History, Philosophy and Theory of the Life Sciences

Volume 21

More information about this series at http://www.springer.com/series/8916

Andrea Gambarotto

Vital Forces, Teleology and Organization

Philosophy of Nature and the Rise of Biology in Germany

Springer

Andrea Gambarotto
Université catholique de Louvain
Louvain-la-Neuve, Belgium

ISSN 2211-1948 ISSN 2211-1956 (electronic)
History, Philosophy and Theory of the Life Sciences
ISBN 978-3-319-65414-0 ISBN 978-3-319-65415-7 (eBook)
DOI 10.1007/978-3-319-65415-7

Library of Congress Control Number: 2017949283

Printed on acid-free paper

This Springer imprint is published by Springer Nature
The registered company is Springer International Publishing AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Foreword

This book by Andrea Gambarotto which I have the honor of prefacing provides an important milestone for understanding how biology came about as an independent science at the turn of the nineteenth century. It is customary to view that outcome, generally identified with the work of Gottfried Reinhold Treviranus in Germany and that of Jean-Baptiste Monet de Lamarck in France, as a major conceptual shift affecting at once the notion of living beings as organisms and the rational and empirical methods applied to their study. Part of the story has been formerly told as a change from natural history as *Naturbeschreibung* to natural history as *Naturgeschichte*, when the temporal and trans-specific dimension of the metamorphosis of life forms first came to be accounted for. Another scheme that was traditionally developed for the sake of explaining the advent of biology has consisted in tracing back the new concepts, models, and statements of law involved in the theories of physiology, pathology, and comparative anatomy that, at the time, tended to dissociate themselves from the methodological patterns of the then-dominant physical sciences.

But these interpretations remained very general and seemed unable to account for an apparent historical paradox, the fact that biology, which would later declare its allegiance to the natural sciences, abide by positive and empirically based methods, and ground its theories on naturalistic concepts, did stem from various forms of late-eighteenth-century vitalism and, even worse in the judgment of some, from transcendental speculations professed by upholders of *Naturphilosophie*. In the 1980s, Timothy Lenoir, in various publications epitomized in his authoritative *The Strategy of Life: Teleology and Mechanics in Nineteenth-Century German Biology* (1982), seemed to offer a way out of that paradox. The core element in Lenoir's interpretation boiled down to the presumed constitution of an influential school of researchers and theorists stemming from Johann Friedrich Blumenbach and his followers at the University of Göttingen. Blumenbach's vitalist physiology and epigenetic embryology would have combined with Immanuel Kant's critical philosophy to offer a consistent methodological pattern for the new biological science.

Especially in the *Critique of the Power of Judgment* (1790), Kant had rendered the conception of organic beings and physiological processes dependent upon the

subordination of causal-mechanist analyses to the judicative use of teleological concepts. And thus appeals to regulative teleology, as opposed to constitutive finality, would have patterned actual methodological and theoretical approaches to biological phenomena, along a research program that bypassed the distinct tradition represented by *Naturphilosophie* and the so-called Romantic science. This tradition, which Lenoir termed "teleomechanism," would have subsequently contributed to define the epistemic profile of the new biological science in early-nineteenth-century Germany and fostered significant advances in embryology, in particular with Carl Ernst von Baer and Johannes Peter Müller; in cell theory, with Matthias Schleiden and Theodor Schwann; and in experimental physiology, with Carl Ludwig, Emil du Bois-Reymond, and Carl Ernst von Brücke.

