Force and Law in Kielmeyer's 1793 Speech

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Introduction

Carl Friedrich Kielmeyer is an enigmatic figure in the history of science. On 11 February 1793, Kielmeyer gave a speech at the Hohen Karlsschule to celebrate the 65th birthday of its founder, Carl Eugen. He honoured the occasion with a condensed summary of several years of research in physiology, zoology and natural history. While the lecture offers an extremely difficult, even baffling text to the contemporary reader, it was snapped up by a local publisher and released the same year under the title, *On the Relations of Organic Forces*. The publication was an immense success, and a striking number of Kielmeyer's peers pronounced the speech as a generation-defining achievement that consolidated a range of pressing issues in philosophy, natural history and physiology into a single programme of research. Friedrich Schelling proclaimed it as 'a speech from which in the coming era an entirely new epoch of natural history is expected.'[1] After reading the speech, Alexander von Humboldt dedicated his new research in comparative anatomy to Kielmeyer, announcing him 'the greatest physiologist' of the age.[2] Johann Wolfgang von Goethe cited key passages from the speech in his call for a new

[1] F. W. J. Schelling, *Von der Weltseele: Eine Hypothese der höhern Physik zur Eklärung des allgemeinen Organismus* (Hamburg: Perthes, 1798), 298.
[2] A. von Humboldt and A. Bonpland. *Beobachtungen aus der Zoologie und vergleichenden Anatomie* (Tübingen, 1806-9), v.

science of comparative anatomy.[3] In short, the publication of his speech given at the Karlsschule thrust Kielmeyer into the limelight as a generational '*phenomenon*',[4] leading many to see him as the *Wegbereiter* for a new movement in natural philosophy.[5] After 1793, however, Kielmeyer published virtually nothing. While he continued to develop the speech's methodology in the classroom and through extensive personal correspondence, he never settled on a finished programme of research.[6]

Scholars are in no doubt that Kielmeyer's 1793 speech marks a defining moment in the study of living nature. Yet there is no consensus on what it actually achieved. Edmund Lippmann claims that Kielmeyer advances a vitalist heuristic by which the physiologist can discern organic laws on the 'belief' that the organic sphere is governed by an original, organising force.[7] For Timothy Lenoir, Kielmeyer offers a prolegomena for 'vital materialism', a new programme of research that 'unified mechanistic and teleological principles of explanation.'[8] James Larson goes a step further, arguing that Kielmeyer opens a new system programme for the investigation of living nature in which 'vital forces become causal agents.'[9] On Larson's reading, Kielmeyer personifies the living forces, thereby enabling the naturalist

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[3] See, for example, Goethe, *Erster Entwurf einer allgemeinen Einleitung in die vergleichende Anatomie, ausgehend von der Osteologie*, in *Die Schriften zur Naturwissenschaft* (Leopoldina Ausgabe), ed. D. Kuhn (Weimar: Hermann Böhlau Nachfolger, 1947), I/9: 124.

[4] K. T. Kanz, 'Carl Friedrich Kielmeyer (1765-1844) – Leben, Werk, Wirkung: Perspektiven der Forschung und Edition', in K. T. Kanz (ed.), *Philosophy des organischen in der Goethezeit: Studien zu Werk und Wirkung des Naturforschers Carl Friedrich Kielmeyer* (Stuttgart: Steiner, 1994), 14.

[5] I. Schumacher, 'Karl Friedrich Kielmeyer, ein Wegbereiter neuer Ideen: Der Einfluß seiner Methode des Vergleichens auf die Biologie der Zeit', in *Medizinhistorisches Journal* 14 (1979); K. T. Kanz, 'Carl Friedrich Kielmeyer (1765-1844): Wegbereiter des Entwicklungsgedankens', in H. Albrecht (ed.), *Schwäbische Forscher und Gelehrte* (Stuttgart: DRW-Verlag, 1992).

[6] K. T. Kanz, *Kielmeyer-Bibliographie: Verzeichnis der Literatur von und über den Naturforscher Carl Friedrich Kielmeyer (1765-1844)* (Stuttgart: GNT Verlag, 1991), 12. Kuhn speculates that Kielmeyer has been overlooked as a serious contributor to the development of biology due to his few publications, and points instead to his commanding personality as the source of his influence. See D. Kuhn, 'Uhrwerk oder Organismus: Carl Friedrich Kielmeyers System der organischen Kräfte', in K. T. Kanz (ed.), *Philosophy des organischen in der Goethezeit: Studien zu Werk und Wirkung des Naturforschers Carl Friedrich Kielmeyer* (Stuttgart: Steiner, 1994), 37.

[7] E. Lippmann, *Urzeugung und Lebenskraft: Zur Geschichte dieser Probleme von den ältesten Zeiten an bis zu den Angängen des 20. Jahrhundrets* (Berlin: Julius Springer, 1933), 94.

[8] T. Lenoir, 'Kant, Von Baer, and Causal-Historical Thinking in Biology', in *Poetics Today* 9.1 (1988), 104. See also T. Lenoir, *The Strategy of Life: Teleology and Mechanics in Nineteenth-Century Biology* (Dordrecht: Reidel, 1982), 44-53.

[9] J. Larson, 'Vital Forces: Regulative Principles or Constitutive Agents? A Strategy in German Physiology, 1786-1802' in *Isis* 70.2 (1979), 241.

to examine the manifold of appearances as the result of an action. Peter Hanns Reill consolidates Larson's reading, claiming that Kielmeyer advances a metaphysical form of vitalism.[10]

In this paper, I propose a different interpretation of the 1793 speech in which Kielmeyer neither unifies mechanism and teleology nor advances a vitalistic account of living phenomena. Alternatively, I argue that he outlines a new standpoint from which the naturalist can examine morphological change as the dynamic interaction of five life forces, thereby *avoiding* any recourse to agential language or speculation about the vital properties of matter.[11] This new standpoint, I suggest, extends the analogical interpretation of Newtonianism developed by Haller, Herder, Blumenbach and Kant, which enabled the naturalist to organise the manifold of living nature according to living forces while remaining indifferent in regard to their cause.[12] Yet, in contrast to his predecessors, Kielmeyer decouples the analogical method from its Newtonian origin. Kielmeyer's speech, I contend, subtly and yet decisively transforms analogical physiology into an independent science of affinity.

