Haller began a series of careful examinations of fertilized chicken eggs and the development of their contained embryos.<sup>12</sup> He thought he observed the gradual unfolding of translucent, incipient parts out of what must have been invisible but essentially structured antecedents.<sup>13</sup> He did not, to be sure, think the parental seed to be a miniature adult that would simply balloon out. Rather the seed and then the fertilized embryo had pre-existing *nascent* parts. These embryonic elements would, during gestation, gradually alter their topology, change shape, solidify, and slowly become identifiable organs. The process of embryological development could thus be understood as a mechanical articulation and assembly of parts, an evolution, which required no mysterious forces to produce out of formless matter a little man.<sup>14</sup>

<sup>10</sup>Albrecht von Haller, in Hermann Boerhaave, *Praelectiones academicae*, edited with notes by Albertus Haller, vol. 5, part 2 (Göttingen: Vandenhoeck, 1744), p. 489.

<sup>11</sup>*Ibid.*, p. 490.

<sup>12</sup>Albrecht von Haller’s studies were published in his *Sur la formation du coeur dans le poulet; sur l’oeil; sur la structure du jaune &c*, 2 vols (Lausanne: Bousquet, 1758).

<sup>13</sup>*Ibid.*, vol. 1, p. 186.

<sup>14</sup>Shirley Roe discusses Haller’s wavering positions in her *Matter, Life, and Generation: Eighteenth-Century Embryology and the Haller–Wolff Debate* (Cambridge: Cambridge University Press, 1981). James Larson provides an extended context for understanding Haller’s views and those of opponents in his *Interpreting Nature: The Science of Living Form from Linnaeus to Kant* (Baltimore: The Johns Hopkins University Press, 1994), pp. 132–69. Jörg Jantzen’s *Physiologische Theorien* furnishes a comprehensive consideration of reproductive theories, as well as other physiological theories, that formed the background for Schelling’s thought. This monograph is included in *Friedrich Wilhelm Joseph Schelling, Ergänzungsband zu Werke Band 5 bis 9: Wissenschaftshistorischer Bericht zu Schellings Naturphilosophischen Schriften, 1797–1800* (Stuttgart: Frommann-Holzboog, 1994), pp. 375–668.

Haller's final adoption of a refined evolutionary theory received support from his fellow Swiss Charles Bonnet (1720–1793). Bonnet, in contrast to his friend, set preformationism in a larger theoretical context. He explicitly drew out the implications of the theory and advanced the doctrine of *emboîtement*, or encapsulation. According to this auxiliary conception, God had created a multitude of germs, each encapsulating an embryonic organism, which in turn carried yet smaller organisms within its own germs, down through ever smaller encased individuals—whole populations within infinitesimal seeds, enough to reach the Second Coming. From these original germs spilled forth lineages of plants and animals, producing, as Bonnet put it, a 'natural evolution of organized beings [d'Evolution naturelle des Etres Organisés]'.<sup>15</sup> In the course of ages, he suggested, universal catastrophes had swept the earth clean of living creatures, but not their germs, which flowered anew and repopulated the world. Bonnet assumed—since fossils seemed to suggest this—that after each catastrophe more perfect species came forth from the kernels of the old, and that there had been 'a continued progress of all species, more or less slowly, towards a higher perfection'.<sup>16</sup> In arguing in this fashion, Bonnet presaged the transformation of ideas about embryological evolution into those of species evolution. His theories, of course, did not constitute a naturalistic approach to species change: the environment played no causal role in producing transmutation, and natural forces were not invoked. Yet even Thomas Henry Huxley later perceived in Bonnet's ideas 'no small resemblance to what is understood by "evolution" at the present day'.<sup>17</sup>

A year after Haller published his study of fetal development in the chicken, he received a dissertation from a young German doctor by the name of Caspar Friedrich Wolff (1734–1794). In *Theoria generationis* (1759), Wolff defended epigenetic theory against Haller's 'mechanistic medicine', which explained 'the body's vital functions from the shape and composition of its parts'.<sup>18</sup> Wolff himself also studied the developing chick embryo, especially its vascular system. He carefully observed the emergence of structures of the heart out of fluid antecedents. To explain causally the formation of the various articulations out of homogeneous material, Wolff unhesitatingly postulated 'a principle of generation, or essential force [*vis essentialis*], by whose agency all things are effected'.<sup>19</sup> A few years later, in his *Theorie von der Generation* (1764), he elaborated on the reasons, aside from lack of visual evidence of preformation, that urged him to adopt epigenesis. He indicated that all analogy was against the idea of generations of homunculi nesting within one

<sup>15</sup>Charles Bonnet, *La Palingénésie philosophique, ou Idées sur l'état passé et sur l'état futur des êtres vivans*, 2 vols (Geneva: Philibert et Chiroi, 1769), vol. 1, p. 250.

<sup>16</sup>Charles Bonnet, *Considerations sur les corps organisés*, 2 vols (Amsterdam: Marc-Michel Rey, 1762), vol. 2, p. 204.

<sup>17</sup>Thomas Henry Huxley, 'Evolution', *Encyclopaedia Britannica*, 9th ed. (1878), vol. 8, p. 745.

<sup>18</sup>Caspar Friedrich Wolff, *Theoria generationis* (Halle: Hendelianis, 1759), p. 124.

<sup>19</sup>*Ibid.*, p. 106.

another, since ‘one finds nothing in nature that would be similar to an evolution’.<sup>20</sup> Further, the mechanical theory of Haller and Bonnet made all apparent embryological development a prefabricated miracle, which depended on a theological foundation. This presumption simply ran counter to the ‘concept we have of . . . a living nature that undergoes countless changes through its own power’.<sup>21</sup>

Haller and Bonnet were the most important representatives of the evolution theory during the last half of the eighteenth century. Despite our own estimate that the theory seems rather implausible, its Newtonian abstemiousness—that is, in not postulating unnecessary forces—did recommend it to some very shrewd scientists. Even Georges Cuvier (1769–1832), perhaps the most renowned zoologist of the first half of the nineteenth century, held on to the theory, since it obviated the need for German plastic principles.<sup>22</sup> The opposition to evolution, though, was considerable, and the forces against it grew during the last half of the eighteenth century. John Needham (1713–1781) in England offered microscopical observations of the spontaneous generation of infusoria. This supposed abrupt transition from the inorganic to the organic yielded compelling evidence against the views of Haller and Bonnet. And Georges Leclerc, Comte de Buffon (1707–1788) advanced a complex epigenetical theory specifically against Haller. By the end of the eighteenth century, theoretical weight had shifted against evolution. Perhaps the most powerful oppositional force appeared in the form of a small book, authored by the young Göttingen physician and physiologist Johann Friedrich Blumenbach (1752–1840). The book bore the title *Über den Bildungstrieb und das Zeugungsgeschäfte* (‘On the Formative Force and the Operations of Reproduction’, 1781). This brief treatise would ignite a sequence of small explosions concerning the nature of the force called ‘life’.

## 2. Blumenbach’s Theory of the *Bildungstrieb*

Blumenbach studied medicine at the universities of Jena and Göttingen.<sup>23</sup> At the latter, he came to know both Johann David Michaelis (1717–1791), professor of

<sup>20</sup>Caspar Friedrich Wolff, *Theorie von der Generation* (Berlin: Birnstiel, 1764), pp. 40–41.

<sup>21</sup>*Ibid.*, p. 73.

<sup>22</sup>See Georges Cuvier, *Histoire des progrès des sciences naturelles depuis 1789 jusqu’à ce jour*, 4 vols (Paris: Baudouin Frères, 1829), vol. 1, pp. 240–41.