Following Robert Richards, Peter McLaughlin, and John Zammito, Gambarotto questions Lenoir's interpretive hypothesis and resumes some of the criticisms addressed to the hypothesis of an existing and prevalent teleomechanist trend. He nicely clarifies the distinction to be drawn between Kant's and Blumenbach's respective conceptions of teleology. He establishes with all the required evidence that Blumenbach, through his notions of "formative drive" (*Bildungstrieb*) and subordinate "vital forces" (*Lebensvermögen*), conceived of a determinative and constitutive, but by no means reflective and regulative, role for teleology, in representing the purposive and goal-directed sequences of effects that powers immanent and active in organic matter, conceptually symbolized, are capable of yielding. But what is especially original and deserving in Gambarotto's work is his attempt at tracing back the multiple variants and shifting principles in the doctrines of vital forces that marked the emergence of the German biological theories. In this important, complex, yet never before clearly analyzed transition phase, he has been able to demonstrate that *Naturphilosophie*, in Friedrich Wilhelm Joseph von Schelling's paradigmatic formulations, did not steer a course entirely independent of, not to say antagonistic to, the more scientifically oriented synthetic theories. Gambarotto has rightly focused his analysis on the key concepts that were concurrently proposed by physiologists and philosophers to account for the self-organization of the living and the laws that they presumed ruled over epigenetic processes. And he went through a systematic investigation of those concepts and their multiple applications within purview of a broad research program devoted to the principles of life as self-organization, a program spanning over the boundaries of philosophy and the natural sciences. The proposed analysis bears on the self-sufficient theories on generation, functions, classification, and above all the unity of organic and vital processes, which formed the subject matter of a single overarching science in the becoming.

In Gambarotto's analysis of the theories of generation, the originality consists in the weight given to Caspar Friedrich Wolff's arguments for restoring epigenesis against the latest forms of preformation according to Albrecht von Haller and Charles Bonnet. Beyond the empirical statements that underpinned Wolff's arguments, one needed to interpret and appreciate the exact epistemic significance of the so-called essential force (*vis essentialis*). In this case, the suggested interpretation is that Wolff in his *Theoria Generationis* (1759) and *Theorie der Generation* (1764) supported a position that could be rightly termed "vital materialism." As for the

analysis of Blumenbach's theory of generation, it yields unfailing evidence that the *Bildungstrieb* as an organizing principle played a constitutive, rather than a merely regulative, role in generation, growth, and regeneration. And thus the Göttingen physiologist had a different epistemic meaning for his notion of formative drive from the one to be inferred from the critical arguments developed about the "formative force" (*Bildungskraft*) in Kant's *Critique of the Power of Judgment*. This should not make us underrate the fact that Kant and Blumenbach felt that they had a kind of joint agreement. Although the *Bildungstrieb* acts as a causal efficient force for the development of organic bodies according to their type, the teleological contents involved in the notion still have to be appraised through analogy with humanly framed purposes. But this did not prevent Blumenbach from trying to provide objective expressions for the laws of vital organization as general empirical effects dependent on specific teleological principles that acted as their true causes. Further on, the analysis of Johann Christian Reil's 1795 paper points to this author's tendency toward materializing the teleological aspects of the formative principle, which, for Blumenbach, were not to be conceived of as reducible to forms of chemical composition. But still, what makes the difference between laws of living organization and laws ruling over inorganic process is a complex relation that might be diversely characterized as one of supervenience, emergence, or failed reduction depending on the way the typology of the variant theories involved was drawn.

About functions, Gambarotto rightly considers Haller's physiology as offering an original template after which the variant doctrines of late-eighteenth-century physiology can appear to have been molded. But his central argument here is based on a presumed synthesis between Haller's concept of the vital forces and Wolff's epigenetic assumption of the *vis essentialis*. This explanatory scheme had to overcome two potential objections. (1) It is hard to give a vitalist interpretation of Haller's fiber properties: irritability and sensibility. He was a micro-mechanist theorist who felt physiology should be devised as an "animated anatomy." For him, the two "vital" properties had to be identified as effects that causally derived from the inner structure of the fibers involved. At the same time, he would empirically link these properties with their phenomenal effects: vital contraction on the one hand and sensation on the other. This strict delimitation was supposed to prevent analogical extensions that would have transformed irritability and sensibility into vital principles. (2) On the other hand, Blumenbach would never have admitted that his *Bildungstrieb* could be conceived as a derived form of *vis essentialis*. The 1789 memoirs on the *Nutritionskraft* are especially telling on the unsurmountable disparity in doctrine that was involved here between Blumenbach and Wolff. A genetic account was therefore needed on the conceptual shifts that took place and fostered the later typologies of vital forces within and outside the Göttingen School. Gambarotto does a nice job untangling the matter for the Blumenbachian and post-Blumenbachian eras. His analyses of Carl Friedrich Kielmeyer's and Heinrich Friedrich Link's theoretical views are especially convincing. He went a good way explaining the transition phases that resulted into the well-known and influential Blumenbachian typology of vital forces. Blumenbach shifted from his original Hallerian position to a dynamic interpretation of those force as begotten by, and

derivative from, the *Bildungstrieb*, with correlative generalization of irritability beyond muscle fibers and of sensibility beyond the level of sense awareness and with the addition of specific *vitae propriae*. At the same time, Blumenbach retained several features of Haller's models which his followers will get rid of. He would not, for instance, develop a trans-specific scale of apportioned vital properties nor draw empirical laws about the deviant structural-functional processes affecting the various life forms.

