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# The Form of Becoming

*Embryology and the  
Epistemology of Rhythm  
1760–1830*

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INTRODUCTION

**The Form of Becoming**

In his work on secretion, Ignaz Döllinger (1770–1841), professor of medicine at Würzburg and among the most influential German naturalists of his day, sought to set out the principles of a new science of life: biology. Döllinger argued that whereas physics builds causal links between its individual observations, biology cannot proceed that way because life not so much “is” as “becomes.” Accordingly, it is not possible to observe the processes of life themselves, but only the structures that “mediate” them: “only the form of becoming remains, and this form is what we perceive as constant.”<sup>1</sup>

Half a century later, the young Friedrich Nietzsche (1844–1900) worked on a “theory of quantitative rhythm,” not published in his lifetime, which he also entitled “Rhythmic Investigations.” In these notes — preliminary work for a study in classical philology — he tried to understand the “power of rhythm.” Music and poetry affect us, writes Nietzsche, not only because they are themselves rhythmic, but because the rhythmic movement of the body is “restructured” by the movements of music or poetry operating upon it.<sup>2</sup> Rhythm as such is physiological because life is “a continuing rhythmic movement, of the pulse, of the gait, even of the cells.”<sup>3</sup> Only through rhythm does physiological multiplicity attain structure and “individuation.”<sup>4</sup> The power of rhythm thus lies in its “physiological grounding”: “Rhythm is the form of becoming, and in general, the form of the world of appearances.”<sup>5</sup>

This book works at the interface between Ignaz Döllinger’s attempt to describe biological development as the “form of becoming” and Nietzsche’s definition of that very form as rhythm. I argue that rhythm was a new category in science and culture at the turn of the eighteenth to the nineteenth century, one hitherto almost entirely

neglected by historiography. Around 1800, the living world, and especially development, was rethought through concepts of rhythmic pattern, rhythmic movement, and rhythmic representation.

Döllinger and his work will be extensively discussed in the course of this study, but Nietzsche and his deliberations are outside its time frame, the period between 1760 and 1830. That is a significant point to make, for my hypothesis is precisely that rhythm's "physiological grounding," as Nietzsche aptly called it, was not the product of his own era. It was formulated as a central episteme far earlier, in the final decades of the eighteenth century. Nietzsche's attention to and fascination with rhythm dovetails with the conventional historiography, which identifies rhythm as a key cultural and scientific category of the period around 1900.<sup>6</sup> It is this chronological focus, however, that the present book sets out to query. From the perspective I develop here, Nietzsche appears less to anticipate modern theories of rhythm than to have recognized the epistemological roots of the nineteenth century's new physiology and to have reflected on its cultural and historical dimensions.

My claim that the rhythmic episteme was crucial to the founding of biology arises from many years of research and thinking on, especially, the emergence of modern embryology. I was drawn to the topic by an analysis of the "Haller-Wolff" debate. In the 1760s, the influential Swiss naturalist Albrecht von Haller and a little-known German physician called Caspar Friedrich Wolff embarked on a fierce argument carried out by letter. Haller believed that organisms are generated out of preformed germs, the development of which is merely a matter of growing and unpacking, whereas Wolff espoused the "epigenetic" theory of generation in which development is a process of the gradual emergence of forms. Historians have frequently highlighted this debate, regarding the dispute as the "last stand" of preformationism and Wolff's theory as having instigated a paradigm shift toward the modern, epigenetic notion of embryonic development.

What originally interested me in the Haller-Wolff debate was its iconographic dimension. Both Haller and Wolff used drawings in their written texts; my question was how their different theories of development were reflected in differing iconography.<sup>7</sup> Although I believed this investigation had yielded some useful insights, my concern with theories of generation seemed to lead me a step further

back, to the question: What actually was “development” around 1800? Was epigenesis simply an alternative theory that replaced an outdated theory of development, or did the notion of what development is take on a fundamentally new shape around 1800?

Scholars have generally regarded the emergence of the epigenetic theory of development around this time as part of a new view of the world, usually labeled “temporalization” or “dynamization.”<sup>8</sup> Certainly, at the turn of the eighteenth to the nineteenth century, the image of nature underwent profound change. The years from 1760 to 1830 saw the advent of biology as the science of life.<sup>9</sup> The centuries-old practices of collecting, inventorizing, and classifying the world were now superseded by attempts to understand its dynamic relationships. Where the anatomist had seen a cadaver, the physiologist saw a living body in which blood circulates, glands labor, substances are continually transformed into other substances. In this dynamic vision of the world, the genesis of the embryo, too, became a process, one by which the body’s structures gradually take form out of the formless mass of the egg. Existence was subjected to the inexorable onward movement of time, which left nothing as it found it and subjugated life to change and flux. Life had previously been timeless, the product of a single instant of Creation; it now had a beginning and an end.

