

#### BOOK REVIEWS

than others working on the topic of mechanisms in biology, Bechtel stresses the importance of the *organization* of mechanisms. Operations are not only organized by linear sequence, but tend to exhibit more complex forms of organization, such as the cycles and feedback loops found in the mechanisms of cellular respiration, one of the main case studies in the book.

Bechtel correctly claims that those who study interdisciplinary research have had little to say about what exactly results from such work. This case shows how a new discipline emerged to study an intermediate level of organization between the structures previously studied by cytologists using the light microscope and by biochemists doing chemical analyses of reactions in cell free systems. The new territory became accessible because of new techniques and new perspectives as to how to link structure and function. This new research required laboratory settings where the appropriate expertise in both morphological and biochemical studies could be integrated. Accompanying the emergence of new knowledge about cytoplasmic organelles were the challenges of the establishment of a new discipline – one that included scientists from both cytology and biochemistry in its societies, as well as on the editorial boards of new journals. Cell biologists will especially welcome this new history of their field.

Lindley Darden  
University of Maryland, College Park

Jean-Michel Pouget, *La science goethéenne des vivants: De l'histoire naturelle à la biologie évolutionniste*, (Bern: Peter Lang, 2001), xv + 433 pp., \$81.95 (paper).

Johann Wolfgang von Goethe's scientific work has consistently divided commentators: some see him as a wonderfully prescient thinker; others, like Emil du Bois-Reymond, dismiss him as a "self-taught dilettante" (p. 3). Jean-Michel Pouget attempts to move beyond such debates by placing Goethe's achievements in the context of three successive paradigms in the history of biology. Pouget's first two paradigms, taken from Michel Foucault's *Les mots et les choses* (1966), are the classical age, represented by the natural history of Carl Linnaeus, and the age of biology, represented by the comparative anatomy of Georges Cuvier. He breaks with Foucault, however, by following Thomas Kuhn in linking the work of Charles Darwin to a third paradigm: evolutionary

#### BOOK REVIEWS

biology. Throughout, Pouget draws alternately upon Foucault's idea of an "epistemological basis" and Kuhn's idea of a paradigm, using these as methodological foils for his interpretation of Goethe's biology (p. 10).

The book is divided into three parts, corresponding to the three successive paradigms. In the first part, "The Classical Age," Pouget places Goethe's work in the context of a number of standard themes. The first chapter, on taxonomy and botanical classification, argues that Goethe's famous *Urpflanze* (original plant) was part of a new botanical philosophy in which the mere observation of variation is replaced by an account of the development of that variation. As Goethe's own comments make clear, this idea is intimately linked to the classical paradigm: with the derivation of all plant forms from the *Urpflanze*, "it would become possible to accurately determine genera and species" (p. 49). Pouget sees the *Urpflanze* as a bridge between the classical and modern paradigms, for when transferred to the individual plant it leads to the claim that all the organs of a plant are in fact developments of a single organ, the leaf (p. 55). It is this principle of identity that pushes Goethe to seek the "laws of formation of plants," and which marks his decisive break with the classificatory ideal of Linnaean natural history (p. 58).

In the second and third chapters, Goethe is cast as a critic of preformationism and mechanism, both of which Pouget connects to the classical paradigm. However, Goethe's developmental conception of life steers him between these two sets of extremes. Just as his hypothesis of organ identity represents a compromise between variance and invariance in plant metamorphosis, his picture of epigenesis includes "pre-determination" or "pre-stabilization" (p. 85). The same is true of what Pouget, following Timothy Lenoir, calls Goethe's "vital materialism" (pp. 107–112). In this case, the compromise is between the material and spiritual sides of nature, represented by the concepts of polarity and intensification: the former "is a state of constant attraction and repulsion," while the latter "is a state of ever-striving ascent" (p. 110; cf. Goethe, *Scientific Studies*, p. 6). Pouget links this dialectical approach to Goethe's view that scientific disputes can be traced to opposed but equally necessary "modes of representation," each of which is a partial view of nature's complex whole (p. 80).