<sup>23</sup>For information on Blumenbach’s life I have relied on the memoir by his friend K. F. H. Marx, *Zum Andenken an Johann Friedrich Blumenbach*, 1840. This may be found, along with several other of Blumenbach’s works in *The Anthropological Treatises of Johann Friedrich Blumenbach*, trans. Thomas Bendysche (London: Longman, Green, Roberts and Green, 1865), pp. 3–45. Timothy Lenoir has discussed in some detail the development of Blumenbach’s ideas in several works: ‘The Göttingen School and the Development of Transcendental Naturphilosophie in the Romantic Era’, *Studies in History of Biology* 5 (1981), 111–205; ‘Kant, Blumenbach, and Vital Materialism in German Biology’, *Isis* 71 (1980), 77–108; and *The Strategy of Life: Teleology and Mechanics in Nineteenth-Century German Biology*, 2nd ed. (Chicago: University of Chicago Press, 1989). I have found Nicholas Jardine’s discussion of Blumenbach quite helpful. See his *The Scenes of Inquiry* (Oxford: Clarendon Press, 1991), pp. 25–28. I will dissent from Lenoir’s interpretation of Blumenbach’s major theory. My objections also extend to many of the other thinkers that Lenoir discusses: Kiemeyer, Reil, Meckel, Tiedemann, von Baer, etc. My own view is closer, on its negative side, to the critique of Lenoir by Kenneth Caneva,

theology and father of Caroline Michaelis (1763–1809), the femme fatale who became the principal erotic force of the Romantic Circle at Jena at the end of the eighteenth century, and Christian Gottlob Heyne (1729–1812), the well known classicist who taught the Schlegel brothers August Wilhelm (1767–1845) and Friedrich (1772–1829), the inaugurators of the Romantic Movement. Heyne hired the student Blumenbach to put into order his newly acquired natural history collection. It was this experience, as well as his acquaintance with the original owner of the collection, the retired professor of anatomy Christoph Gottlieb Büttner (1708–1776), that led Blumenbach to write his dissertation on an anthropological topic, the races of mankind. Physical anthropology remained a preoccupation throughout his career; and his dissertation, *De generis humani varietate nativa* ('On the Natural Varieties of Human Beings', 1775), went through three well spaced editions. Immediately after he received his degree, the young physician attained the status of Privatdozent at Göttingen; and within three years he advanced to ordinary professor of medicine.

### 2.1. *Über den Bildungstrieb*

Blumenbach's little book *Über den Bildungstrieb* revised and expanded the considerations about generation introduced in his doctoral dissertation and in his highly influential *Handbuch der Naturgeschichte* ('Handbook of Natural History', 1779–1780; and eleven subsequent editions). Initially he had been an advocate of Haller's evolution theory, which he casually endorsed in the dissertation.<sup>24</sup> In the *Handbuch*, though, he began shifting toward a more neutral position. He merely described Haller and Bonnet's thesis and the rival epigenetic conception; only in passing did he suggest that evidence indicated the evolution hypothesis to be more probable.<sup>25</sup> He granted, however, that the evidence was not unequivocal. So, for example, in reference to Haller's notion that essential elements of the embryo were already ensconced in the mother's egg, Blumenbach observed that 'the role of the male semen in the formation of the embryo is probably greater than is usually assumed'.<sup>26</sup> He then cited the evidence of hybrids, inherited defects, and other phenomena as pointing to this greater role. His tract *Über den Bildungstrieb* completed the trajectory begun with the *Handbuch*. In the prefatory remarks to his booklet, Blumenbach admitted his earlier mistaken endorsement of evolution, made while

in his 'Teleology with Regrets', *Annals of Science* 47 (1990), 291–300. My specific objections will be dribbled out below.

<sup>24</sup>Johann Friedrich Blumenbach, *De generis humani varietate nativa* (1775), in *Anthropological Treatises*, pp. 69–70.

<sup>25</sup>Johann Friedrich Blumenbach, *Handbuch der Naturgeschichte*, 2 vols (Göttingen: Johann Christian Dieterich, 1779–1780), vol. 1, p. 18.

<sup>26</sup>*Ibid.*, p. 20.

still green; and with a detailed counterproposal, he sought to shrive himself of that youthful error.<sup>27</sup> He now argued for epigenesis and against evolution.

The occasion for his change of mind was, he said, a certain chance experience that occurred a few years before the publication of his little book, while he was vacationing in the country. In his leisure, he bemused himself by observing a green, many-armed polyp in a mill pond. He then thought to conduct the classic study of cutting away sections of the hydra's body and observing the regeneration of parts, which he did over a period of a few days. He pondered those observations and analogous ones—such as regeneration of flesh after a wound—and was led to conclude that

there exists in all living creatures, from men to maggots and from cedar trees to mold, a particular inborn, life-long active drive [*Trieb*]. This drive initially bestows on creatures their form, then preserves it, and, if they become injured, where possible restores their form. This is a drive (or tendency or effort, however you wish to call it) that is completely different from the common features of the body generally; it is also completely different from the other special forces [*Kräften*] of organized bodies in particular. It shows itself to be one of the first causes of all generation, nutrition, and reproduction. In order to avoid all misunderstanding and to distinguish it from all the other natural powers, I give it the name of *Bildungstrieb* (*Nisus formativus*).<sup>28</sup>

Blumenbach insisted that the *Bildungstrieb* not be confused with forces defined by other authors—for instance, Needham's *vis plastica* (an empty word, indicating an occult quality, Blumenbach claimed<sup>29</sup>) or Wolff's *vis essentialis*. The *Bildungstrieb*, according to Blumenbach, was responsible for reproduction, nourishment and restoration of parts. In these various instances, the force expressed itself differently according to the circumstances in which it operated. These three activities, then, were 'merely modifications of one and the same force'.<sup>30</sup>

Blumenbach piled up his evidence for the existence of a *Bildungstrieb* from instances analogous to that of the green polyp, for example: the restoration of bodily form after an injury; the production of so-called 'sleep apples' in the wild rose from the actions of the gall wasp; the gradual formation of the embryos of larger creatures; the unformed condition of aborted fetuses; and the reproduction through budding in translucent green water moss.<sup>31</sup> (Blumenbach had already men-

<sup>27</sup>Johann Friedrich Blumenbach, *Über den Bildungstrieb und das Zeugungsgeschäfte* (Göttingen: Johann Christian Dieterich, 1781), p. 5. The core of this book was published in subsequent volumes (1880 and 1881) of the journal edited by Georg Christoph Lichtenberg and Georg Forster. See Johann Friedrich Blumenbach, 'Über den Bildungstrieb (*Nisus formativus*) und seinen Einfluss auf die Generation und Reproduktion', *Göttingisches Magazin der Wissenschaften und Litteratur* 1, no. 5 (1780), pp. 247–66; and 'Über eine ungemein einfache Fortpflanzungsart', in *ibid.* 2, no. 1 (1781), pp. 80–89. These parts were brought together with added material in his book.

<sup>28</sup>Blumenbach, *Über den Bildungstrieb*, pp. 12–13.

<sup>29</sup>Ironically, Blumenbach would in later editions of *Über den Bildungstrieb* refer to the principle of the *Bildungstrieb* precisely as a *qualitas occulta*, though in the positive sense (pace Leibniz) that might be associated with Newton's principle of gravity. See the text below for examples of this reevaluation of the category of occult quality.

<sup>30</sup>*Ibid.*, p. 19.

<sup>31</sup>*Ibid.*, pp. 11, 23–24, 40–41, 44, 50.

tioned some of this evidence in the first edition of the *Handbuch*, when he had moved to a more neutral position on the question of generation.)