This paper is divided into four sections. In the first section, I define the problem confronting eighteenth century physiologists as *the problem of the manifold*: how the relations between living beings can be determined within the petametres of Newtonian inquiry. In the second section, I examine the use of Newtonian analogies by Haller, Herder, Blumenbach and Kant as responses to this problem. In the final two sections, I turn to Kielmeyer's unique response in the 1793 speech. His method, I propose, reformulates what he terms the 'two

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[10] P. Reill, *Vitalizing Nature in the Enlightenment* (Berkeley: University of California Press, 2005), 191-2.

[11] See E.-M. Engels, 'Die Lebenskraft – metaphysisches Konstrukt oder methodologisches Instrument? Überlegungen zum Status von Lebenskräften in Biologie und Medizin im Deutschland des 18. Jahrhunderts', in K.T. Kanz (ed.), *Philosophy des organischen in der Goethezeit: Studien zu Werk und Wirkung des Naturforschers Carl Friedrich Kielmeyer* (Stuttgart: Steiner, 1994) and *Die Teleologie des Lebendigen: Kritische Überlegungen ur Neuformulierung des Teleologie-problems in der angloamerikanischen Wissenschaftstheorie* (Berlin: Dunker and Humblot, 1982), 97-98.

[12] I draw the term 'analogical Newtonianism' from Charles Wolfe's topography of Newtonianisms in 'On the Role of Newtonian Analogies in Eighteenth-Century Life Science', in Z. Biener and E. Schliesser (eds), *Newton and Empiricism* (Oxford: Oxford University Press, 2014), 223-4.

chapters' of Kant's *Critique of Pure Reason*, the 'chapter on experience' (the Transcendental Analytic) and the 'chapter on reason' (the Transcendental Dialectic). First, I argue that Kielmeyer extends Kant's doctrine of space and time as forms of intuition to include organic structure. Second, I evaluate the implications of this move for the systematic reconstruction of the manifold according to the demands of reason. I conclude with several remarks on the significance of the 1793 speech for the generation of naturalists following Blumenbach and Kant.

The Problem of the Manifold

Kielmeyer's lecture proposes a ground-breaking solution to the problem of the manifold. During the seventeenth and eighteenth centuries, the integration of experimental practices into philosophy introduced a new standard of scientific explanation based on the physical connections between particles. While this standard led to unprecedented gains in celestial mechanics, and then in particle physics, it simultaneously left the connections between *specific* natural products underdetermined, such as the elements studied in alchemy and the species studied in natural history. In *Origins of Forms and Qualities* (1633), Robert Boyle presented a manifesto for experimental philosophy that rejected the natural system of elements and introduced instead a corpuscular theory of matter. Corpuscularism is a form of monism about the corporeal in which matter is understood as a homogenous, physical substance. Boyle elaborates the consequences of corpuscular philosophy for the natural system of classification as follows:

> Men having taken notice that certain conspicuous accident were to be found associated in some bodies, they did for conveniency, and for the more expeditious expression of their conceptions, agree to distinguish them into several sorts, which they call genders

> or species … as, observing many bodies to agree in being fusible, makeable, heavy, and the like, they gave to that sort of body the name of metal.[13]

On the assumption that qualitative determinations can be reduced to physical connections, Boyle rejects the use of essential qualities to classify natural kinds within the natural system. In *An Essay Concerning Human Understanding* (1689), John Locke extends Boyle's denial to plants and animals. Locke contends that corpuscular philosophy demonstrates that the association of certain individuals within a kind is not based on real essences but rather on the naturalist's interest to gather natural diversity into relations of affinity. He redefined the qualities of an object as ideas in the mind of a perceiving subject, which do not necessarily track natural divisions. 'So uncertain are the Boundaries of *Species* of Animals to us', Locke exclaimed, for we 'have no other Measures than the complex *Ideas* of our own collecting.'[14]

The problem of the manifold is that the affinities we discover in nature are *subjective*. Classificatory marks are not based on the objects themselves, but rather on the connections made between ideas in our minds. While this entails that empirical concepts are artificial, it does not, however, result in full-blown nominalism. Boyle and Locke deny epistemic access to real essences, for ideas do not *necessarily* track real classificatory divisions. Their scepticism is thus generated by a commitment to metaphysical realism, for it is generated by the assumptions that there are natural boundaries to be found. The epistemic limits they place on classification simultaneously open the question of how the boundaries in nature might be reimagined as the result of a natural process and discerned via an experimental method.

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[13] R. Boyle, *Works*, ed. M. Hunter and E. B. Davis (London: Pickering and Chatto, 1999), III 36.
[14] J. Locke, *An Essay Concerning Human Understanding* (Oxford: Clarendon, 1975), III vi 27, 290.

Analogical Newtonianism

Isaac Newton altered the course of experimental philosophy by demonstrating how a property that is, at first, merely subjective can be vindicated as a genuine property of an object. In his celestial mechanics, gravity is initially proposed as a hypothetical force to unify the manifold of planetary phenomena. Through the application of mathematics, it is then established as universal and necessary for all planetary movement. The question opened by his work, especially by the ambiguous queries found in later editions of *Principia* and *Opticks*, is whether such a method could be extended to phenomena more specific than matter, such as the bonds between chemical compounds or physiological movement. No one was more successful in providing a positive answer than Göttingen physiologist, Albrecht von Haller. At the close of the eighteenth century, Christoph Heinrich Pfaff commended Haller's achievement with words that foreshadow Schelling's praise of Kielmeyer. Haller's extension of Newton's method to the examination of physiological properties, Pfaff states, initiated a new era 'in the history of the cultivation of physiology.'[15] In this section, I examine Haller's physiology as a ground-breaking response to the problem of the manifold. In the following sections, I argue that Kielmeyer's 1793 speech both extends and surpasses Haller's response.