It was in this context that, around 1800, embryology arose as a science. The beginnings of embryology have been studied primarily from two perspectives: the teleological dimension of life processes and the vital forces driving those processes. In the usual historiographical view, the epigenetic stance depended on the assumption that processes of life — in contrast to other natural processes — always move teleologically. This was necessary in order to explain why, once the idea of preformed germs had been jettisoned, developmental processes still would have a direction. The notion of vital forces resolved a second and crucial problem of emerging embryology: how living organisms were able to organize themselves independently. This capacity distinguished them radically from mere matter, and even if little could yet be said about the nature of vital forces, their existence seemed to offer an explanation for that distinction.<sup>10</sup>

So far, so good — but did these perspectives help to answer the question of what development was in the period around 1800? I did not feel that the conundrum of developmental thinking was resolved, but rather that it had disappeared from view. To talk about the

directionality of processes and of the forces guiding them is already the second step. It takes for granted change, gradual progression, process itself. Yet what *is* a process?

Progression over time alone is not an adequate definition, given that theories of preformation had by no means denied progressive change — in preformationism, too, the organism was recognized as being profoundly different at the start of ontogenesis and at its end. Added to this, was it really a trivial matter to *see* the changing of the embryo? What did researchers around 1800 observe when they looked at chick embryos through their microscopes? And why was what they observed in this period different from what they had observed before?

Examining the role of images in the Haller-Wolff debate had shown me that pictures played a pivotal role in Wolff's blueprint for epigenetic developmental thinking, whereas they did not for Haller's theory of preformation. Wolff needed pictures in order to "see" development. So how exactly did he observe development? Could he see the changes in the embryo, or did he construct them on the basis of his observations? And what was the role of pictures in developmental thinking after Wolff, for example in the work of Christian Heinrich Pander and Karl Ernst von Baer, the founders of modern embryology?

A study of developmental thinking — and this is the premise of the present book — requires answers to these questions that go beyond the finding that the organism simply "becomes" a constantly changing, temporal entity. To understand the "form of becoming" that seemed to characterize living nature, a new conceptual framework had to be built, along with new experimental practices, new techniques of observation, and, crucially, new forms of visual representation. Reading the embryological treatises of the period with an eye to aspects other than their confrontation with the questions of teleology and forces, it becomes clear that a different problem also preoccupied naturalists around 1800. What they observed through the microscope was extremely difficult to grasp: living matter always changes, and the organism was a different one each time they looked through the lens. Nevertheless, it was a functioning whole, well ordered and coordinated. How could the organism continually change, yet still be ordered? How could the parts combine into a highly complex formation when they themselves were all changing as incessantly as did the whole?

In this book, I argue that the solution to the riddle was supplied by the episteme of rhythm. Around 1800, rhythm became a new way of imagining that played a critical role in the consolidation of the new science of biology. It may seem counterintuitive to describe a continuous change in time, a gradual transformation, as rhythmical. Although rhythm is a temporal structure, after all, in contrast to the flow of time — to time's unbroken and amorphous flux — it signifies the restriction of fluidity in favor of a rule. In fact, however, this power of rhythm to *structure* temporal processes was precisely what made it such an important concept in the period around 1800. Rhythm did not abolish time; it subjugated time. It imposed an order, a rule, on the unceasing transformation undergone by everything organic. Establishing a science of organic life did not, then, mean regarding the organic as something governed by temporal change. Rather, it meant conceiving of the organic as an ordered structure under the condition of temporality. Rhythm described the emergence and formation of life not as a mere progression in time, but as an *ordering* of time.

By asserting that a new episteme of rhythm became established around 1800, this book differs from existing scholarship in several respects. First, it offers an analysis of rhythm that has so far been almost entirely lacking in the history of science. Second, it shifts the focus of historical research on rhythm back a hundred years, to the threshold of the nineteenth century. And third, it embeds the emergence of embryology in the context of aesthetics, poetics, and philosophy around 1800.