The chapter on classification is by all means one of the most important contributions of this book to historical and philosophical scholarship. Gambarotto is right in stressing the strong imprint of Georges-Louis Leclerc de Buffon's notion of biological species in contrast to Carl von Linné's nominal taxonomical categories. Obviously, much of Kant's and Blumenbach's views on the scale of nature and the degenerative processes affecting life forms were quite in line with that former tradition. Rightly though, Gambarotto tends to relativize the universality of scheme that could have stemmed from the so-called Kantian principle for natural history. Alternative options were on the rise, elements of which were provided by Johann Wolfgang von Goethe's comparative morphology, as well as by Kielmeyer's comparative appraisal of the harmonic economy of life forces. Two principles bred various theories about the inner dynamics of the system of life forms: the unity of plan and the law of continuity underpinned several significant attempts at accounting for such a system. And this was precisely the stage at which *Naturphilosophie*, and especially that of Schelling, developed speculations that shared a common basis with contemporary interpretations of anatomical and physiological processes which seemed to require some a priori explanatory framework. What is indeed surprising, but proof-telling for Gambarotto's narrative, is that there appears to have been but very slight gaps between metaphysical presuppositions, such as those concerning a universal organism and the derivative speculative schemes they authorized, on the one hand, and hypothetical inferences drawn from contemporary empirical studies in comparative morphology or general physiology, on the other.

Among the principal outcomes of this exceptional research work, major issues are evoked and at least partially solved, concerning the conceptual contexts that favored the advent of biology at a time when a precise borderline between the metaphysics of life and the biological science had not yet been drawn. In particular, there is much to be learned from Gambarotto's extensive analysis of Treviranus's work as an epitome of the synthetic approaches that the Göttingen School had fostered and to which *Naturphilosophie* had grafted its theoretical inventions. What is especially telling in those pages devoted to the late outcomes of the Blumenbachian-styled life science is the idea that a true explanation of vital phenomena could not take place, if not within a framework of speculations about the unity and dynamic integration of the system of nature, whether these could be treated as verifiable hypotheses in experimental enquiries or as sorts of ontological axioms for a purely deductive venture of the mind. It is evidently in support of that view that Gambarotto concludes: "I hope to have shown that what was at stake in this proximity [of the Göttingen School to Romantic *Naturphilosophie*] was a shift from a regulative to a constitutive understanding of teleology, which, at least in the German-speaking world, can be

regarded as the historical condition for the emergence of biology as a field." But, if this argument forms the core ingredient for the proposed interpretation of the main research program that transformed biology in the initial decades of the nineteenth century, it should be further stressed that we needed a solid demonstration of the way this new understanding of endogenous teleology fostered the unification of ontogenetic, physiological, embryological, and taxonomic hypotheses within a common theoretical framework, under the aegis of a generalized conception of organisms. And this is precisely what Gambarotto's book provides.