In a series of two papers presented to the Royal Society of Sciences at Göttingen in 1752, Haller proposed an experimental method for the classification of muscle fibres according to their physiological properties. At first glance, the idea of physiological properties seems incompatible with Newtonainism, understood as the reduction of phenomenal characteristics to the interaction of homogenous particles. However, Haller interpreted Newton's method as a model for investigating movement according to inner properties, without requiring one to speculate about hidden causes. If the Newtonian method is indifferent to hidden causes, then it would not overreach the boundaries of experimental inquiry to apply it to phenomena that do

[15] C. H. Pfaff, *Über tierische Elektricität und Reizbarkeit* (Leipzig: Crusius, 1795), 236.

not seem reducible to matter in motion, such as the fibrous matter of muscles. To classify the various kinds of fibres found in animal bodies, Haller proposes two distinct properties, irritability (*Reizbarkeit*) and sensibility (*Empfindung*). These properties do not cause physiological effects, just as gravity does not cause objects to fall. Rather, they stand as methodological postulates by which the naturalist can classify fibres according to their effects. Haller proposes that a fibre is irritable if a contraction can be observed without the organism being sensible to it.[16] It is sensible, in contrast, if stimulation causes the organism to turn the sensation into an image. In the opening line of his textbook on physiology, *Elementa physiologiæ*, Haller identifies the methodological basis of physiology through an analogy with geometry: '*Fibra enim physiologo id est, quod linea geometræ*', the fibre is to physiology what the line is to geometry.[17] The analogy between geometry and physiology enables the naturalist to search for the qualities of known points in a single space based on their relations, and to discover new points within the nexus of connections. The result is an objective procedure by which muscles and nerves can be classified according to their effects.

While most of his successors found the two properties of muscle fibres too simplistic to account for the movement of organic bodies, Haller's investigation opened a new era of physiology by providing a model for extending Newtonian inquiry to living phenomena. In *Ideas for a Philosophy of Human History* (1784), Herder employed the Newtonian analogy to propose three faculties, adding elasticity to Haller's two life forces.[18] Herder's goal, however, was not simply to classify muscle fibres, but to organise the entire manifold of living phenomena under a principle. Herder saw that Haller's method did not acknowledge a difference between the universal properties of matter and the physiological properties of

[16] A. von Haller, 'A Dissertation on the Sensible and Irritable Parts of Animals,' ed. O. Temkin in *Bul. Hist. Med.* 4 (1936), 692.
[17] A. von Haller, *Elementa physiologiæ corporis humani*, (Lausanne: Marc-Michel Bousquet, 1757), I 2.
[18] J.G. Herder, *Ideas*; translated as: *Outlines of a Philosophy of the History of Man*, ed. T. Churchill (London: J. Johnson/L. Hansard, 1803).

fibrous matter, thereby leaving the question of reduction unanswered. While the properties of matter are universal and reactive, physiological properties are specific and responsive. Herder's solution is to separate mechanical and organic inquiry by identifying two distinct analogies, both of which are grounded in a single, unifying principle. The result is that physiology stands on equal footing with physics: '*where effect is, there must be a force; where new life is, a principle of new life must exist*.'[19] This is to say that the representation of an object as living carries with it, by power of analogy, a transcendental principle of lawfulness. Just as we have warrant to assume that in physical nature every effect is caused by a force, we have equal warrant to assume that living nature is the expression of an organic principle. Herder claimed that his paired analogies can classify living nature under a unifying principle, just as Newton's presumption of a single force that unifies the solar system enabled the discovery of gravity.

Herder's organic analogy received mixed reviews. The idea of a unifying principle seemed to imply a non-Newtonian, teleological power capable of realising its intentions in nature. Blumenbach outlined an alternative analogy that, in his view at least, solved the Hallerian problem while remaining within the Newtonian frame. He defined the field of physiology according to five hierarchically arranged forces, with Haller's irritability and sensibility at the most general level, and the more specific forces of conception (*Zeugung*), nourishment (*Ernährung*) and reproduction (*Reproduction*) beneath them.[20] Following Herder, Blumenbach's five *Lebenskräfte* are discovered through an analogical procedure by which the naturalist proposes an unknown force as the ground of known effects. Yet Blumenbach denied that the higher forces are governed by a unifying principle. Rather, he identified a further *Lebenskraft* that is limited to organic bodies:

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[19] *Ibid.*, 51. I have modified Churchill's translation of *Kraft* from 'power' to 'force' for consistency.
[20] J.F. Blumenbach, *Über den Bildungstrieb* (Göttingen: Dieterich, 1791), 25.

> in the prior brute unformed generative matter of organised beings, before it has arrived at its maturity and determinate place, a particular and enduring active drive [*thätiger Trieb*] begins to take on its determinate shape, which it maintains for its whole life and, if maimed, is able to restore.[21]

Blumenbach names this drive the *Bildungstrieb*, which he presents as the *Lebenskraft* responsible for the form of organised beings. While the idea of a formative drive seems at odds with Newton's mechanical conception of force, Blumenbach insists that the word '*Bildungstrieb*' functions in natural history just like the word 'gravity' in Newtonian mechanics, for it serves 'no more and no less than to signify a force whose constant effect is recognised from experience, and whose *cause*, like the causes of the aforementioned widely recognised natural forces, is for us an *qualitas occulta*.'[22] Like gravity, the *Bildungstrieb* cannot be reduced to more basic powers, for it serves to render intelligible the movement of the parts within a system that cannot be otherwise explained. To examine organised beings as the effect of natural forces is to enable the naturalist 'to give closer determination to their effects and bring them under general laws.'[23]