Aside from these positive observations supporting epigenesis and the operations of a formative drive, Blumenbach also marshaled the negative instances, the cases that Haller's evolution theory could not readily handle. The disconfirming evidence, he thought, was rife, for example: freshly fertilized chicken eggs initially showed no traces of blood vessels or blood (vivid traits that ought to be visible from the first, even in a tightly folded miniature chicken); animals of the same species would often produce spermatic organisms of different forms (thus unlikely that the little worms would hold the same kind of miniatures within); hybrids of different varieties or species could be generated (surely impossible if offspring were already preformed in one of the parents); young boys in the near East often no longer had to be circumcised, since the practice had produced an acquired characteristic (with no likely way for each of the cascading homunculi to be shorn of its infinitesimally small sheath); and most amazingly, a chimera could be formed when half of a brown polyp was joined to a half of a green polyp (which, aside from attributing bad taste ultimately to the Creator, seemed unlikely on the basis of any mechanical explanation the evolutionists could conjure up).<sup>32</sup>

Though Blumenbach's discussion, with its medley of examples, did have a lethal effect on assumptions of evolution, it yet left unclear the status of the principal causal agent that drove the opposing epigenetic process. As Pierre Flourens (1794–1867) put it in his eulogy for Blumenbach, the postulation of the *Bildungstrieb*, unlike the rival view, did not create any problems, yet it did not remove any.<sup>33</sup> What more exactly, then, was the *Bildungstrieb*?

In the first edition (1781) of *Über den Bildungstrieb*, Blumenbach considered the drive to be an independent vital agency. It caused the formation of the embryo out of homogeneous seminal material and continued to operate in maintaining the vitality of the organism and in repairing its injuries. In this respect the *Bildungstrieb*, despite Blumenbach's asseverations to the contrary, did appear rather like Wolff's *vis essentialis*, that 'orders every thing in vegetative bodies on account of which we ascribe life to them'.<sup>34</sup> Both of these forces supposedly acted as independent agencies that provided matter with special vital properties. The way in which the *Bildungstrieb* differed, perhaps, from other such forces was in its comprehensive architectonic character: it directed the formation of anatomical structures and the operations of physiological processes of the organism so that various parts would come into existence and function interactively to achieve the ends of the species. Kant would have rejected any such force pretending to be constitutive

<sup>32</sup>*Ibid.*, pp. 28–29, 33, 69, and 78. Blumenbach learned of the supposed effects of circumcision from his friend the theologian Michaelis (p. 69).

<sup>33</sup>Marie-Jean-Pierre Flourens, *Éloge historique de Jean-Frédéric Blumenbach* (1847), in *The Anthropological Treatises of Johann Friedrich Blumenbach*, p. 54.

<sup>34</sup>Wolff, *Theorie von der Generation*, p. 160.

of nature, since a force of this kind would have to operate according to an intellectual plan or an intention, which he believed could only be found in a rational mind but not in a-rational, mechanical nature. For Kant, as I will discuss in a moment, the *Bildungstrieb* could only be an heuristic concept, one that helped the naturalist seek out the mechanistic causes assumed to be at work. But, for Blumenbach, the *Bildungstrieb* endowed the homogeneous, formless mixture of male and female semen with its most essential character—form, organization—and set the various parts so articulated into mutually harmonious operation. This was a teleological cause fully resident in nature.<sup>35</sup> And depending upon the matter on which it operated, the *Bildungstrieb* would produce more or less regular effects, the properties of which might be formulated into laws governing all organisms. So, for instance, Blumenbach asserted, as a general proposition, that the younger the creature, the ‘more rapid the growth and the more quickly would form move toward perfection’.<sup>36</sup>

In later studies, Blumenbach expanded the use of the *Bildungstrieb* to explain other phenomena, most notably the formation of new varieties and subspecies. In the first edition (1775) of *De generis humani*, he had suggested that the varieties of animals and human beings arose from the impact of climate and nutrition on a given stock. He presumed, for example, that cold temperatures effected the smaller stature of Greenland foxes as compared with those animals inhabiting more temperate zones.<sup>37</sup> But in the second edition (1781) of *De generis humani*, he introduced the additional factor of the *Bildungstrieb* to explain the degeneration of an original type into the varieties found populating the world.<sup>38</sup> The concept of degeneration itself and that of its ultimate causes in climate, nutrition and hybridization were hardly of Blumenbach’s own devising. Buffon had earlier argued that degeneration from originally created types, via the aforementioned agencies, had produced the varieties (sometimes called ‘species’) with which we were familiar.<sup>39</sup> What Blumenbach added to this theory was the proposal that these agencies worked on the *Bildungstrieb* to deflect this ‘formative force [*nisum formativum*] markedly from

<sup>35</sup>Francois Duchesneau provides a good account of the functionally integrative character of Blumenbach’s *Bildungstrieb*; though he, like Lenoir, suggests (albeit rather vaguely) that the force could have been only an heuristic concept for Blumenbach. The sole evidence for this interpretation seems to be that Kant liked the concept and, well, what else could it be but ‘subjective’? See Francois Duchesneau, ‘Vitalism in late Eighteenth-Century Physiology: the Cases of Barthez, Blumenbach and John Hunter’, in *William Hunter and the Eighteenth-Century Medical World*, eds W. F. Bynum and Roy Porter (Cambridge: Cambridge University Press, 1985), pp. 259–95; especially, p. 278.

<sup>36</sup>Blumenbach, *Über den Bildungstrieb* (1st ed.), p. 43.

<sup>37</sup>Blumenbach, *De generis humani varietate nativa* (1775), in *Anthropological Treatises*, p. 104.

<sup>38</sup>Johann Friedrich Blumenbach, *De generis humani varietate nativa*, 2nd ed. (Göttingen: Vandenhoeck, 1781), pp. 1–2.

<sup>39</sup>Georges Louis Leclerc, Comte de Buffon, ‘De la dégénération des animaux’ (1766), *Histoire naturelle, in Oeuvres complètes de Buffon*, ed. Pierre Flourens, 12 vols (Paris: Garnier, 1853–1855), pp. 110–44. In *De generis humani*, Blumenbach has many citations to Buffon’s *Histoire naturelle*.

its usual path, which deflection is the generous origin of degeneration and the mother, properly speaking, of varieties'.<sup>40</sup>

## 2.2. Biological Revolution

As a complement to his ideas about the production of species varieties, Blumenbach also devised a theory of biological revolution in which the *Bildungstrieb* played the creative, central role—it would be the agency for the production of *new species*. In his *Beyträge zur Naturgeschichte* ('Contributions to Natural History', 1790), he contended that fossils indicated a pre-Adamite creation, which was subsequently destroyed in a general, neptunic catastrophe. After a while, according to this supposition, the Creator repopulated the earth, but did so by employing 'the same natural powers [*Naturkräfte*] to effect the production of the new organic creation that had filled the same purpose in the pre-world [*Vorwelt*]'.<sup>41</sup> Thus the *Bildungstrieb* operated to produce—presumably out of the inorganic—a new living world, which would display some creatures similar to those of the old creation, but in addition vast kingdoms of entirely new species. The main difference between the operations of the *Bildungstrieb* in the pre-world and in the current world was 'only that the *Bildungstrieb* had to be applied to a greatly modified matter—after such a total revolution—and through the production of new species, it had to take a direction differing more or less from the old'.<sup>42</sup>

Even in the present dispensation, Blumenbach argued, evidence indicated that some new creations had arisen—for instance, certain kinds of worms in the flesh of domestic pigs, though not in their wild ancestors. He confessed ignorance about the exact process by which such creatures originated, but generally attributed the cause 'to the great changeability in nature', which itself was but a feature of the *Bildungstrieb*. Ultimately, though, 'this great changeability itself [had to be the result of] the most beneficent and wise direction of the Creator'.<sup>43</sup> Such mutability, that is, the fluctuating fortunes of the *Bildungstrieb* under differing conditions, also produced degeneration of existing species, supplying new varieties and subspecies to an ever-changing world.