Université de Montréal
Montréal, Canada

François Duchesneau

Acknowledgments

This book was once a PhD dissertation. The project behind it was born at the University of Padua back in 2010 when, not long after graduation, I stumbled upon the idea of writing about the relation between the life sciences and philosophy of nature in German Romanticism. Completing this project has been a long journey, one punctuated by many mentors and friends who led me along parts of the way. Luca Illetterati helped me give shape to the very first draft of the project, turning a vague idea into a viable working hypothesis – to him I owe some of the fundamental arguments developed in this book. Ferdinando Abbri, who sat on the board that accepted this project, helped convince me that I could turn it into a valuable book on the rise of biology in Germany. I did my best to honor his confidence. Stefano Poggi directed my research on the history of science and enabled me to identify the philosophical potential of Romantic biology. The supervision of Philippe Huneman skyrocketed my learning curve and laid the foundations upon which this book was built. Hannah Ginsborg hosted me as a visiting student researcher at UC Berkeley, where I developed the first draft of this manuscript. Charles T. Wolfe took the time (and patience) to read subsequent versions of that manuscript, helping me turn a rough jumble of ideas into rigorous scholarship. Luca Corti, François Duchesneau, Jim Kreines, Stéphane Schmitt, and John Zammito provided important insights that helped me refine later versions of the manuscript. Amanda Swain contributed considerably to turning that manuscript into a good, readable book. Across the years, I have also benefited from the funding of several institutions: Istituto Italiano di Scienze Umane (SUM), Università degli Studi di Padova, Deutscher Akademischer Austauschdienst (DAAD), Université Bordeaux-Montaigne, and Fonds National de la Recherche Scientifique (FRS-FNRS). A final thanks go to Gianni and Teresa, who always supported my research and encouraged me to pursue my goals – even when my goal was to write a book about Romantic philosophy of nature.

Contents

Introduction

Teleology Beyond Regrets

This book addresses the rise of biology as a unified science in Germany at the turn of the nineteenth century. It does so by reconstructing the history of the notion of "vital force" from its first formulation in Albrecht von Haller's lecture *De partibus corporis humani sensilibus et irritabilibus* (1752) through the publication of Gottfried Reinhold Treviranus' *Biologie, oder Philosophie der lebenden Natur für Naturforscher und Aerzte* (1802–1822), where the concept of biology was first used to define the life sciences as a unified field. I argue that Romantic *Naturphilosophie* played an important role in the rise of biology in Germany during this period and that this role especially concerned how post-Kantian philosophers and naturalists thought about teleological principles as they determined the object of biological research.

The title of this introduction refers to an old controversy in the history and philosophy of biology that originates from the scholarly work of Timothy Lenoir, which has influenced our understanding of the turn-of-the-nineteenth-century German life sciences for more than 30 years. In a paper entitled "Teleology Without Regrets" (1981), Lenoir discusses the main features of his account of the relation between teleology and mechanics in nineteenth-century Germany – an account that also serves as the backbone of his seminal monograph.[1] According to the "received view," Lenoir maintains, the origins of scientific biology can be traced to the efforts of the so-called 1847 group (Ludwig, du Bois-Reymond, Helmholtz, and Brücke). These scientists allegedly threw off the yoke of "vitalistic explanation" and swore allegiance to the cause of "mechanistic reductionism" (Lenoir does not provide a clear definition for either of these terms). With this move, they cast aside vitalism and teleology, paving the way for the new reign of mechanistic biology.[2] Lenoir's scholarly intervention is to show how this "received view" implied that the

[1] Lenoir 1978, 1980, 1981a, b, 1982.

[2] Lenoir 1982, 293–294.

foundations for biology lay solely in the development of mechanistic reductionism. Lenoir argues to the contrary that the rise of biology in Germany was the result of a non-reductionist research program, which he defined as "teleomechanism" and ascribed three different phases: "vital materialism" (Kant, Blumenbach, Reil, Kielmeyer), "developmental morphology" (Meckel, Döllinger, von Baer, Müller), and "functional morphology" (Schwann, Liebig, Bergmann, Leuckart).

In Lenoir's reconstruction of this history, the "vital materialism" phase in the development of biology was dominated by the theories elaborated by the physicians and naturalists of the so-called Göttingen School. He isolates the approach to vital organization developed at Göttingen by means of a research program based on Kant's *Critique of the Power of Judgment* (1790), and he identifies Johann Friedrich Blumenbach (1752–1840) as the first naturalist to embrace Kant's understanding of teleological principles and to apply those principles to empirical research. In this respect, Lenoir introduced the idea of a Kant-Blumenbach "vital materialist" research program based on a regulative understanding of teleology, which he believed constituted the foundations of the Göttingen School and was further developed by Blumenbach's most influential students: Johann Christian Reil (1759–1813), Carl Friedrich Kielmeyer (1765–1844), Heinrich Friedrich Link (1767–1851), and Gottfried Reinhold Treviranus (1776–1837).[3]

As William Bechtel has pointed out, Lenoir's aim was to identify a genealogy within nineteenth-century German biology separate from either "vitalistic *Naturphilosophie*" or "reductionist materialism."[4] By locating an intellectual tradition in which teleology was not entangled with vitalism, Lenoir believed teleology could finally be considered in naturalized terms (i.e., without regrets), as a specific characteristic of organic processes that marked biological phenomena's irreducibility to mere physics and chemistry. Accordingly, Lenoir saw his study of the Kantian teleomechanistic tradition as a response to those who wrongly believed that early–nineteenth-century German biology had been dominated by Romantic *Naturphilosophie* and its "vitalistic" conception of teleology.