To flesh out the first two of these points, the following section sketches the existing historiography of rhythm and its dominant paradigms. I then briefly present the methodological and historiographical basis of my own argument, paying particular attention to the difficulties that arise from the search for a rhythmic episteme in such diverse areas of knowledge as music theory, poetics, and physiology.

### ***The Paradigm of Rhythm around 1900***

As mentioned, rhythm has previously been regarded first and foremost as a feature of the threshold between the nineteenth and the twentieth century. Art history and cultural studies have frequently shown how rhythm became a quintessential cultural phenomenon

around 1900, responding to the challenges of modernity — to technologization and rationalization, to the redefinition of time, space, and matter in physics, and to societal and political change. In the arts, as well, rhythm became a novel creative principle, for example in the work of Klee, Kirchner, and Mondrian, and it took up a central position in new understandings of corporeality. In this way, the argument typically runs, rhythm came to emblemize the epoch around 1900 and contributed importantly to the transition into the twentieth century. As Janice Joan Schall has put it, rhythm was “the key to a new world view,” and in that capacity, it connected aesthetic reorientations as divergent as art nouveau, Expressionism, Dada, and Bauhaus.<sup>11</sup> In Geneva, the music professor Émile Jaques-Dalcroze invented rhythmic gymnastics. The rise of eurhythmics entailed an aesthetics of staging the voice and body that reached its artistic peak with the operas performed in the garden city of Hellerau, near Dresden, between 1910 and 1914.<sup>12</sup> Historians of rhythm have also often discussed the Leipzig economist Karl Bücher and his study *Arbeit und Rhythmus* (Work and rhythm). Bücher argued that the rhythmical structure of work is by no means a primitive form, but mirrors the natural physical predispositions of the human being. He concluded that the organization of work in civilized societies — which regard human beings as indolent by nature and seek to counter that indolence with ever more efficient motion sequences and mechanized labor — amounts to humankind’s estrangement from its innermost rhythmic constitution.<sup>13</sup>

Most historical analyses of the era around 1900 concur in characterizing rhythm as the specific articulation of a particular historical moment. In this view, rhythm was the historical response to the need for “vitality, order, and unity.”<sup>14</sup> Especially in Germany, writes Schall (among others), the conjunction of this “irrational” model with nationalist political positions ultimately, in the 1920s and 1930s, fueled Nazi views of the human being and the aesthetic mise-en-scène of National Socialism; in the person of Rudolf Bode, at least, eurhythmics was united with Nazi physical education.<sup>15</sup>

Despite the wealth of rhythm research on the period around 1900, historians of science have addressed the topic only sporadically.<sup>16</sup> This is surprising, since there is little doubt that rhythm was an object of interest in the natural sciences at this time. A paradigmatic discipline was experimental psychology as it emerged around 1900,

especially in the work of Wilhelm Wundt. Although Wundt sought to understand rhythm through experimental methods and apparatuses, rhythm in his view was not only a technical and experimental category, but was also marked by its close connection to affect. The course of a rhythm, writes Wundt, is always the “expression of the course of a feeling,” and accordingly itself generates feelings — it is “affect-arousing.”<sup>17</sup> Similarly, physics around 1900 saw an increasing interest in rhythmic movements, for example with the work of Ernst Mach and Wilhelm Ostwald; the same is true of biology, for example in the “law of series” proposed by the Viennese biologist Paul Kammerer.<sup>18</sup> These approaches have attracted little or no attention from historians of science. But if specific historical research on rhythm in science around 1900 is sparse, broader contextualizations in the history and theory of science are far more so. There is no systematic or comprehensive study of the history of rhythm in the sciences or of rhythm as an epistemic concept for either the exact sciences or the life sciences.<sup>19</sup> This lacuna is all the more striking, given that rhythm is playing an increasingly prominent part in current experimental and theoretical biology — a new development that has not yet left its mark on the historiography of science.<sup>20</sup>