In the final two chapters of the first part, Pouget shows that Goethe calls into question the classical ideal of a great chain of being and its accompanying anthropocentrism. At the outset, he points to an interesting parallel between Charles Bonnet and Goethe, both of who stress nature's continuity (p. 136). For Goethe, however, this continuity is

#### BOOK REVIEWS

placed in the service of a “new ideal of knowledge,” i.e. the laws of organization of living beings, and cannot be used as evidence for any pre-established harmony: thus there is continuity between the intermaxillary bone of a tortoise and that of an elephant, but a yawning gap between a mineral and a plant (pp. 143–144). Goethe also inverts the classical hierarchy of beings, which attempts to seek man in the animal; rather, Goethe writes, we must “begin at the bottom to rediscover...the simple structure of the animal in the composite structure of man” (p. 171). Pouget ties this claim to Goethe’s famous hypothesis of the vertebral origin of the skull, arguing that Goethe ends the “hegemony of the brain” by emphasizing the equal importance of all organs (pp. 184–188).

The second part of the book centers on the modern biological paradigm, epitomized by the discipline of comparative anatomy. In his anatomical writings of the 1790s, Goethe studied the unchanging “principle of construction” or “osteological type” that lies behind each animal skeleton (p. 216). Pouget highlights the connection with Goethe’s botanical work, discussed in the first part: with plants, the metamorphosis is real, whereas with animals, the anatomist must imagine the transformations both within the individual and across species (pp. 244–248). In both cases, however, a basic identity is preserved beneath continuous variation.

In the last chapter of the second part, Pouget compares Goethe’s work with that of Georges Cuvier and Étienne Geoffroy Saint-Hilaire. He presents two antagonistic conceptions of animal organization: transcendental morphology, emphasizing form and the unity of morphological structures, and empirical morphology, emphasizing function and the mode of life of each animal (p. 279). On the face of it, Goethe is firmly transcendental, but Pouget quickly complicates this picture. He argues that, in the 1820s, Goethe started to distance himself from his earlier anti-functionalist position. For instance, he began to link osteological structures to the mode of life of the animal in question (p. 290). This culminated in Goethe’s published review of the famous debate between Cuvier and Geoffroy, which he interpreted as a quarrel between two kinds of thinkers: analytic naturalists (e.g. Cuvier), who precisely describe a vast array of facts, and synthetic naturalists (e.g. Geoffroy), who discover analogies and hidden affinities (pp. 296–297). For Goethe, both approaches are necessary.

In the third and shortest part of the book, “Evolutionism,” Pouget argues that although Goethe’s idea of metamorphosis has much in common with evolutionary thinking, the latter made real those

#### BOOK REVIEWS

transformations that were, for Goethe, merely imaginary (p. 336). In Goethe's eyes, metamorphosis concerned ontogeny and not phylogeny. The idea that an organism is a perfectly determined whole prevented Goethe from making the jump from development to evolution – where Goethe saw harmony, Darwin saw struggle (pp. 356–357).

The problems with this stimulating book are primarily historiographical. Pouget does not clarify what he means by 'paradigm' or 'epistemological basis' beyond a brief reference to a "homogeneous intellectual universe" where objects of study, rules, and research objectives are shared (p. 10). It is far from self-evident that this is the case for any of the three paradigms described by Pouget. Also, this periodization fails to adequately register conceptual continuities: for instance, the idea of an economy of nature is found in the work of Linnaeus, Cuvier, and Darwin, although Pouget restricts it to the second paradigm. The relation of Pouget's overall view to that of his predecessors simply adds to the confusion: while Foucault connects Lamarck to the classical age, Pouget moves him forward to the evolutionary paradigm, falsely stating that Lamarck's "*circonstances*" include other organisms (p. 396; cf. Lamarck, *Philosophie zoologique*, p. 225). This said, however, the periodization does at least provide a framework for Pouget's historical narrative, which is consistently interesting and informative. Historiographical quibbles aside, Pouget's book greatly expands our understanding of Goethe's biology and demonstrates its lasting importance for historians and scientists alike.

Trevor Pearce  
University of Chicago

Brian W. Ogilvie, *The Science of Describing. Natural History in Renaissance Europe* (Chicago: University of Chicago Press, 2006), xvi + 385pp., illus., \$45.00.

This erudite and lively book traces the invention of natural history over the course of a long sixteenth century (roughly 1490–1620), a period in which the study of plants and animals became a subject and a kind of learning in its own right, distinctive from medicine and natural philosophy. Ogilvie's thoughtful and richly detailed analysis of naturalists' multiple practices gives us the fullest and most vivid picture we have of this scholarly universe, making it a valuable and illuminating contribution, and one that is a pleasure to read.