Kant was impressed by Blumenbach's account of the *Bildungstrieb*, for it demonstrated how teleological properties can be examined alongside mechanical properties of living beings.[24] He was not, however, convinced that the *Bildungstrieb* could be discerned via an analogy with Newtonian forces. In his critical philosophy, Kant aimed to vindicate the use of analogical reflection by separating two uses of analogy. To ensure that analogy is not merely a subjective projection of what reason would like to find in nature, Kant anchors Newtonian

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[21] *Ibid.*, 24.
[22] *Ibid.*, 25-26.
[23] *Ibid.*, 26.
[24] I. Kant, *Critique of the Power of Judgment*, trans. P. Guyer (Cambridge: Cambridge University Press, 2000), 5:424.

inquiry within a conception of the manifold that is not a mere chaos of particulars which must then be reconstructed in the mind according to affinities between ideas. In Kant's epistemology, the manifold is spontaneously presented in spatial and temporal form and schematised with a causal structure. Kant contests that the manifold qualifies as cognition by going through three syntheses: modifications are apprehended in the mind in intuition, reproduced in the imagination and finally recognised in a concept.[25] In the Analogies of Experience, Kant argues that we search for causes only when the connection between phenomena is presented *a priori*. The category of causation provides a transcendental rule connecting two events that are sequential in time (X is followed by Y) as a causal connection, allowing one on appearance of Y_1 to hypothesise X_1 as its cause. The determination of the manifold does not tell us what the cause is, but makes it the case *that* there is a cause to be found.

The upshot of Kant's epistemology is that the causal structure of living beings, by which the parts not only cause the whole (as an aggregate of rock causes a mountain) but the whole also causes the parts (as a living being repairs itself according to an idea of the whole), lies beyond the causal structure of cognition. The capacity of a living being to repair itself, for example, bears a different temporal structure to the linear sequence of appearances *in us*, which is either adjacent in space or sequential in time. Kant's Third Analogy identified the necessary community of parts as a *compostium reale*, which means that each part must be considered within a single causal sequence.[26] Yet the relation between the community and the parts is not causal, for composition is predicated on causal relations between *the parts*. In contrast, the causality of a living natural product moves from parts to whole *and* from whole to parts. Organic movement, including repair and morphological change, is the function of a causality

[25] I. Kant, *Critique of Pure Reason*, trans. P. Guyer and A. Wood (Cambridge: Cambridge University Press, 1999), A97.
[26] *Ibid*., A215/B262.

that moves from whole to parts. Even if repair could be explained mechanically, the *possibility* of repair cannot lie in nature understood as mechanism.

In the Transcendental Dialectic, Kant states that when cognition leaves the manifold underdetermined, reason proposes certain ideas that never appear in experience but nevertheless enable the naturalist to unify a particular domain of inquiry, such as the pure elements in chemistry or lines of descent in natural history.[27] On the assumption that specific forces give rise to localised effects, reason aims to unify the manifold by reconstructing it within a projected system. Yet, in contrast to the constitutive ordering of the categories, the ideas of reason do not determine the manifold. They simply guide our reflection, meaning that experimental sciences such as chemistry and natural history cannot determine hypothetical properties as properties of the object; they carry merely subjective necessity. In the third *Critique*, Kant argues that the variation of living beings must be considered as a dynamic interaction between external forces, which act on living beings, and inner purposes, by which the organism gives shape to itself. Yet, inner purposes are not examined by an analogy with the causality of the understanding; they are examined by an analogy with *our own purposiveness* as rational agents, by which a representation of the whole determines our parts.[28] Thus, the *Bildungstrieb* cannot be a law of nature. It is a subjective law for unifying the manifold, and cannot be reduced to the mechanical properties of matter.[29]

Space, Time and the Manifold

Early in his career, Kielmeyer began work on a new conception of natural history that built on Kant's distinction between inner and outer nature. Yet he questioned Kant's twofold conception of analogy, for it denies the investigation of living nature as a matter of cognition.

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[27] *Ibid*., A644/B672-A645/B673.
[28] Kant, *Critique of the Power of Judgment*, 5:375.
[29] *Ibid*., 5:424.

In the following two sections, I suggest that Kielmeyer's conception of natural history transforms Kant's transcendental account of nature in two important ways. First, it reframes Kant's account of space and time such that they include the spatial and temporal form of organised nature. Second, it derives the laws that regulate the distribution of vital functions in the animal kingdom. Together, these modifications enable the naturalist to systematise the manifold according to general laws, thereby opening the prospect of a science of affinity. In this section, I focus on Kielmeyer's account of time and space, beginning with his early writings and then turning to the introduction to the 1793 speech.

In an unpublished paper from 1790, 'On Natural History', Kielmeyer presents the problem of the manifold as a consequence of the finite conditions of human knowledge. In keeping with Kant's epistemology, he affirms the discursive nature of human cognition. Thought does not produce objects by virtue of thinking them. Rather, it gives spatial and temporal form to an objective order of nature that exists independently of us. The discursive nature of cognition thereby entails that natural divisions are not immediately given. Yet Kielmeyer then provides a definition of nature that modifies the Kantian frame. Nature, he states, consists of 'everything emergent [*alles Entstandene*] or actually appearing to our senses [*unsern Sinnen wirklich Scheinende*] and which is perceived with our outer and inner sense, connected in time and space and apt to follow certain laws' (p. 00 above). If nature does not simply concern the totality of natural products but also the laws by which they became manifest in time and space, then the idea of a *natural* history 'must … address not only the question of their present state, but also that of the states preceding and perhaps succeeding the present one – thus, how it *is*, how it *was*, and how it *will be*' (p. 00 above). In contrast to many experimental philosophers, who consider the manifold as a collection of facts awaiting systematisation,