Though Blumenbach left no overt indications of sources for his theory of biological revolution, his ideas harmonize with those of Bonnet (see above) and especially with those of his contemporary Johann Gottfried Herder (1744–1803). In his *Ideen zur Philosophie der Geschichte der Menschheit* ('Ideas on the Philosophy of the History of Mankind', 1784–1791), Herder constructed a naturalized version of *Genesis*. He maintained that the earth and planets had developed out of a nebular chaos, but in obedience to universal laws. He supposed that from a volcanic maelstrom

<sup>40</sup>Blumenbach, *De generis humani varietate nativa*, 3rd ed. (Göttingen: Vandenhoeck et Ruprecht, 1795), p. 88.

<sup>41</sup>Johann Friedrich Blumenbach, *Beyträge zur Naturgeschichte*, part 1 (Göttingen: Johann Christian Dieterich, 1790), pp. 24–25.

<sup>42</sup>*Ibid.*, p. 25.

<sup>43</sup>*Ibid.*, pp. 31–32.

eventually a habitable environment, with great varieties of plants and animals, emerged. The first ages proved harsh, winnowing out all but the most suitable creatures for subsequent times: ‘Those innumerable volcanos on the surface of our earth that once spewed flames, no longer do so; the oceans no longer seethe with the vitriol and other materials that once covered our land. Millions of creatures have passed away that had to die; those that could survive, remained and have perdured for thousands of years in great harmony with one another’.<sup>44</sup> Throughout the plant and animal kingdoms, vital powers, ‘the fingers of God’, operated ontogenetically to form creatures—a *Bildung* rather than an evolution of preformed parts. And these powers, according to Herder, drove species to ever more complex development during an early period of the formation of life on the planet. ‘Could we but penetrate to those first periods of creation’, he reflected, ‘we would see how one kingdom of nature was built upon another; what a progression of advancing forces would be displayed in every development’.<sup>45</sup> These ‘organic forces’, he declared, ‘bud forth in great creations and strive toward new formations’.<sup>46</sup> At some point, however, ‘the door of creation was shut’.<sup>47</sup> Thereafter, vital powers continued to produce improvements, but only within established limits of fixed animal and plant species. The whole development of the world, in Herder’s religious cosmology, arched, with deliberate intent, toward the crowning achievement, human nature and the perfection of humanity: ‘The purpose of our present existence’, he proclaimed, ‘is directed to the formation of humanity [*Bildung der Humanität*], and all the lower necessities of the earth only serve and lead to this end’.<sup>48</sup>

Herder wove his history of the earth from threads of sound science, reasonable speculation, Spinozistically tinged theology, and a great many colorful strands of poetic musing. Kant, in his extensive review of Herder’s *Ideen*, complained about the fanciful and indefinite character of the fabrication.<sup>49</sup> Herder’s conception of vital powers investing nature seemed to the philosopher mostly blooms from ‘the fruitful field of creative imagination’, yet nurtured by ‘a rather dogmatic metaphysics’.<sup>50</sup> These speculations, though, were hardly innocent growths. In Kant’s estimation, they suggested ‘ideas so monstrous that reason shudders before them’. And with vibrant irritation, he made these ideas explicit: ‘either one species [*Gattung*] would have arisen out of another, and all out of one single original species

<sup>44</sup>Johann Gottfried von Herder, *Ideen zur Philosophie der Geschichte der Menschheit*, in *Herder Werke*, ed. Martin Bollacher, 10 vols (Frankfurt a.M.: Deutscher Klassiker Verlag, 1985–), vol. 6, p. 637 (III, 15, ii).

<sup>45</sup>*Ibid.*, p. 176 (I, 5, iii).

<sup>46</sup>*Ibid.*, p. 178 (I, 5, iii).

<sup>47</sup>*Ibid.*, p. 176 (I, 5, iii).

<sup>48</sup>*Ibid.*, p. 187 (I, 5, v).

<sup>49</sup>Kant reviewed parts one and two of Herder’s *Ideen* (about half the book) in several numbers of Schütz’s *Allgemeine Literatur-Zeitung* in 1785–1786. See *Rezension zu Johann Gottfried Herder: Ideen zur Philosophie der Geschichte der Menschheit*, in *Kants Werke*, ed. Wilhelm Weischedel, 6 vols (Frankfurt a.M.: Insel Verlag, 1964), vol. 6, pp. 781–806 (A17–22, 309–10, 153–56).

<sup>50</sup>*Ibid.*, p. 792 (A22).

or perhaps out of a single, productive mother-womb [i.e., the earth]'.<sup>51</sup> Kant admitted that it might be unjust to attribute these ideas to Herder, though he did not doubt that they seemed to drift along with his former student's meandering considerations.<sup>52</sup> Kant's estimate of the danger of these monstrous ideas, however, softened during the next five years, when he spied the same specters hovering over the more rigidly scientific analyses of Blumenbach. For Kant, the threat of the ideas seemed lessened, since he had found, in his *Kritik der Urteilskraft*, a way to tame them: he discovered he could render them as merely heuristic principles instead of foundational laws. (Schelling and Goethe, showing a greater boldness, would adopt these general notions, and with them infuse nature with the necessary energies to produce new organisms and transmute older ones.)

### 2.3. Refinements of the Concept of *Bildungstrieb*

Blumenbach's initial theory of the *Bildungstrieb* certainly took no lead from Herder, rather the reverse: Herder developed his own notion of *Bildung* and vital force in light of Blumenbach's work.<sup>53</sup> But, reciprocally, Blumenbach undoubtedly found some inspiration in Herder for applying the concept of *Bildungstrieb* to this new area of inquiry, the history of the earth. In addition to these new applications, Blumenbach continued gradually to alter and refine the core of the concept. These refinements were first introduced in his *De nisu formativo et generationis negotio* ('On the Formative Drive and the Operation of Generation', 1787) and in the second edition (1788) of the *Handbuch der Naturgeschichte*. He consolidated these changes a year later in the second edition of *Über den Bildungstrieb*, where they were perspicuously revealed. In that edition he added this paragraph to the general definition of the *Bildungstrieb*:

<sup>51</sup>*Ibid.* More generally these ideas had dangerous implications for two fundamental Kantian convictions: the mechanistically necessary structure of scientific law, which would have been compromised by Herder's vitalism, and human freedom, which certainly could not emerge from the interactions of material nature. Beiser argues that the intended outcome of Kant's analysis in the *Critique of Judgment* was precisely this removal of a threat to human rationality and freedom. See Frederick Beiser, *The Fate of Reason* (Cambridge: Harvard University Press, 1987), pp. 156–57.

<sup>52</sup>Herder, Kant's one-time student, bridled at the review he had received from the master. He wrote to his friend, and Kant's nemesis, Johann Georg Hamann (1730–1788) to express his deep irritation: 'I have heard from several distant quarters that the review has had little success; rather, it has been read with amazement that Herr Kant would mention a shudder of reason. His final preceptorial lectures to me are simply inappropriate: I am 40 years old and no longer sit on his metaphysical school bench'. See Johann Gottfried Herder to Johann Georg Hamann (14 February 1785), in *Johann Gottfried Herder Briefe*, edited by Karl-Heinz Hahn *et al.*, 9 vols (Weimar: Hermann Böhlau Nachfolger, 1977–1988), vol. 5, p. 106.

<sup>53</sup>Herder frequently cited the second edition of Blumenbach's *De generis humani varietate nativa*, in which the naturalist had introduced his new concept of *Bildungstrieb*. See, for example, Herder, *Ideen zur Philosophie der Geschichte der Menschheit, Werke*, vol. 6, pp. 119, 120, 128 (I, 4, I), 249 (II, 6, vii), etc. Herder's own analysis of *Bildung* followed closely Blumenbach's discussion of preformation vs. epigenesis. See *ibid.*, p. 172 (I, 5, ii): 'one speaks improperly if one talks about a seed [*Keim*] that only unfolds, or of an epigenesis according to which limbs form by an external power. *Bildung* (*genesis*) is an effect of an inner force that forms the mass prepared by nature and in which it will be manifest'.