Lenoir's historical reconstruction has been harshly criticized by Kenneth Caneva in a review entitled, ironically enough, "Teleology with Regrets." Caneva charges Lenoir with "many serious mistakes in historical analysis": "errors, misinterpretations, inconsistencies, unsupported claims and plain unclear writing."[5] A further criticism has recently been formulated by Robert Richards and John Zammito, who argue that Lenoir's account of an alleged agreement between Kant and Blumenbach is based on a "historical misunderstanding" and that the "Lenoir thesis" needs to be "revisited."[6] Building on these critiques, I will excavate the historical interrelation between the "vital materialism" of the Göttingen School and Romantic

[3] Lenoir 1981b, 115–119. As I argue in chapter "Generation: The Debate Over the Formative Force and the Question of Ontogenesis", Johann Christian Reil was never Blumenbach's student, as Lenoir has it, and should not be included in any "Göttingen School." Thanks to John Zammito for pointing this out.

[4] Bechtel 1983.

[5] Caneva 1990, 300.

[6] Richards 2000; Zammito 2012.

Naturphilosophie, in order to show that the distinct boundary between the two described by Lenoir is historically unattested. Indeed, I argue that *Naturphilosophie*, like the Göttingen School, played a pivotal conceptual role in the birth of biology as a unified science. The emergence of biology required a discursive break with Kant's understanding of teleology as a regulative principle, so that teleology could be considered a constitutive character of living organisms. This break occurred in the writings of the Göttingen tradition and is given a clear philosophical formulation in Schelling's *Naturphilosophie*.

Stressing teleological thinking in biology only inasmuch as it can be reduced to a mechanistic framework of explanation, Lenoir's work acknowledges a role for teleology but does so "with regrets." I argue that we instead need a historical account that moves beyond those regrets. In fact, I contend that the formalization of biology as an autonomous field at the beginning of the nineteenth century implied a shift from a *regulative* to a *constitutive* understanding of teleology – a shift most strongly endorsed by Romantic *Naturphilosophie*. In this sense, biology as a science became possible only once purposeful organization was considered a constitutive characteristic of living bodies and, as such, something that required scientific explanation.

It should be noted that the vast majority of scholarly work dedicated to this historical period continues to use the vocabulary first introduced in the late 1970s by Imre Lakatos to discuss the methodology of scientific research programs.[7] In fact, the idea of a Kant-Blumenbach "teleomechanical" research program for biology, which was first formulated by Lenoir in 1982, is still endorsed in recent studies.[8] However, this notion of a Kant-Blumenbach research program is inadequate to describe the transformations that led to the rise of biology at the beginning of the nineteenth century. As scholars like Philippe Huneman and Rachel Zuckert have shown, the idea that the *Critique of the Power of Judgment* provides a research program for biology can be criticized not only by emphasizing the divergence between Kant and Blumenbach but also by highlighting how Kant's attention to biological issues did not (at least not primarily) emerge from interest in scientific concerns. Rather, biological issues emerged in his work as a product of his interrogation of metaphysical questions concerning the concepts of necessity, contingency, and purposiveness.[9]

It is true that Kant dealt with at least three biological issues: (1) the relationship between the notion of *Naturzweck* and modern epigenesis, which interested him because the process of embryogenesis seems to presuppose its result (the adult organism) and to be directed toward its realization; (2) the problem of biological functions, which he believed could not be explained without reference to final causes; and (3) the difference between *Naturbeschreibung* and *Naturgeschichte*, which he considered an index of natural history's epistemological status as a descriptive cataloguing or causal explanation of varieties. Nevertheless, Kant did not consider biology a proper science that treats its objects wholly according to a

[7] Lakatos 1978.

[8] Bach 2001; Schmitt 2006; Dupont 2007.