Kielmeyer follows Herder by claiming that natural history is possible only according to a transcendental presupposition that the manifold is the product of a causal history.[30]

Kielmeyer's inclusion of 'everything emergent' in the concept of nature signals his attempt to transpose Kant's regulative account of natural products into a constitutive account of natural processes. Kielmeyer shares with the analogical Newtonians the idea that the *scala naturae* is not an object of knowledge but rather a regulative hypothesis that enables the naturalist to search for the forces that determine the connections in one's model. Yet to give this hypothesis transcendental grounding, he replaces the logical conception of the *scala naturae* with the 'series of organisations', the idea of a dynamic and open system that is in a constant state of growth and change.[31] In his lecture notes for a course on the development of organisations given in 1793/4, Kielmeyer repeats the Kantian refrain that, when it comes to organic change, all we experience are alterations that are contingent in regards to the universal laws of nature. However, he then states that

> In addition to these irregular changes, we note in all organizations a series of definite successive changes which are the same in the individuals of the same genus, and which remain the same even in altered external circumstances, and in contrast to different circumstances in individuals of a different genera, and, therefore, seems to be independent of external circumstances, and seems to be made up more of its own inner forces. (*GS*, 107)

[30] For a study of Kielmeyer's relation to Herder, see W. Pross, 'Herders Konzept der organischen Kräfte und die Wirkung der Ideen zur Philosophie der Geschichte der Menschheit *auf Carl Friedrich Kielmeyer*', in K. T. Kanz (ed.), *Philosophy des organischen in der Goethezeit: Studien zu Werk und Wirkung des Naturforschers Carl Friedrich Kielmeyer* (Stuttgart: Steiner, 1994).
[31] T. Bach, *Biologie und Philosophie bei Kielmeyer und Schelling* (Stuttgart: Frommann-Holzboog, 2001), 93.

Kielmeyer insists that the changes that occur in organisations are not constructed by the subject. They are the effects of inner forces, which means that they can be investigated in search for principles of change. Given that the development of organisations is not simply a product of reason's demand, which is merely subjective, Kielmeyer concludes that they must be considered according to an alternative conception of nature as the totality of connections of effects in time and space, that is, the series of organisations. The goal of natural history is to grasp the laws that govern the development of the series, not simply the regulative principles that govern *our* attempt to comprehend it.

In the 1793 speech, Kielmeyer states that his goal is to develop a 'physics of the animal kingdom [*Physik der Tierreichs*]' through comparative anatomy. In Kant's view, experimental physics is guided by categorised experience, which provides the universal form of causation (*X* is the cause of *Y*). Natural history, in contrast, examines natural changes according to the causal form of organised beings (things of *such and such a kind* do *Y* when *X* happens). This causal form is foreign to categorised experience, and is derived analogically by extending the form of rational determination as a guide for reflecting on the manifold of living nature. Thus, to ground a *physics* of the animal kingdom, Kielmeyer modifies Kant's account of space and time as forms of intuition such that the unique causal form of organisations *is* a part of nature.[32]

To achieve this goal, Kielmeyer begins the lecture by questioning the privileged position given to cosmology in eighteenth century natural science. While naturalists have hitherto contemplated the heavens as the greatest display of nature's order, he invites his audience to consider instead the startling and unparalleled order manifest in the organisations of living nature. Our capacity to identify some objects as organisations, as interdependent clusters of organs that manifest internal unity, does not occur on the level of our reflection *on*

[32] M.-L. Heuser-Keßler, 'Raum, Zeit, Kraft und Mannigfaltigkeit. Kant und die Forschungsmethodologie der Physik des Organischen in Kielmeyers "Rede"', in K. T. Kanz (ed.), *Philosophy des organischen in der Goethezeit: Studien zu Werk und Wirkung des Naturforschers Carl Friedrich Kielmeyer* (Stuttgart: Steiner, 1994), 113.

the manifold. Rather, it occurs on the primitive level of the schematising understanding, such that organisations are *given within* the manifold:

> If, by the powers of our minds, we separate the phenomena of nature – for us connected in a system by space and time – from their connection, then surely those phenomena that we isolate and subsume under the name 'animate nature'—I mean the organisations of our earth—are the most able to fill us with feelings of nature's greatness of those [phenomena] with which we are closely acquainted. To be sure, no masses, volumes, or distances found here are like those of the skies, by which nature convinces us of its greatness. However, if, when judging the greatness of an object, we can deign to give voice and listen with a little patience to the multiplicity [*Vielheit*], diversity [*Mannigfaltigkeit*] and harmony [*Harmonie*] of effects in a small space and short periods of time, then there are things of another kind that speak to us no less forcefully. (p. 00 above)

Rather than turning to the celestial system as the model by which reason organises the manifold presented in cognition, Kielmeyer invites his audience to begin with the pre-structured multiplicity of organised nature, and to discern the harmony of effects and causes that express another kind of order. First, this draws our attention to the incredible diversity of organisations on the surface of the earth, which is a remarkably small space compared to the planetary system. Second, it draws our attention to the manner in which these things occupy time. The changes undergone by an organisation result in the reciprocal adaptation of all the other organs, thus forming a system that is united such that 'each is reciprocally cause and effect of the other' (p. 00 above). This same configuration characterises the organisations within a species, and the

organisations within an environmental system, which come together to 'form the life of the great machine of the organic world' (p. 00 above).

Kielmeyer's mechanical metaphor does not imply that the organic world is reducible to physics, nor that it is the product of a pre-structured plan. Rather, it illustrates the systematic combination of forces.[33] Consider his presentation of the machine of the organic world in 'On Natural History':

> Since a machine in the broadest sense is a combination of one or more forces (towards a specific end), by the cooperation of which certain results will be obtained, it is permitted, if the larger results are not obvious to us and to the extent that we note interconnectedness, to represent nature as a great machine whose cogs we grasp according to all the phenomena that arise for us. (p. 00 above)

The mechanical metaphor enables the naturalist to look at the emergent levels of complexity on the assumption that each is determined by lower-level connections, without needing to reflect on what those connections are. The emergent system is a dynamic product of several forces that compensate each other within space and time.