### ***Rhythm circa 1800: A Neglected Topic***

To all intents and purposes, a history of the concept of rhythm has never been written; accordingly, there has been practically no research on the cultural and scientific history of rhythm before 1900. Exceptions are the comparatively well-researched area of etymology (to which I return below) and the works of Wilhelm Seidel. In fact, Seidel’s studies in music history remain the point of departure for any historical research on rhythm even today. His 1976 definition of the term, *Rhythmus: Eine Begriffsbestimmung*, is still the only book-length historical overview, which he subsequently modified in further publications.<sup>21</sup> Seidel is to be commended for addressing the changing fortunes of the concept of rhythm from antiquity into the twentieth century, but his contribution is limited by its almost exclusive focus on music. Chapter 2 of the present book, on music theory, returns to Seidel’s findings, and here I will mention only one crucial result of his research. For Seidel, Johann Georg Sulzer’s definition of rhythm in *Allgemeine Theorie der Schönen Künste* (General theory of the fine arts) of 1773–1775 marks a historical turning point in what

I call the rhythmic episteme. In the second half of the eighteenth century, Seidel argues, the origins, manifestations, and quality of rhythm were reformulated for the first time into an embracive concept of the rhythmic.<sup>22</sup>

Besides Seidel's studies, a brief essay on the nature and history of rhythm by Rudolf Steglich appeared in 1949 in a special issue of *Studium generale* dedicated to rhythm. Steglich differs from Seidel in including literary sources, although his comments remain little more than a sketch. Citing Schiller and Goethe, he describes the rhythm propounded by German classicism as "a forward movement that is experienced, in its rise and fall, with the 'inner and outer senses,'" in which the concord of the "elemental and personal, of body and mind, founds the organic-harmonious, classical *Humanität* of rhythm."<sup>23</sup> For Steglich, too, the turn of the eighteenth to the nineteenth century brought a rupture in conceptions of rhythm. In Romanticism, rhythm lost its onward-striding character. Instead, it was caught in a circle that became the "encasement of the rhythm of the Romantic self as it hovers and oscillates around the core of its own soul."<sup>24</sup> The up-and-down motion that distinguished the old rhythm was now supplemented by the to-and-fro motion of oscillation. This doubled, alternating motion, Steglich finds, is the basis of the epoch's rhythmic richness.<sup>25</sup>

Only recently have new impulses arisen, this time from literary and cultural scholarship.<sup>26</sup> Although so far these are isolated studies, a renewed interest in rhythm is coming into view, accumulating evidence that rhythm increasingly became a key epistemic category from the second half of the eighteenth century onward. However, in most cases, these are marginal comments or occasional hints of a novel significance for rhythm at the epochal boundary around 1800. Franz Norbert Mennemeier, for example, mentions a "high, speculative level" and "new historical quality" of reflection on rhythm, which became a foundational poetological category in German idealism.<sup>27</sup> In his history of German verse, Wolfgang Kayser points to August Wilhelm Schlegel's new understanding of rhythm as the "originary phenomenon of the human spirit."<sup>28</sup> For Isabel Zollna, nascent Romanticism ushered in a liberation of poetics from the previous "classical models," resulting in a turn to the aesthetic and therefore especially the rhythmic dimension of language.<sup>29</sup>

While several of the more recent studies on the reciprocities of

music, poetics, and aesthetics around 1800 largely ignore rhythm,<sup>30</sup> the work of Barbara Naumann — for example, on Novalis, August Wilhelm Schlegel, and F. W. J. Schelling — has revealed the foundational importance of rhythm for these writers' literary, philosophical, and aesthetic thinking. Naumann stresses August Wilhelm Schlegel's belief that rhythm is anchored in human nature, which she distinguishes from the stronger emphasis on art and reason in the explanations of rhythm offered by Schiller and by Schlegel's brother Friedrich. Analyzing the theoretical writings of Novalis, Naumann highlights the centrality of rhythm as a principle of both poetry and nature, but attends only peripherally to the physiological resonances that typify these poetic conceptions of rhythm.<sup>31</sup> An important study by Clémence Couturier-Heinrich on the discourse of rhythm in Germany between 1760 and 1820 identifies four different strands: rhythm as an anthropological given; conversely, rhythm as a specifically historical phenomenon of a past era, namely, classical antiquity; third, rhythm in the narrower philological sense; and fourth, rhythm in aesthetic theories. Couturier-Heinrich's investigation demonstrates not only the presence of ideas about rhythm around 1800, but also the expansion in meaning that the concept underwent in the Germanophone debate from the Enlightenment to Romanticism.<sup>32</sup>

However, all this historical research in literature and culture lacks a history of science perspective. The *physiological* dimension of rhythm is at most — for example in the work of Naumann or Couturier-Heinrich — a distant echo in historical studies of rhythm around 1800. Discussions of this theme and period have not addressed the discipline of biology that was emerging at the same time, the new concept of organic life, or the era's notions of the development and formation of organisms. My book's argument rests on the claim that around 1800, rhythm was precisely not “only” an aesthetic and philosophical category, but was reconceptualized as a biological figure of thought. This new character of rhythm as a law of the ordering and formation of organic nature is the object of my investigation.