[9] Zuckert 2007; Huneman 2008.

priori principles, because such consideration of living beings for him implied teleological principles and, in his view, teleological principles have a regulative (i.e., heuristic) character that makes them insufficient to ground a theory.

This denial of biology as a proper science is most explicit in the third *Critique*. Yet, despite Kant's denial, in the late eighteenth century, the term "biology" began to appear in the works of several naturalists. The most important instance is in the monumental *Biologie, oder Philosophie der lebenden Natur für Naturforscher und Aerzte* (1802–1822) by Gottfried Reinhold Treviranus. This historical fact leads us to the following question: what happened between 1790, the year Kant's third *Critique* was published, and 1802, when Treviranus used the term "biology" to title his scientific work about physical life as a natural phenomenon?

In attempt to account for this shift between Kant's disavowal of the very possibility of a life science and the rise of a general biology in Treviranus' work, I will trace the conceptual history of the notion of "vital force," which was a unifying element of most scientific and philosophical enterprises concerned with the explanation of organic nature in the second half of the eighteenth century. This might seem a counterintuitive strategy, since the prevailing view of the history of biology – already promulgated at the end of the nineteenth century by those who elaborated modern cell theory, Schwann and Schleiden, and by the physiologist du Bois-Reymond and the biochemist Liebig – considers vitalism and "vital forces" epistemological obstacles to the birth of biology as a science. This view, however, rests on a limited definition of the term "vitalism." Indeed, in challenging the idea that vitalism per se constituted an obstacle to the rise of biology at the turn of the nineteenth century, I aim to interrogate what the label "vitalism" has come to mean in the first place.

Georges Canguilhem has argued that "in general and as a consequence of the signification it acquired in the eighteenth century, the term *vitalism* is appropriate for any biology careful to maintain its independence from the annexionist ambitions of the sciences of matter."[10] In this respect, "a history of biology systematic enough not to privilege any bias or point of view would perhaps teach us that the fecundity of vitalism as such is far from null – and in particular that this fecundity is a function of historical and national circumstances."[11] This idea constitutes the fundamental

[10] Canguilhem 2008, 61.

[11] *Ivi*, 67. In his preface to *The Normal and the Pathological*, Michel Foucault makes an important point about the paradoxical fact that the "scientificization" of the life sciences occurred by bringing to light physical and chemical mechanisms – through the constitution of domains such as molecular chemistry or biophysics – that make use of mathematical models, but that this process was simultaneously "able to develop only insofar as the problem of the specificity of life and of the threshold it marks among all natural beings was continually thrown back as a challenge." This does not mean that vitalism (however we define it) is true, but simply "that it had and undoubtedly still has an essential role as an 'indicator' in the history of biology. And this in two respects: as a theoretical indicator of problems to be solved (i.e., what constitutes the originality of life without, in any way, constituting an independent empire in nature); as a critical indicator of reduction to be avoided (i.e., all those which tend to ignore the fact that the life sciences cannot do without a certain position of value indicating preservation, regulation, adaptation, reproduction, etc.)" (Foucault 1991, 18). In other words, the historical and conceptual significance of vitalism lies in its perpetual attempt to justify the autonomy of biological entities from the explanatory framework of physical sciences.

working hypothesis of this book and is applied in particular to Romantic *Naturphilosophie*.

Lenoir tried to rehabilitate eighteenth-century vitalism by showing that its research program could be considered in "naturalized" terms. His most important concern was marking the difference between the Göttingen program and *Naturphilosophie*, which he considered the metaphysical and anti-naturalist program *par excellence*. However, his analysis is one-sided. We could perhaps best describe its nature by adapting an expression used by Ron Amundson: "modern synthesis historiography."[12] What Lenoir presents seems to be a rather distinct form of "naturalist historiography," since the naturalist historiographer holds the belief that biology – which we as contemporary (more or less) naturalist readers consider to be a scientific framework – must necessarily have a "naturalized" origin. This assumption leads scholars like Lenoir to undertake a quest to "naturalize" the past, in order to purge the history of natural science from all traces of non-naturalist metaphysics. Unfortunately, from the standpoint of contemporary biology, the natural-historical concerns (and attendant metaphysical commitments) of Kant and Blumenbach are just as alien to us as those of Herder, Goethe, Schelling, and Oken.