In a letter to Cuvier in 1807, Kielmeyer considers the relation between the qualitative distinctness of matter and quantitative relations of forces. He notes that Kant's empirical concept of matter in *Metaphysical Foundations* aimed to show that qualitative distinctness can be reduced to quantitative relations of forces. The essence of matter for Kant lies simply in the communion of attractive and repulsive forces, through which matter effects and exists. Sceptical of Kant's reduction, Kielmeyer takes the discussion in an alternative direction:

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[33] Bach, *Biologie und Philosophie*, 137.

> Were the *essence* of matter in general posited as consisting in the sheer coexistence of these two forces, it would follow from this that the *difference* of matters would depend solely on different quantitative proportions of the two forces; gold and limestone would differ only in the quantitative proportions of the expansive and attractive forces in them. Now, since the quantitative proportions are determinable *a priori*, so one should think that the whole range of varieties of matter on our earth could easily be worked out and determined *a priori* from the concept of matter in general. *Kant*, in order to explain the diversity of nature, that obstacle to the Idealists which, by means of separating the subjective and the objective in our knowing, he seemed fortunately to have avoided, would unexpectedly face this same obstacle again; and we could equally ask him to explain the natural variation as a consequence of his principles and to construct these principles *a priori*. (p. 00 above)

Kielmeyer identifies Kant's empirical concept of matter as a moment of transition between experimental philosophy and a new kind of idealism. Kant identified the ground of objectivity in the subjective conditions of experience, yet he nevertheless attempted to reduce qualitive relations to attractive and repulsive forces. What can be known objectively is simply objects as determined by the categories, while the remainder of the manifold is a matter of subjective reconstruction. For Kielmeyer, Kant's failure to determine the qualitative distinctness of matter *a priori* reveals a gap between the manifold and our cognition of objects:

> If, however, it is also acknowledged that – as Kant wants – *space and time are subjective*, then the manifold, when treated as such and determined according to its specific type, in our representations of objects, is just as universal, indeed as necessary, as spatial, in so far as we cannot represent objects to ourselves without boundedness,

> but boundedness is only produced by the manifold in space and what is active in it. One would therefore have to explain not only the spatial and temporal, but also the *bounding manifold* (taking this *in abstracto*) as subjective and formal, *contrary* to Kant's view, and explain them on the same grounds as the foregoing. For there would no more be a geometry without prior experience of the manifold than there would be an experience without geometry. All that remains for the objective is the particular kind of manifold. (p. 00 above)

On Kielmeyer's account, Kant failed to recognise that the manifold contributes the limits by which the understanding can then schematise objects. What is given in the manifold is more than spatial and temporal form, but also spatial and temporal *effects* by which objects limit *themselves*. By reducing the manifold to what can be constructed as an object in experience, Kant underdetermines the manifold's significance *for* experience. He does, however, make some headway in his account of reflective judgment in the third *Critique*. Yet, reflective judgment can only reflect on the unschematised manifold via subjectively determined analogies. Thus, to expand the Kantian standard of explanation to include reflection, Kielmeyer does not transform Kant's 'heuristic principle into a constitutive agent', as one commentator puts it.[34] Instead, he locates the reflective operation of judgment prior to its determinative application, thereby opening a way to search for and establish the laws of animate nature.

Force and Law in the 1793 Speech

In the introduction to the 1793 speech, Kielmeyer outlines a new method that opens a possible physics of the animal kingdom. The natural historian begins with the great machine of the organic world, understood as a dynamic equilibrium in which the relation between the various

[34] Larson, 'Vital Forces', 241.

forces of living nature are balanced in time and space. She then searches for the laws of animal physics, which establish the boundaries between species groups. Given the unique manner in which organisations occupy space and time, Kielmeyer identifies three basic tasks for animal physics: it must (a) define 'which forces are united in the greatest number of individuals'; (b) discern 'the proportions [*Verhältniße*] of these forces to each other for different species of organisations, and by what laws do these proportions modify themselves in the series of different organisations'; and (c) determine how these relations 'are grounded in [the forces] as their cause' (i.e. how *b* is grounded in *a*) (p. 00 above). Let us consider each task in turn.

a. The forces unified in the greatest number of individuals

In Kant's account of natural science, the naturalist has warrant to propose hypothetical forces in the analogical form *X* stands to *Y* as *X* stands to *Z*, for she knows that possible objects stand in the relations determined by the categories: succession, causation and simultaneity.[35] Only by presupposing that physical objects stand within a dynamical system in outer sense can the naturalist reflect on possible grounds for their existence and then propose that the same *X* causes, say, the orbit of the moon *and* the motion of the sea. To extend this analogical procedure to animate nature, Kielmeyer proposes that organisations are a matter of intuition. Like non-living nature, organisations occupy space as an unfathomable manifold. Yet in contrast to non-living nature, they occupy time as a reciprocal relation of cause and effect. The reciprocity of cause and effect is not added by reflecting on the part-whole structure, which in Kant's account was somehow both available to cognition and yet in want of reflective systematisation. Rather, organisation is a temporal relation given in intuition. That the part-whole temporality of organisations is given in intuition enables us to propose various forces that govern manifest effects.

[35] Kant, *Critique of Pure Reason*, A177/B220.