### ***What Is Rhythm?***

This book argues that around 1800, the living world, especially organic development, was rethought in terms of rhythmic patterns, rhythmic motion, and rhythmic representation. The question thus arises: What is rhythm?

There is no simple answer to that question. One might say that it can be answered in as many different ways as it can be posed. Particular approaches may be roughly ascribed to particular disciplines, to anthropological, sociological, linguistic, or art-historical lines of questioning, or to shared historical contexts; however, this does little to clarify what the essential features of the phenomenon of rhythm actually are. If I now outline certain definitions of rhythm, this is not intended as an exhaustive account or as even the barest historical overview. Instead, I would like to highlight a particular current within rhythm research that is of special relevance for my own questions, namely, research on the ways that rhythm mediates between the spheres of biology and culture.

There is no consensus even on the etymology of the word “rhythm.” The term comes from the Greek ρυθμος (*rhythmos*), which is generally derived from the root ρεῖν (*rhéin*, to flow), though alternative etymologies refer to the Greek ἐρῦ or ῥῦ (*eru*, *ru*, to pull) and ἐρυσθαί (*erusthai*, to fend off, protect).<sup>33</sup> Émile Benveniste’s authoritative study demonstrates the etymological proximity of the term “rhythm” to the meanings “form” or “figure.” Benveniste calls rhythm “the form as improvised, momentary, changeable,” as “a configuration of movements organized in time.”<sup>34</sup> Indeed, human measure, understood both in an ethical sense and in that of the concrete perception of quantities, dominated thinking on rhythm in antiquity. In Plato’s fourth-century BCE discussion of rhythm’s ethical dimension, rhythm is not a matter of aesthetics alone, but above all a political issue. Plato defines rhythm as the “order of movement” and identifies this ordering function as the moral and normative force that is required for a community to settle on a shared measure of actions and values.<sup>35</sup>

The most wide-ranging theory of rhythm to survive from antiquity is Aristoxenus of Tarentum’s *Elementa rhythmica*. For Aristoxenus, a pupil of Aristotle’s, rhythm is the combination of motion and time, as he explains using the example of the human gait. In order to be rhythmical, the sequence of steps cannot be random; the individual steps must be related to each other — to the steps that preceded them and to the ones that follow. Aristoxenus asserts that this relationship is subject to a rule, that the length of strides or the interval at which the foot touches the ground obeys a law. The simplest such law describes the precise repetition of each step. Additionally, each

step can be divided into an upward and a downward movement (*arsis* and *thesis*). As possible natural relations between these movements, Aristoxenus names even ratios of 1:1 and 1:2 or 2:1.

What he proposes for the physical motion of the step also applies to language. In the *pes*, or metrical foot, short and long (long being the sum of two short syllables) are ordered into different metrical units — iambs, dactyls, trochees, and so on. The ratio of upbeat to downbeat, lifting to sinking, *arsis* to *thesis*, determines the quality of the metrical foot. Even today, this remains the basic framework for describing language rhythms. Aristoxenus also made a theoretical move that would prove important for the subsequent history of ideas of rhythm: he posited that rhythm does not achieve expression by itself, but needs matter for its expression. Accordingly, in rhythm, formed material (the body of the dancer, for example, or the notes of music) encounters a forming principle. This distinction allows rhythm to be understood more abstractly, as the movement of a unit of time, which Aristoxenus describes as “primary time” (*chronos protos*). The movement of the formed material (that of a body or a syllable) merely manifests this.<sup>36</sup>

The reason that classical antiquity is so important for my interest in rhythm’s mediation between the spheres of nature and art is, first, that classical thinkers made of rhythm an order of motion. As something spatiotemporal, rhythm remained bound to the measure of the human senses, even for St. Augustine (354–430 CE), whose ontology of rhythm as governed by numerical relationships was antiquity’s last complex examination of rhythm. The second crucial aspect is the unity of the arts in the classical view of rhythm, which addressed pulse and pace, breath and music, the sway of dance and the stress of a line without distinction. In the Middle Ages, this unity dissolved as the arts drifted apart. Music, especially, adopted new perspectives. The new polyphony was interested in the consonance and layering of music, not in its temporal sequentiality.