I hope it will be superfluous to remind most readers that the word *Bildungstrieb*, like the words attraction, gravity, etc. should serve, no more and no less, to signify a power whose constant effect is recognized from experience and whose cause, like the causes of the aforementioned and the commonly recognized natural powers, is for us a *qualitas occulta*. What Ovid said pertains to all of these *forces*—*causa latet, vis est notissima* [the cause is hidden, the force is well recognized]. The service rendered by a study of these forces is only that one can more carefully determine their effects and bring those effects into general laws.<sup>54</sup>

Blumenbach secured this Newtonian reconfiguration of his force with a careful footnote to Newton's *Opticks* and by emphasizing, in the last pages of the booklet, that one could generalize the various effects of the *Bildungstrieb* into some six laws—for example, that the strength of the *Bildungstrieb* was inversely related to the age of the organism; that it operated more strongly on young of mammals than on the young of ovipara; that it operated with variable rapidity and strength on different organs of the same creature, and so on.

It is crucial to note that in this Newtonian rendering of the *Bildungstrieb*, Blumenbach had not suggested that the term referred to nothing, rather that it stood for a force, specified by its effects, but whose cause could not be known directly. As he indicated in the second edition of the *Handbuch*, where he introduced the Newtonian comparison: 'it is a proper force [*eigenthümliche Kraft*], whose undeniable existence and extensive effects are apparent throughout the whole of nature and revealed by experience'.<sup>55</sup> In this respect, he thought his use of the term paralleled the way Newton used 'attraction'. His footnote quotation from Clarke's Latin version of Newton's *Opticks* made the point. Newton wrote: 'I thus use this term attraction so that it be understood generally to signify any power by which bodies mutually tended toward one another, no matter what cause might be attributed to this power'.<sup>56</sup> In comparable fashion, Blumenbach construed the *Bildungstrieb* as a force, deriving from an unknown cause, that could only be characterized by its conspicuous effects. The paradigm employed, then, was a causal chain of this sort: cause (unknown) — produces → force (the *Bildungstrieb*) — produces → perceptible effects (e.g., epigenesis). The *Bildungstrieb* thus became a secondary cause

<sup>54</sup>Johann Friedrich Blumenbach, *Über den Bildungstrieb*, 2nd ed. (Göttingen: Johann Christian Dieterich, 1789), pp. 25–26. See also Johann Friedrich Blumenbach, *De Nisu formativo et generationis negotio* (Göttingen: Johann Christian Dieterich, 1787), p. x; and *Handbuch der Naturgeschichte*, 2nd ed. (Göttingen: Johann Christian Dieterich, 1788), p. 14.

<sup>55</sup>*Ibid.*, p. 14.

<sup>56</sup>Blumenbach, *Über den Bildungstrieb*, 2nd ed., pp. 25–26. Newton was often more circumspect about forces than the above quotation suggests. In 'Definition VIII' of the *Principia*, he declared that he did not wish to consider forces physically, but only mathematically. See Isaac Newton, *Mathematical Principles of Natural Philosophy*, trans. Andrew Motte (1729), ed. Florian Cajori, 2 vols (Berkeley: University of California Press, 1962), vol. 1, pp. 4–6. In the *Opticks*, Newton gave way to freer speculation about forces. In any case, it is clear that Blumenbach understood forces to be real phenomena, even if occult. He may have been brought to the Newtonian comparison by an obscure doctoral dissertation (*De respiratione*, by Michaelis Birkholz) that likened his *Bildungstrieb* to Newton's *principium trahens*. Blumenbach cited the dissertation in *Über den Bildungstrieb*, 3rd ed. (Göttingen: Johann Christian Dieterich, 1791), p. 37. The quotation from the *Opticks* and the probable source of the comparison suggest that Blumenbach's knowledge of Newton was less than comprehensive.

yielding immediate effects, while itself being the effect of some hidden, primary cause.

#### 2.4. Status of the Concept

This cautious Newtonian rendering of the concept of *Bildungstrieb* reduced, though only a little, its metaphysical valence. But did it turn the *Bildungstrieb* into what Lenoir has called a teleomechanistic principle? That is, was the *Bildungstrieb* a principle that Kant could *justly* have adopted, a principle employed to represent a mechanical cause *as if* it were teleological? Lenoir argues that this was precisely the case, that Blumenbach and Kant supported ‘the same program’, that of ‘teleomechanism’.<sup>57</sup> In an otherwise illuminating reconstruction, Lenoir concludes that with the principle of the *Bildungstrieb*,

Blumenbach adopted what is best characterized as an emergent vitalism: that is to say, the vital force was not to be conceived as separate from matter, but matter was not the source of its existence; rather it was the *organization* of matter in certain ways that gave rise to the *Bildungstrieb*. Organization was taken here as the primary given: the presence of organization could not be further explained in terms of unorganized parts.<sup>58</sup>

I will discuss Blumenbach’s relationship to Kant in a moment, but I believe one can see immediately why Lenoir’s interpretation of the *Bildungstrieb emerging out of organization* is implausible. Blumenbach, it must be remembered, originally developed the concept of the *Bildungstrieb* as an inherent causal principle to explain the possibility of epigenesis, that is, the gradual development of fetal organization out of an unorganized, homogeneous substrate. In the first edition of his booklet, he presented the *Bildungstrieb* straightforwardly as a real cause, a force that produced the phenomenon: ‘This drive’, he said, ‘initially bestows on creatures their form’. Moreover, this drive ‘shows itself to be one of the first causes of all generation, nutrition, and reproduction’.<sup>59</sup> The *Bildungstrieb*, therefore, could not be an *effect* of organization, a property emerging out of organization; it was initially postulated as a *cause* to explain organization. This fundamental employment of the concept is further driven home by Blumenbach’s extension of the application of the *Bildungstrieb* so as to demonstrate the generation of forms where no like forms could have previously existed—that is, the formation of new species during the pre-Adamite and post-Adamite biological revolutions; and the strange case of gall wasps producing ‘sleep apples’ on rose bushes, which latter he regarded as a kind of spontaneous generation. In the second edition of his *Bildungstrieb* booklet, Blumenbach did not alter his conception of this fundamental causal

<sup>57</sup>Lenoir, *The Strategy of Life*, pp. 23–24.

<sup>58</sup>Lenoir, ‘The Göttingen School and the Development of Transcendental Naturphilosophie in the Romantic Era’, p. 155. See also his *Strategy of Life*, p. 21: ‘For Blumenbach the *Bildungstrieb* did not exist apart from its material constituents, but it could not be explained in terms of those elements. It was an emergent property having a completely different character from its constituents’.

<sup>59</sup>Blumenbach, *Über den Bildungstrieb* (1781), pp. 12–13.

relationship, namely of the formative power causally producing organization. In this edition, he merely suggested that one could grasp this causal force only through its effects. Even after he had received Kant's endorsement, Blumenbach maintained the same causal structure in his account of the *Bildungstrieb*. Thus, from the last edition of the *Handbuch* (1830):

When the ripe, but as yet unformed [*ungeformte*], but organizable [*organisierbare*] seminal matter reaches its time and enters into the required conditions in the place of its determination, then it becomes initially receptive of that same and now purposive [*zweckmässig*] operative life-force, namely the *Bildungstrieb* (*nisus formativus*) . . . This power is able to form the variously organizable seminal matter in comparably many, telically modifiable ways into determinate forms.<sup>60</sup>

The *Bildungstrieb* was thus not a Kantian 'as-if' cause, but a real teleological cause (that is, acting towards ends), which, however, was known only through the ends it achieved. The actions of that cause, like causes in physics, could be expressed in general laws, which Blumenbach carefully formulated in the manner of Newton—something that Kant would methodologically prohibit in the case of biology. And behind this anonymous force, Blumenbach clearly spied the Creator unabashedly pulling the strings, a perception no scientific theory in the Kantian mold would legitimate. Kant did, to be sure, adopt aspects of Blumenbach's conception; but he turned them to his own purposes, which must now be considered.