In Kielmeyer's methodology, a force is merely a 'makeshift word' [*Behelfwort*]' that ought to be used only 'for now [*einstweilen*]' (p. 00 above). In Newtonian science, gravity is initially proposed as a problematic force, for its truth remains to be established. It acquires objectivity only when the naturalist establishes that no other candidate force could unify the manifold which such simplicity and completeness. Building on this method, Kielmeyer proposes five organic forces: sensibility (*Sensibilität*), irritability (*Irritabilität*), the force of reproduction (*Reproductionskraft*), the force of secretion (*Secretionskraft*) and the force of propulsion (*Propulsionskraft*) (p. 00 above). In this list, he replaces Blumenbach's forces conception and nourishment, which are not really forces but capacities, with propulsion and secretion, which concern movement alone.[36] More significantly, Kielmeyer rejects the idea of an organisational force that guides and directs the expression of the five organic forces. He is concerned only with the relations (*Verhältniße*) of the forces, signalling a much more empiricist programme of research to that proposed by Blumenbach.[37]

b. Relations and their Laws

In contrast to the planetary system, which is constituted by the relation between attraction and repulsion, the great machine of the organic world consists of the relations of the five life forces. It is not a fixed, but rather a self-generating system that changes itself in time as natural history. The universal principle that structures animate nature is not an active drive but rather a process of exchange by which each force comes to dominance or is repressed in proportion to the other

[36] Gambarotto claims that, in the speech, 'Blumenbach's *Bildungstrieb* is renamed as the reproductive force.' Alternatively, I propose that it is not renamed but replaced. A. Gambarotto, *Vital Forces, Teleology, and Organization: Philosophy of Nature and the Rise of Biology in Germany* (Dordrecht: Springer, 2018), 44.

[37] Dougherty argues that Kielmeyer's approach to organic forces is more empirical than Blumenbach, whose *Bildungstrieb* had metaphysical implications Kielmeyer wished to avoid. F. Dougherty, 'Über den Einfluß Johann Friedrich Blumenbachs aufs Kielmeyers feierliche Rede von 1793', in K.T. Kanz (ed.), *Philosophy des organischen in der Goethezeit: Studien zu Werk und Wirkung des Naturforschers Carl Friedrich Kielmeyer* (Stuttgart: Steiner, 1994), 60-65.

forces. Kielmeyer defines this process as the 'law of compensation [*Kompensationsgesetz*].'[38] The law of compensation is not a governing relation, for nothing directs the interplay of the forces. Rather, it captures the self-regulation of the forces within the constraints of the earth. Kielmeyer uses the geometrical metaphor of a parabola to explain the openness of the organic system, which 'never closes in on itself' (p. 00 above). As Thomas Bach explains, the parabola metaphor captures the individual character of the great machine of the organic world, which is regular and yet undergoes continual alteration.[39] It offers a vision of natural history as a 'self-expanding spiral', to use Marie Heuser-Keßler's phrase, which grows in complexity through the dynamic capacity of organised beings to compensate their effects in relation to other effects.[40] Organic systems are thus irreducible to the Kantian concept of matter, for they are constituted by forces that rise or decline in relation to the other forces.

Kielmeyer's rejection of an organising force means that he does not need to make any ontological claims about levels of reality or kinds of matter. Consider one of his many descriptions of the simultaneous and consecutive changes in each organ within an organisation: 'according to our manner of speaking, each is reciprocally cause and effect of the other' (p. 00 above). Locutions such as this suggest that Kielmeyer views the language of organisations and their laws as pertaining to a phenomenological level of scientific analysis. He claims that even if this phenomenological level were reducible to efficient causation, it would not hamper his new scheme in the slightest:

> suppose that nature had no intent in artificially placing phenomena one after another and next to each other in time, that those effects and consequences were not ends that [nature] wanted to achieve… we would still nevertheless have to admit that in most

[38] The law can be stated as follows: 'the more one of these forces on one side is cultivated, the more it is neglected on the other' (p. 00 above).
[39] Bach, *Biologie und Philosophie*, 101.
[40] Heuser-Keßler, 'Raum, Zeit', 116.

> cases this chain of cause and effect looks like a chain of means and end to us, and we even find it conducive to our reason to accept such a chain; and we must thereby, at least in the end, admit that nature is no less able here than in the skies of convincing us of the truth of that [the greatness of nature] from which I began [i.e. the unique temporal structure of animate nature]. (p. 00 above)

Kielmeyer's counterfactual conditional acknowledges that even if nature has no intrinsic purposes – even if organisation is the emergent structure of mechanical forces – we can nevertheless acknowledge the reciprocal causal structure that permits systematic reconstruction no less than celestial mechanics.[41] The principle of compensation does not make it the case that a teleological cause governs the series of organisations; it simply unites the systematic interconnection of the manifold as a natural process, meaning that the system is not closed and complete but spiralling upward. This is nothing less than a Copernican revolution in physiology, such that the dynamic system of living nature can be reconstructed from the subjective standpoint of the inquirer, who is herself part of the system. From such a standpoint, one does not need to ground organisation in an organising force, either hyperphysical or immanent to organic matter. Organisation is rather the shifting relation of the lower three forces, irritability, sensibility and reproduction, which determines the degree of sophistication.

To exemplify this process, let us consider the relation between sensitivity and reproduction. In Kielmeyer's analysis, sensitivity and reproduction can be understood in a relation of polarity. As the series of organisations diminish in complexity from humans to animals and to vegetables, the diversity of sensations diminishes to the point of uniformity of movement.[42] This observation gives rise to the law, 'the manifoldness of possible sensations

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[41] R. J. Richards, *The Romantic Conception of Life: Science and Philosophy in the Age of Goethe* (Chicago: University of Chicago Press, 2002), 242.
[42] G. Bersier, 'Visualising Carl Friedrich Kielmeyer's Organic Forces: Goethe's Morphology on the Threshold of Evolution', in *Monatshefte* 97.1 (2005), 22.

in the series of organisations decreases as the fluency and refinement of the remaining sensations increases in a more restricted scope' (p. 00 above). Alternatively, for plants, where forms of reproduction are at their most various, irritability and sensibility are almost non-existent: 'irritability increases as the speed, frequency and diversity of the same expressions, and the diversity of sensations, decreases' (p. 00 above). The increase in diversity of reproduction thus occurs in reverse proportion to the diversity of sensations, where in plants it receives maximum diversity. This gives rise to a further law: 'the reproductive force … increases as the size of the producing individuals, or more universally, the individuals produced as they appear after birth, decreases' (p. 00 above). The discovery of the laws of organisation occur through observing the relation between the forces, such that if one force is less present in an organism, the others tend to be more fully developed. The distribution of the organic forces is regulated by the law of compensation, which states that the sum of all forces must remain constant.

