Andrea Gambarotto. *Vital Forces, Teleology and Organization: Philosophy of Nature and the Rise of Biology in Germany*. Springer 2018. 137 pp. $109.99 USD (Hardcover ISBN 9783319654140); $109.99 USD (Paperback ISBN 9783319880235).

German *Naturphilosophie* had a bad reputation since at least the mid-nineteenth century. Although some scholars have been arguing for its reassessment recently, historians of science such as Timothy Lenoir and Peter Hanns Reill have tried to distinguish *Naturphilosophie* from and contrast it with other, presumably more respectable traditions in science and philosophy. The upshot of this is supposed to be that it is these respectable traditions (teleomechanism built upon the Kant-Blumenbach regulative use of teleology in the study of organisms in the case of Lenoir, Enlightenment vitalism in the case of Reill), and not *Naturphilosophie*, that made significant contributions to the development of biology.

In his book Gambarotto argues that contrasts like these are based on a historiographical bias. Against Lenoir, he argues that the emergence of biology as an independent and unified science, at least in the German context, was closely connected with the move toward 'understanding of teleology as a constitutive feature of organized beings' (115), a move in which *Naturphilosophie* played an important role. Against Reill, Gambarotto argues that there was much more continuity between *Naturphilosophie* and the groups and institutions which, according to Reill, belonged to Enlightenment (such as the Göttingen school) than Reill suggests.

Gambarotto starts with a discussion of the debate about ontogenesis in Germany. The proponents of preformation viewed organisms as products of divine intentional activity and ontogenesis as merely growth and unfolding of already existing individual organisms. The discovery of the regenerative capacities of animals such as polyps has challenged this view. While some scientists such as Caspar Friedrich Wolff attempted to explain the development of organisms without resorting to teleology (Gambarotto argues that Wolff's *vis essentialis* is non-teleological), Blumenbach did introduce a teleologically acting *Bildungstrieb* in order to account for both the development and regeneration of organisms. Kant, although he agreed that *we* cannot comprehend the possibility of natural organisms without employing teleological concepts, has restricted the legitimacy of such concepts to regulative and heuristic use only.

Kant occupies a transitional point in Gambarotto's story (an unstable middle position, as he calls it). On the one hand, he is the one who makes the distinction between external teleology that requires an intentionally acting agent and internal teleology that is displayed by self-organizing entities. On the other hand, in the end Kant blurred his own distinction and was unable to provide an account of internal teleology without reference to any intentions. Instead, he built into his account of it a reflective reference to the author of the world. Because of this, Kant did not complete the transition from the Leibnizian tradition that understood organisms as divine machines to the new approach that viewed them as self-organizing. It was *Naturphilosophen* of the Schellingian circle on the one hand, and the scientists of the Göttingen school on the other, that completed this transition and thereby opened up conceptual space for the new science of biology in Germany.

Gambarotto then outlines the stages of this transition. As mentioned, Blumenbach has already conceived organisms as being organized by the teleological drive that is peculiar to them. In fact, he integrated the account of organic development and reproduction in terms of the *Bildungstrieb* with other peculiarly organic functions such as sensibility and irritability that already played a prominent role in Albrecht von Haller's work. The next major move was undertaken by Kielmeyer (and, fol-

lowing him, Link), who applied this framework to the whole of organic nature. In doing so he formulated the program of finding laws pertaining to the classification of living organisms for biology. Kielmeyer and Link suggested, based on empirical data available to them, that the vital forces of sensibility, irritability and reproduction stand in certain reciprocal relationships in different kinds of organisms. More specifically, they are inversely related to each other, so that, for example, the organisms with a variety of sense organs and highly developed nervous system are less fertile and much less capable to regenerate injuries than the organisms with fewer sense organs and more primitive nervous system. An attempt to find laws and regularities like these signifies the move from classifications of organisms based on isolated observable traits *à la* Linnaeus to the classifications grounded in comparative physiology.