### 3. Kant's Theory of Biological Explanation

The impact of Kant's *Kritik der Urteilskraft* on the discipline of biology has, I believe, been radically misunderstood by many contemporary historians. It is frequently thought that Kant provided a conceptual framework in terms of which biological science could be conducted.<sup>61</sup> This is, I think, a fundamental misinterpretation of Kant's relationship to the work of biologists during the Romantic period. Those biologists who found something congenial in Kant's Third Critique, either misunderstood his project (as did, for example, Blumenbach and Goethe) or reconstructed certain ideas to have very different consequences from those originally intended by Kant (as did Kielmeyer and Schelling). There were some, of course, who simply and explicitly rejected Kant's analysis of teleology (such as Reil).<sup>62</sup> These latter two groups seemed to have understood more clearly than the first that the *Kritik der Urteilskraft* delivered up a profound indictment of any biological discipline attempting to become a science.

The Third Critique's charge against efforts to make biology into an authentic

<sup>60</sup>Johann Friedrich Blumenbach, *Handbuch der Naturgeschichte*, 12th ed. (Göttingen: Dieterich'schen Buchhandlung, 1830), p. 15.

<sup>61</sup>In addition to differences with Lenoir on Kant's role, I also take exception to the interpretations of James Larson, in his *Interpreting Nature*, pp. 170–82, and of Jörg Jantzen, in his *Physiologische Theorien*, pp. 658–664. Both of these historians generally follow Lenoir.

<sup>62</sup>I have discussed Reil's rejection of Kant's conception of teleology in 'Rhapsodies on a Cat-Piano'.

science (that is, one having necessary laws comparable to Newtonian mechanics) can be simply stated, even if its expression lay entangled in the thicket of Kantian distinctions. Kant maintained that in comprehending the organization and operations of creatures, an investigator had to assume a teleological causality—since no application of merely mechanistic laws could make biological processes intellectually tractable. One had, from this perspective, to regard, ultimately, the organizational features of animate nature as the result of a kind of causality in which the idea or plan of the whole produced the specific formal relationships of the parts to one another. Yet such assumption of final causes could only be heuristic, an *as-if* causality—since no telic causes, which ultimately presumed intentionality, could be validly understood as producing natural phenomena. Natural phenomena, according to Kant, could only be scientifically—that is, properly—explained by appeal to mechanistic laws. Such laws specified the constituent parts as the adequate causes of the organizational character of some phenomenon.<sup>63</sup> Kant did not assert that natural phenomena were possible *only* as the result of mechanistic causes (that would be to assert too much, to presume knowledge of the supersensible world). He rather claimed that, given the character of our understanding, we ‘*ought* always reflectively consider all events and forms in nature [i.e., biological occurrences] according to the principle of the mere mechanism of nature, and we *ought* to employ this principle, as far as we can, in research, since without it as a basis for our investigations, we can in no way have proper natural knowledge [*Naturerkenntnis*]’.<sup>64</sup> He thus suggested that biology could not really be a science, but at best only a loose system of uncertain empirical regularities, not a *Naturwissenschaft* but a *Naturlehre*.<sup>65</sup> Most biologists of the period, by contrast, thought their disciplines could be developed into sciences and could, in that respect, come to stand as certainly on that pinnacle of human accomplishment as did Newton’s physics. They believed, in part due to Friedrich Schelling (1775–1854), that teleological processes could be found governing natural phenomena, and that valid laws could be formulated to capture such relationships. It is, however, quite understandable how some of them might have been misled into thinking that Kant’s

<sup>63</sup>See Immanuel Kant, *Kritik der Urteilskraft*, in *Werke* vol. 5, p. 526 (A347, B351): ‘When we consider a whole of some material object, in respect of its form, as a product of the parts and their forces (*Kräfte*) and abilities (*Vermögen*), which parts combine on their own . . . then we represent to ourselves a mechanistic kind of production of the whole.’ For a lucid exposition of Kant’s notion of mechanism, see Peter McLaughlin, *Kant’s Critique of Teleology in Biological Explanation* (Lewiston: Edwin Mellen Press, 1990), pp. 152–56.

<sup>64</sup>See Immanuel Kant, *Kritik der Urteilskraft*, in *Werke*, vol. 5, p. 501 (A311, B315); emphases added. For a general discussion of Kant’s respective conceptions of mechanism and teleology, see Jardine, *Scenes of Inquiry*, pp. 28–33.

<sup>65</sup>Kant, *Werke*, vol. 5, p. 510 (A325–29, B329–333). That Kant excluded biology from the realm of real science (*Wissenschaft*) is, I think, indisputable. But for those who might wish further discussion of this conclusion, see the extensive and authoritative account of Kant’s position offered by Reihard Löw in his *Philosophie des Lebendigen: Der Begriff des Organischen bei Kant, sein Grund und seine Aktualität* (Frankfurt a.M.: Suhrkamp Verlag, 1980), pp. 130–131.

system was congenial to biology, especially if they received blandishments from the great philosopher himself, as Blumenbach did in that letter of August 1790.<sup>66</sup>

Kant, like Blumenbach, saw in the *Bildungstrieb* a way to understand the nature of organic form. In his consideration of this topic, he broached two interrelated conceptions that would come to dominate theories of life through the next century. The first was that of the ‘archetype’; the second, more dubious idea was that of a gradual biological development, that is, an evolution (in our sense) of animal forms out of the inorganic, and their continued transformation into the multitude of species. In his discussion, Kant admitted that animal species, despite their variety, seemed to display common patterns, or archetypes (*Urbilde*). On this basis, we might suspect that mechanical transformations of an archetypal pattern could indeed have produced the various species:

Many animal species resemble one another according to a certain common scheme, which scheme seems to lie at the foundation not only of the structure of their bones but also of the ordering of their other parts, so that the proliferation of species might arise according to a simple outline: the shortening of one part or the lengthening of another, the development of one part or the atrophy of another. This possibility produces a faint ray of hope that something might be done with the principle of mechanism, without which no natural science can generally be constituted. This analogy of forms—insofar as they seem to have been produced, despite their differences, according to common archetypes [*Urbilde*—strengthens the suspicion of a real relationship of these forms by reason of their birth from a common, aboriginal mother [*Urmutter*].<sup>67</sup>

The archeologist of nature, according to Kant, might make such an assumption and, on the evidence of fossils, even propose that out of a state of chaos, ‘the maternal womb of the earth (like a large animal) might have given birth initially to creatures of a less-purposeful form, and these to others whose forms became better adapted to their place of origin and their relationships to each other’.<sup>68</sup> In outline, this theory of development that Kant mooted conformed to suggestions made both by Herder, in his *Ideen zur Philosophie der Geschichte der Menschheit*, and by Blumenbach, in his *Beyträge zur Naturgeschichte*. But in the Critique, Kant moderated what had been his initial reaction to proposals like those of Herder, which he had previously considered as ‘monstrous ideas’.<sup>69</sup> Now he had no conceptual objection to what became a ‘daring adventure of reason’. If one actually dared such a theory, one would, nonetheless, have to refrain from supposing a sheer transition from the inorganic to the organic. One would, instead, have to ‘attribute to this common mother an organization that purposefully produced these creatures, otherwise one could not at all conceive of the possibility of the purposeful form

<sup>66</sup>See the letter from Kant to Blumenbach quoted on the first page of this article.