The explanatory role of the law of compensation can also be seen in Kielmeyer's account of the relation between sensitivity and reproduction. For sensitivity: as the variety of sensations diminishes across the system of organisations, the degree of refinement of the remaining senses increases. For reproduction: the number of new organisations brought forth by genetic replication increases as the size and complexity of the generated individuals diminishes. Reproduction permits a second law concerning transformation, which concerns the capacity of an organisation to substitute organic reproduction with partial organic regeneration or metamorphosis: 'the less the reproductive force is expressed in many new individuals, the more it is expressed either through metamorphoses that the body withstands, or through unusual artificial reproduction, or both together, or by indeterminate growth, or by greater division in the newly begotten formations' (p. 00 above).

c. Grounding the Laws

The final task of a physics of the animal kingdom is to determine how relations are grounded in the forces as their cause. Here Kielmeyer steps back from the relations themselves to examine the systematic arrangement of the organic world according to the laws discovered in *b*. From this higher vantage, the law of compensation is not the equilibrium that emerges through the vanishing and emergence of opposed forces; rather, it is the equilibrium that emerges through their repulsion and even destruction. Plants, because they possess little or no sensibility and irritability, 'repel all destructive forces of the animal kingdom with their reproductive force' (p. 00 above). Worms, which are a class between plants and animals, withstand the animal kingdom by virtue of its 'indestructible irritability and reproductive capacity.' The higher animals, who are the most destructive by virtue of their great mass, are supported by the great number of smaller individuals. The animals with greater irritability and sensibility, and thus who move more swiftly and frequently, are given towards predation. The continued existence of the organic world is thus determined by the balancing (*Ausgleichung*) of the forces, captured by a further law: 'destruction by one force was thus regularly repelled by another force, or limited by a different side of the same one, and thereby the species was at least preserved' (p. 00 above). The law of compensation thus entails that as one force disappears, another emerges. The relation between parts within a plant or animal, the relation between various species, and relation between living beings and the earth are determined by balancing of the laws. This is how the relations are grounded in the life forces: the 'vanishing of one [force] can therefore be regarded as the cause of the emergence of the other' (p. 00 above).

Kielmeyer concludes with a remarkable reflection on the human being as the species that possesses the greatest power of compensation of one organic force for another. Rationality 'turns up' in humanity's organisation due to an 'over-preponderance' of the forces, giving rise

to ‘the capacity to freely alter (within certain limits) the relation of the other forces that it has in common with other animals’ (p. 00 above). Where humans lack in sight or movement, they can create technologies such as telescopes or domesticate other species such as horses, granting to the human species ‘a decisive preponderance over most other animal species and their forces of preservation’ (p. 00 above). The human species is uniquely plastic, for it can freely alter the balance of the forces. ‘The human spirit [*Geist*]’, Kielmeyer states, ‘displays changed proportions [*Verhältniße*] of the forces united in it’, such that ‘changes of circumstance present these [changes of forces] with their development’ (p. 00 above). Because the compensation of forces is internal to the human organisation, the capacity is analogous to the self-healing of the polyp, which actively responds to privation by supplementing itself with an alternative force. The character of the human species is ‘that capacity of compensation [*jene Erstattungs Fähigkeit*], or in other words, the capacity to flourish in all external circumstances’ (p. 00 above). Wisdom and happiness do not lie in the unnatural attempt to steer fate, Kielmeyer concludes, but rather in the cultivation of the natural capacity through which fate is confronted.

Conclusion

Examining Kielmeyer’s lecture as a response to the problem of the manifold clarifies its historical significance. During the eighteenth century, natural historians and physiologists responded to the problem of the manifold by transposing the *systema naturae* into a regulative ideal for searching out nature’s order. The analogical interpretation of Newtonianism proposed by Haller, Herder, Blumenbach and Kant enabled each naturalist to develop a system of classification according to life forces. In his 1793 speech, Kielmeyer takes this development to its conclusion – and beyond it – by establishing a system of organised nature as a self-expanding spiral, a developing parabola that manifests its systematic connections as the great machine of organic nature. In Bach’s terms, Kielmeyer’s speech transforms ‘the forces of the

soul [*Seelenkräfte*] … into the forces of bodies [*Körperkräften*]', placing the static Newtonian cosmos within a self-generating causal sequence without the addition of a vital organising force.[43] Thus conceived, membership in a genus such as quadrupeds is not determined by the mere fact of having four legs, which is simply an accidental characteristic; rather, it is determined by a specific relation between sensation and reproduction, such that the former is extremely abundant while the latter is constrained to a single mode of expression. The transformation of the forces of the soul to the forces of bodies is of monumental significance for the development of a unified science of organic life, for it rejects the analogy between mechanical and living nature and opens an independent physics of organisation. Life for Kielmeyer *is* the 'system of effects' and an organisation *is* the 'system of organs' (p. 00 above).[44] As an open spiral, the *systema naturae* can be understood as continuity in change, unity in development, an ever-growing abundance of living forms within the finite economy of the earth.

[43] Bach, *Biologie und Philosophie*, 198.
[44] See I. Jahn, *Grundzüge der Biologiegeschichte* (Jena: G. Fischer, 1990), 296; Bach, *Biologie und Philosophie*, 134-5.