As Gambarotto argues, this shift of the focus from individual organisms to the whole of organic nature meant that Kielmeyer and his followers started treating nature as a whole as an organism, a point in which their standpoint came close to that of *Naturphilosophie*. He reinforces this point by considering Kielmeyer and Link's assessment of *Naturphilosophie* which was by no means univocally critical. Thus, although Kielmeyer was critical of the a priori methodology of the *Naturphilosophen*, he approved the fact that 'through the recent philosophical systems it has become customary to consider nature in its entirety as an organism and as living in all its aspects, and the single organizations as individualized representations of the great nature, an idea that lay already in the ancient opposition between macrocosm and microcosm, the organism and the universe' (52). Similarly, although Link has developed his own version of a philosophy of nature in opposition to Schelling and his circle, Gambarotto suggests that that version was actually not so different from those offered by some of the *Naturphilosophen*, for whom the relationship between experience and speculation was a problem and not a dogma.

Gambarotto substantiates these claims by the consideration of some of the most important projects which belonged to *Naturphilosophie*, in particular those of Goethe, Schelling and Oken. Common to them is the move from artificial classifications like that of Linnaeus to some version of the graduated series of organisms based on compensatory considerations not unlike those of Kielmeyer and Link. Thus, Goethe puts the morphological type, 'a general picture containing the forms of all animals' (75), into the foundation of his morphological studies, and argues that in different animals different parts and features of this type are pronounced to a different degree (in such a way that highly developed extremities, for example, come at the expense of other bodily parts). Schelling's approach is the one closest to Kielmeyer's with the inverse relations between the vital forces or functions. Finally, Oken classifies large taxonomic groups of animals by the preponderance of certain organs or organic systems in animals that belong to them.

In the last step of his main narrative, Gambarotto discusses how Treviranus, one of the fathers of biology as a distinct and unified science, has drawn upon ideas developed by the *Naturphilosophen* and the scientists of the Göttingen school alike. In particular, he endorsed irreducibility of organic phenomena to mechanics and physics and the view of organic nature as an organized whole governed by the laws of compensation and structured in a hierarchical way. What was new with Treviranus in comparison to these earlier developments was his attention to the geographical distribution of organisms and to their conditioning by environmental factors, and his understanding of the hierarchy of organisms not merely as ideal but also as historically generated. In other words, Treviranus, like his French counterpart Lamarck, was a transformist about species and believed that the more complex and perfect species have developed from the more primitive ones historically.

In a short conclusion, Gambarotto provides a quick summary of Hegel's critical assessment of both Kant's analysis of teleology and the Romantic *Naturphilosophie*. What is significant here is

that Hegel, the well-informed philosophical contemporary, did not draw any sharp distinction between the *Naturphilosophen* and the scientists of the Göttingen school. This reinforces Gambarotto's point that any such sharp distinction is a product of historiographical bias.

There are some matters of detail which one can criticize in this book. For example, Gambarotto characterizes Schelling and his followers as vitalists and keeps calling sensibility, irritability and reproduction 'vital forces.' Schelling himself, however, explicitly rejects and criticizes vitalism and the very idea of a vital force as an entity that is operative only in living organisms (especially in the *Erster Entwurf eines Systems der Naturphilosophie*). Now, Gambarotto is working with a more inclusive concept of vitalism, something that he signals in the introduction, where he points out that its nineteenth-century critics had too narrow a definition of the term. Gambarotto follows the suggestion of Georges Canguilhem who considered any anti-reductionist account of biology vitalist. It seems, though, that Schelling himself had a narrower concept of vitalism than Gambarotto and Canguilhem. Because of this, it would perhaps have been more cautious to talk about 'vital functions' (as Gambarotto occasionally does) that are not reducible to physico-chemical processes, rather than about 'vital forces' when talking about sensibility, irritability, and reproduction. Likewise, the statement that 'Two fundamental forces are necessary, namely the repulsive force and the vital force, to account for the phenomena of both organic and inorganic nature' (96) is a strange characterization of Schelling's position. In spite of his criticism of Kant's dynamic construction of matter, Schelling still accepted attractive force and, as mentioned above, was critical of at least some notions of the vital force.

Such quibbles aside, Gambarotto's main point about the continuity between the investigations of the practicing life scientists and the *Naturphilosophen* in the late eighteenth century is quite convincing, and the discussion of the specific convergences of their investigations substantially contributes to our understanding of the emergence of biology during that period.

Anton Kabeshkin, Johns Hopkins University