<sup>67</sup>Kant, *Kritik der Urteilskraft*, *Werke*, vol. 5, p. 538 (A363–64, B368–69).

<sup>68</sup>*Ibid.*, p. 539 (A365, B369–70).

<sup>69</sup>See my discussion above.

[*Zweckform*] that exists in the production of the animal and plant kingdoms'.<sup>70</sup> Purposeful organization, in Kant's judgment, could only be understood by us as the crafted product of an intentional being—that is, one that acted consciously for ends—ultimately an 'archetypus intellectus', as he called it.<sup>71</sup> For from mechanism alone one could not understand the possibility of purpose. This was why he found Blumenbach's principle of the *Bildungstrieb* so attractive—because he interpreted the biologist to be saying that ultimately only organized matter could causally produce organized matter.<sup>72</sup> In the end, though, Kant rejected the theory of species transformation, even under the aegis of the *Bildungstrieb*, since he did not believe any empirical evidence supported it.

For Kant, the *Bildungstrieb* united (as he mentioned in his letter to Blumenbach) mechanistic considerations with teleological. Because the principle had that Newtonian ring, it sounded mechanistic, and thus could play a role in scientific judgment about organisms. Yet it also implied an ultimate causality having intellectual features. As he put it in the Third Critique:

In all physical explanations of this sort [i.e., epigenesis], Blumenbach begins with organized matter. He rightly declares as unreasonable any proposals that raw matter has originally formed itself according to mechanistic laws, that out of the nature of the lifeless, life has sprung, and that matter could have produced in itself a form of self-preserving purposiveness. Under this principle of an original organization (a principle we cannot further explore), he provides an undeterminable but unmistakable role for natural mechanism [*Naturmechanism*]. To this ability of matter in an organized body (which ability he distinguishes from the commonly present, merely mechanistic power of formation), he gave the name *Bildungstrieb* (and this latter guides and directs the mechanistic power of formation).<sup>73</sup>

For Kant, the postulation of the *Bildungstrieb* was supported by our experience of the epigenetic properties of organisms, while making 'the smallest possible expenditure of the supernatural' in explanations of phenomena.<sup>74</sup> Yet the concept of the *Bildungstrieb* nonetheless did spend the currency of the supernatural (that is, the non-mechanical) in explanation, and thus could not properly serve as a foundational—that is, *constitutive*—principle of any purported science of biology. At best the *Bildungstrieb* could only be suggestive and function as a *regulative aid*

<sup>70</sup>Kant, *Kritik der Urteilskraft*, Werke, vol. 5, p. 539 (A365, B370).

<sup>71</sup>*Ibid.*, p. 526 (A346–47, B350–51).

<sup>72</sup>Two years before the publication of the *Kritik der Urteilskraft*, Kant published an essay in the *Teutschen Merkur* (January 1788, pp. 36–52, and February 1788, pp. 107–36) that made this same point. In that essay, he declared, citing Blumenbach: 'For my part I derive all organization from organic beings (through reproduction) and later forms of these kinds of natural individuals according to the laws of general development of such forms from aboriginal dispositions [*Anlagen*]—of the sort that are often found in the transplanting of vegetation. These dispositions often characterize the original stem of these organisms. How the stem itself arose is a question beyond the limits of physics possible for human beings, within whose ambit I must remain' (Immanuel Kant, 'Über den Gebrauch teleologischer Prinzipien in der Philosophie', Werke, vol. 5, p. 164). Kant credited Bonnet with the idea that organisms might harbor aboriginal dispositions that would manifest themselves in a changed environment (*ibid.*, note).

<sup>73</sup>*Ibid.*, p. 545 (A374, B378–79).

<sup>74</sup>*Ibid.*, p. 545 (A373, B378).

for the examination of mechanistic laws involved in the formation and operation of organisms. Kant had met, in the work of his former student Herder, the ‘monstrous idea’ of vital, organic development. By the time he confronted the same idea in the scientifically astute Blumenbach, he thought he had a means to tame it, and so returned to Blumenbach the now domesticated idea, apparently declawed of the threats to science and human freedom it had initially bared.

Blumenbach was obviously flattered by Kant’s endorsement of a principle with which he was so solidly identified. After 1790, as I have indicated above, he usually added to his description of the *Bildungstrieb* the Kantian formulation that the principle ‘united the mechanistic with the purposively modifiable’.<sup>75</sup> But aside from this grateful bow to Kant, was the principle as Blumenbach formulated and used it a sign that he agreed with or adopted the Kantian program, which Lenoir calls teleomechanism?

#### 4. Conclusion: Blumenbach’s and Kant’s Creative Misunderstandings

I have already indicated some of the reasons why it would be a mistake to interpret Blumenbach’s principle in the fashion of Lenoir and other like-minded historians. Let me now try, in conclusion, to portray more exactly that deep divide across which Kant and Blumenbach made overtures to one another but which they never successfully bridged.<sup>76</sup>

Kant interpreted Blumenbach’s theory of the *Bildungstrieb* as implying that he could only understand a particular zoological organization by assuming that it had come from matter already having organization. In drawing this implication, he meant one of two things: either that, for instance, the genital fluid of an animal pair already had organization, which then could produce a further-developed organization—i.e., the fetus; or he meant something more general, namely that only a being with organization (the mother) could produce another being with organization (the child). But neither of these interpretations can really be squared with Blumenbach’s general theory. In contradistinction to Kant, Blumenbach wanted to explain the origin of organization in the first place. If Blumenbach were merely contending that biological organization comes from biological organization, he would not have needed to postulate the *Bildungstrieb*. One could hardly claim any originality in asserting *omne vivum a vivo*. Moreover, Blumenbach certainly denied that the genital fluid had any initial organization, though it was organizable—hence the first interpretation of Kant’s conclusion is precluded. And so is the second: Blumenbach proposed that a pre-Adamite creation had entirely disappeared—hence there was no residual organized matter—but that it was then replaced by a new

<sup>75</sup>See, for example, Johann Friedrich Blumenbach, *Handbuch der Naturgeschichte*, 12th ed., p. 17.

<sup>76</sup>Phillip Sloan has meticulously shown the ways in which, on the related issue of the nature of species, Kant and Blumenbach also creatively misunderstood one another. See his ‘Buffon, German Biology, and the Historical Interpretation of Biological Species’, *British Journal for the History of Science* 12 (1979), 109–153.

creation produced by the *Bildungstrieb*, which operated in materially different circumstances. In both of these examples, new vital forms arose in matter initially entirely bereft of biological form.

The principal objection, however, to amalgamation of the Kantian and Blumenbachian research projects concerns their respective understanding of the science of life. For Kant, an organism was one in which ‘every [part] is reciprocally an end and a means’.<sup>77</sup> One could not therefore explain why a particular part existed in an organism, except that it was understood as either a goal of certain physiological processes or as a means to achieve some other process or structure. In short, one had to conceive of an organism as realizing a *Bauplan*, a network of purposeful design. Yet, Kant insisted, no such concept of a purposeful design could play any *constitutive* role in scientific explanation. If we considered, for example (Kant’s), the structure of a bird’s anatomy, we would find its hollow bones, the angle of connection of its wings, the structure of its tail feathers, and so on, all directed to the purpose of flight. Without the concept of flight as the end or purpose, we could not understand the necessary unity of configuration found in the bird’s anatomy. Kant maintained, in other words, that

nature herself, regarded as mere mechanism, might have been formed in a thousand different ways without hitting upon that unity [of organization] according to such a principle [of purpose]; thus one cannot hope to have any foundation purely a priori for such unity, except that we look beyond the concept of nature, not within it.<sup>78</sup>

But in scientific explanation, one had to stay within the concept of nature, not vault beyond it into the transcendent realm. In Kant’s view, only mechanistic principles or laws involving mechanistic causes could serve really to explain natural phenomena, organic or otherwise. Principles that jumped the natural world, leaping over the limits of mechanism, simply landed beyond the range of sober science.