As Nicholas Jardine has suggested, "this alienation does not arise from their having given what are, according to present-day biology, largely false answers to genuine questions, nor does it arise from their having addressed what are, from our scientific viewpoint, genuine but eccentric or uninteresting questions." Rather "the alienation is engendered by their having addressed what are for the most part, for us, unreal questions," because in fact "too few of the questions they addressed are, by our lights, real questions; too few of their beliefs are for us even candidates for truth."[13] Indeed, I maintain that Kant's arguments are at least equally alien to us, and just as "non-naturalistic," as the metaphysical arguments of the *Naturphilosophen*. In this sense, if we take up Lenoir's search for a non-metaphysical, naturalist-friendly, conceptual framework in Kant's work upon which to found biology, we come up empty-handed.

Rather, as far as biological organization is concerned, Kant lies at the crossroad of two metaphysical traditions: the rationalist metaphysics of Leibniz, Wolff, and Baumgarten, according to which teleology is construed as (God's) intention, and the metaphysics of *Naturphilosophie*, in which teleology is interpreted as self-organization. We find Kant at the border of these two conceptual spaces, a position conceptually expressed by his distinction between *external* and *internal* purposiveness. The former defines vital organization as the product of technical agency and the latter as the result of autonomous activity. Despite the significance of this distinction, Kant ended up conceiving teleology in technical terms, as the result of subjective intention, i.e., as *external* purposiveness, in a manner coherent with the former metaphysical tradition. Yet he was unwilling to appeal to God as an explanatory ground for natural science. He thus held an "unstable middle position"[14]

[12] Amundson 2005.

[13] Jardine 1991, 51.

[14] Weber and Varela 2002, 99.

by arguing, on the one hand, for the impossibility of a mechanical account of organisms, while, on the other hand, maintaining that the teleological features displayed by living systems should only be considered heuristic concepts, not ontologically essential characteristics of those systems.

My central argument is that the problem of intrinsic teleology is bound to the philosophical enterprise of the *Naturphilosophen* and belongs to the historical conditions from which something like a "biology" was able to emerge at the turn of the nineteenth century. The authors that fall under the category of the "Göttingen School" played a crucial role in facilitating a discursive shift from an *external*-technical conceptual paradigm to an *internal*-autonomous understanding of purposiveness. Of course, as physicians and naturalists engaged in empirical research, they were unable to provide (and uninterested in) a philosophical account of this shift. This account is instead provided by Schelling's *Naturphilosophie* at the very end of the eighteenth century. Using a method of a priori deduction, Schelling aimed to establish a metaphysical foundation for the theories found in the works of the Göttingen naturalists – an attempt not dissimilar in nature from the one we find of Newtonian mechanics in Kant's *Metaphysical Foundations of Natural Science* (1786). The theoretical framework elaborated by Schelling's *Naturphilosophie* played a significant role in laying the foundations for the emerging biological science and in fact became a fundamental reference for Treviranus' *Biologie*. In this way, both the Göttingen tradition and the *naturphilosophisch* movement interrogated the self-organizing features of organic nature and thereby played crucial roles in establishing conceptual space for biology as what Nicholas Jardine would define as a new "scene of inquiry."

Certainly, Romantic *Naturphilosophie* upheld an idea of science that differs quite strongly from our current naturalistic approach, but, strictly speaking, so did Kant and Blumenbach. If adherence to our current scientific beliefs is the yardstick for our evaluation of past scientific enterprises, none of the authors I take into account are likely to pass the test. Indeed, if our attention is focused on *answers*, all we can do is try to "translate" past scientific theories into our contemporary language in order to make them understandable or consider them "forerunners" of our current views. Yet if we instead focus on *questions*, we see a totally different picture. We are instead able to assess the meaning of a scientific enterprise not according to the degree to which it accords with "naturalization" but rather with regard to the scenes of inquiry that its questions open up.

This book will expand on this argument through four chapters and a conclusion:

1. Chapter "Generation: The Debate Over The Formative Force and the Question of Ontogenesis" is concerned with the problem of generation in the mid- to late eighteenth century and reconstructs the debate on the notion of *formative force* with reference to Caspar Friedrich Wolff (1734–1794), Johann Friedrich Blumenbach (1752–1840), Immanuel Kant (1724–1804), and Johann Christian Reil (1759–1813). This debate interrogated the origin of form and addressed the epistemological status of the *Bildungskraft* as the fundamental principle behind

organization. My analysis focuses especially on the different interpretations of the notion of "teleology" defended by the authors, with the objective of providing a sort of general typology of the different forms of vitalism characterizing the German debate of this period.