In Kant’s scheme such principles as the *Bildungstrieb* could only play an heuristic, or *regulative*, role in a discipline; such principles, to put it in the Kantian jargon, resulted from *reflective* as opposed to *determinative* judgment. As he argued in the first introduction to the *Kritik der Urteilskraft*: ‘a concept [of purposiveness], though it certainly does not objectively determine the synthetic unity [of experience of objects] the way a category does, it nonetheless provides a subjective consideration that serves as a guide [*Leitfaden*] for research into nature’.<sup>79</sup> This meant that the biologist could treat organisms *as if* they were teleologically regulated, *as if* the idea of the whole, its design, operated to organize the parts, to cause them to develop toward certain ends. This would be an aid for the discovery of those mechanistic laws that could actually be employed to explain certain operations of creatures. For example, to presume, as a regulative idea, that the vertebrate eye has the purpose to provide accurate information about the environment—ultimately for

<sup>77</sup>Kant, *Kritik der Urteilskraft*, *Werke*, vol. 5, p. 488 (A292, B295–96).

<sup>78</sup>*Ibid.*, p. 470 (A265, B269).

<sup>79</sup>Kant, ‘Erste Fassung der Einleitung in die Kritik der Urteilskraft’, *Werke*, vol. 5, p. 181 n.

the welfare of the entire organism—allows one to explore how that end is accomplished. The physiologist might then discover that an image on the retina serves that ultimate goal. Further, he (and it would always be a ‘he’ in the late eighteenth century) might then explore just how an image gets cast on the retina. Examination might show, then, that the various translucent media of the eye have performed that function because of their refractive properties. He might then apply Snell’s law of refraction, a quantitative, mechanistic law, to understand how light rays are bent by the cornea, the aqueous humor, the lens and the vitreous humor, to form an image on the retina. Snell’s law then allows the physiologist properly to explain, *given the arrangement or organization* of various refracting media, the mechanisms by which an image is produced on the retina. No mechanistic law, however, can strictly explain—according to the Kantian view—why or how the various media of the eye are so organized. As Kant succinctly phrased it: there could be no Newton of the grass blade.<sup>80</sup> On the other hand, non-mechanistic principles likewise could not *properly* be used to explain biological organization; for in such efforts ‘reason is betrayed into poetic dreaming’.<sup>81</sup>

As part of his explanatory methodology, Blumenbach, of course, made no such distinction between a regulative, reflective principle and a constitutive, determinate one. He blissfully used the *Bildungstrieb* as part of a constitutively causal account of organization. After 1790, he continued to employ the *Bildungstrieb* in the formation of general laws, comparable to the way Newton used the concept of gravity. He thus conceived of this teleological principle as quite analogous to a mechanistic principle in its explanatory function, something simply unacceptable to Kant.<sup>82</sup> It is likely, of course, that Blumenbach never really understood what Kant was getting at in the Third Critique. He was, nonetheless, quite happy to have Kant’s sanction. Kant, for his part, employed Blumenbach’s rather loose theory for his own ends, just as many contemporary historians of science have.

*Acknowledgements*—I am grateful to Frederick Beiser and the Journal’s editor for many helpful suggestions.

<sup>80</sup>*Ibid.*, p. 516 (A334, B338). Kant held that we could ultimately neither affirm nor deny the possibility (outside of human experience) of a completely mechanistic explanation of organization, since that would require insight into the noumenal realm. Within the domain of human experience, however, biological organization would never completely yield to a mechanical account. For Kant, that would have been an utter impossibility. Philosophers of science—many of my acquaintance, at least—are keen on impossibility arguments, such as Kant enunciated. And from a given set of premises, they can often rigidly deduce comparable consequences. Ah, but premises are often discarded or forgotten—and thus impossibilities are often overcome—as history of science reveals.

<sup>81</sup>*Ibid.*, p. 529 (A351, B355).

<sup>82</sup>Larson says (*Interpreting Nature*, p. 178): ‘Only after Blumenbach had introduced the principle of an original organization was he in a position to “prove” the theory of epigenesis. His principle was a determinate concept, but its application remained reflective’. But there is no evidence that Blumenbach made any such distinction between a determinate and reflective use of a concept, implicitly or explicitly. First, prior to 1790, he had not even heard of the distinction; he would have met it, if at all, only in the Third Critique, which Kant sent him as a gift in 1790. But second, it is unclear what it would mean, even in Kant’s terms, to say that the principle was a ‘determinate’ one, but that its application was ‘reflective’. By a reflective concept Kant precisely meant those that were indeterminate.

Robert J. Richards, "Kant and Blumenbach on the Bildungstrieb : a historical misunderstanding", *Studies in History and philosophy of biology and biomedical science*, 31, 1, 2000, 11-32 Shirley Roe, *Matter, life and generation . Eighteenth century embryology and the Haller-Wolff debate*, Cambridge UP, 1980. Jacques Roger, *Les sciences de la vie dans la pens e fran aise au XVIII me si cle*, Paris, (Colin 1963), Albin Michel 1993 Phillip Sloan, "Preforming the categories: Eighteenth-Century Generation Theory and the Biological Roots of Kant's A Priori", *Journal of the history of philosophy*, 40, 2 Kant and Blumenbach on the Bildungstrieb: A Historical Misunderstanding. *Studies in History and Philosophy of Biological and Biomedical Sciences* 31: 11-32. CrossRefGoogle Scholar. Richards, R.J. 2002. *The Romantic Conception of Life*. Chicago: University of Chicago Press. CrossRefGoogle Scholar. Shabel, L. 2005. *Apriority and Application: Philosophy of Mathematics in the Modern Period*. German philosopher Immanuel Kant was a prominent figure of the Enlightenment whose work in such fields as epistemology, ethics, and aesthetics was hugely influential in the development of philosophical thought. Kant's three "Critiques," beginning with the "Critique of Pure Reason" in 1781, are his best-known works, and they formed a significant part of the foundation for critical philosophy (Kantianism). "Der einzig m glichste Beweisgrund zu einer Demonstration des Daseyns Gottes" (1763). "The Employment in Natural Philosophy of Metaphysics Combined with Geometry, of Which Sample I Contains the Physical Monadology" (1756). "Universal Natural History and Theory of the Heavens" (1755). "Principiorum Primorum Cognitionis Metaphysicae Nova Dilucidatio" (1755). Kant's treatment of the question of race in terms of a construct he called the Stammrassen, and the specific manner in which he attempted to ground that concept on Blumenbach's theory of the Bildungstrieb-conceived as an organic version of a Newtonian force, a mechanico-teleological drive operating materially within organic bodies to give rise to their determinate structures-led Blumenbach. to realize the consequences that his own views, as modified by Kant, might hold for the construction of a general theory of natural history. \*Department of History, University of Arizona, Tucson, Blumenbach's Bildungstrieb concept influenced the debate between preformationists and epigenesists, as it attacked the assumptions underlying preformationism. According to preformationism, an organism existed fully formed within the egg or sperm (germ cell), and the process of development was one of the animal unfolding, or growing, from its miniature germinal form to more mature and adult forms. Many scholars, such as Albrecht von Haller, in Switzerland, Marcello Malpighi, in Italy, and Jan Swammerdam, in the Netherlands, believed that some form of preformationism best explained developm... "Kant and Blumenbach on the Bildungstrieb: A Historical Misunderstanding." *Studies in the History and Philosophy of Biology and Biomedical Sciences* 31 (2000): 11-32.