2. Chapter "Functions: The Göttingen School and the Physiology of Vital Forces" provides a reconstruction of the physiology of vital forces as it was elaborated in the mid- to late eighteenth century by the physicians and naturalists gathered under the category of the "Göttingen School," namely, Albrecht von Haller (1708–1777), Johann Friedrich Blumenbach (1752–1840), Carl Friedrich Kielmeyer (1765–1844), and Heinrich Friedrich Link (1767–1851). I argue that the theoretical framework of the Göttingen School implied two fundamental tenets: first, an interpretation of teleology as internal purposiveness (argued by Blumenbach) and, second, a proposal to reform natural history in terms of comparative physiology, i.e., as a taxonomy of vital functions and an analysis of their distribution in the animal and plant kingdoms (articulated by Kielmeyer and Link). The chapter concludes with a reconstruction of Kielmeyer's and Link's assessment of *Naturphilosophie*. Whereas the aim of Lenoir's reconstruction of the Göttingen School was to stress its distinction from *Naturphilosophie*, my aim in this chapter is to emphasize the continuities between these two traditions.
3. "Classification: *Naturphilosophie* and the Reform of Natural History" reconstructs the reform of natural history that *Naturphilosophie* advocated in opposition to Kant and Blumenbach, with references to Johann Wolfgang Goethe (1749–1832), Friedrich Wilhelm Joseph Schelling (1775–1854), and Lorenz Oken (1779–1851). This chapter is organized as a counterargument to Peter Hanns Reill's stark distinction between "Enlightenment vitalism" and "Romantic *Naturphilosophie*." I will demonstrate that, although a difference can be identified between the approach to animal classification upheld by Kant and Blumenbach, on the one hand, and the reform of natural history promoted by Goethe, Schelling, and Oken, on the other, this division is much less significant than Reill assumes it to be. Moreover, I will show why the difference between the two camps cannot be reduced to their alleged lack of "epistemological modesty" but is rather ascribable to their desire to bring to completion what Kant and Blumenbach left unfinished: a program for a scientific classification of living organisms. I also argue that Kielmeyer's program for a comparative physiology was considered, especially by Schelling, a stepping-stone for this philosophical mission.
4. Chapter "Biology: Treviranus and the Life Sciences as a Unified Field" is devoted to thorough analysis of the work of Gottfried Reinhold Treviranus (1776–1837), including his monumental six-volume *Biologie, oder Philosophie der lebenden Natur für Naturforscher und Aerzte* (1802–1822) and the two-volume *Erscheinungen und Gesetze der Organischen Leben* (1831–1833). I argue that Treviranus' work constitutes a compelling synthesis of the framework elaborated by the Göttingen naturalists and later developed by *Naturphilosophie*. I focus on textual evidence that the formalization of biology at the turn of the nineteenth century implied a shift from the Kantian understanding of teleology

as a regulative principle to the idea of purposiveness as a constitutive characteristic of living systems. I stress that Schelling's organicist views played a relevant role in this shift and inform several key passages of the *Biologie*. At the same time, through emphasis on the geographical distribution of organisms and their transformation over time, Treviranus moved beyond *Naturphilosophie* to establish the foundation of biology as a historical science.

5. I conclude with some considerations of Hegel's position on Romantic *Naturphilosophie*. Unlike Kant and Schelling, Hegel did not play an active role in the scientific debate culminating in the emergence of biology as a unified field. However, as an external observer, he was well-positioned to grasp its fundamental philosophical stakes. In particular, he criticized Kant for interpreting teleology solely in terms of intention and the *naturphilosophisch* movement for its speculative excesses. These critiques, however, establish that Hegel did not consider *Naturphilosophie* something to be thoroughly rejected, but corrected and integrated. His attempt to facilitate this integration resulted in a theory of biological individuality in which teleology is understood as *internal* purposiveness, i.e., autonomous self-organization.

The original version of this book was revised. An erratum to this book can be found at https://doi.org/10.1007/978-3-319-65415-7_6