The next radical transformation in thinking on rhythm came only in the second half of the eighteenth century. The aesthetics of Johann Georg Sulzer, as will be discussed in detail later in this book, reconnected the arts with the body, placing the physiological measure of the human being at the core of all aesthetic experience. This conception of rhythm endured well into the first half of the twentieth century, when twentieth-century music eroded

rhythm's dependence on the aesthetics of measure. Rhythm became something difficult to define, the elastic description of an event's temporal structure.

In modern everyday language, rhythm has come to be regarded almost exclusively as a phenomenon of musical experience. However, in the last hundred years, there have been several systematic attempts to reveal rhythm's epistemological importance by stressing its mediating role between biology and culture. In his 1933 publication *Vom Wesen des Rhythmus* (On the essence of rhythm), a key text of the *Lebensphilosophie* movement, Ludwig Klages (1872–1956) gave a new turn to the topic by distinguishing rhythm, as a principle of life, from meter or cadence (*Takt*) as a principle of the intellect. Rhythm here is a “general phenomenon of life,” meter a human act of rationality.<sup>37</sup> Structurally, meter and rhythm in Klages's account differ along the lines of their respective affiliations: meter keeps us alert, rhythm relaxes us; meter repeats, rhythm renews; meter brings forth the same, rhythm the similar;<sup>38</sup> meter is an “identically repeatable span,” rhythm, with its alternation of rise and fall, is “polarized continuity.”<sup>39</sup>

While Klages approached rhythm through his emphatic concept of life, Alfred North Whitehead (1861–1947) opened up analytical philosophy for the concept. In *An Enquiry concerning the Principles of Natural Knowledge* (1919), proposing a philosophical foundation for physics, Whitehead held that the organic world could not be described by means of the usual physical laws and therefore exceeded the horizons of his investigation. Because, however, he did not wish to exclude the organic from his deliberations, he found himself obliged to set out in a new form the special laws applicable to the living world. For this task, he chose the concept of rhythm, which the *Enquiry* introduces as follows. In place of the term “living objects” to describe organisms, Whitehead proposes to use the term “objects expressing life” or “life-bearing objects.” He defines the state of being alive exhibited by these objects as the “relation of the object to the event which is its situation.”<sup>40</sup> That relationship is a rhythmic one: “Life (as known to us) involves the completion of rhythmic parts within the life-bearing event which exhibits that object.” Rhythm as a way of identifying living objects, Whitehead continues, is an exclusive condition: “wherever there is some rhythm, there is some life. . . . The rhythm is then the life.”<sup>41</sup> In other words, life is coterminous with

rhythm. Rhythm can be defined more precisely. It has a particular structure: “A rhythm involves a pattern and to that extent is always self-identical. But no rhythm can be a mere pattern; for the rhythmic quality depends equally upon the differences involved in each exhibition of the pattern.” The order of rhythm is therefore a structure of deviating repetitions. Whitehead arrives at the following concise characterization of rhythm: “The essence of rhythm is the fusion of sameness and novelty; so that the whole never loses the essential unity of the pattern, while the parts exhibit the contrast arising from the novelty of their detail.”<sup>42</sup>

The American philosopher John Dewey (1859–1952) took the aspect of the object–environment relationship in a different direction. For him, rhythm is the “interaction of the live creature with his surroundings”<sup>43</sup> and thus the origin of all human experiences. As the basis of every human activity, rhythm is also the crucial precondition for the products of the sciences and arts — it is “the tie which holds science and art in kinship.”<sup>44</sup> In *Art as Experience* (1934), Dewey presents rhythm as a figure of recurrence, but not the recurrence of the same. Unlike mechanical recurrence, “esthetic recurrence” always involves variation, and it is an order of “recurring *relationships*.”<sup>45</sup> As a result, rhythm in nature and art is always “novel as well as a reminder.” The recurring relationships connect the parts to the whole in a mutually illuminating way to “constitute an object as a work of art.”<sup>46</sup>

In her 1953 study *Feeling and Form*, Susanne Langer, following the lead of her teacher Ernst Cassirer, conceptualized music as a symbol of “living form.”<sup>47</sup> Music as a symbolic form represents time not as the disparity between two instants or states,<sup>48</sup> but as passage — “an audible passage filled with motion that is just as illusory as the time it is measuring.”<sup>49</sup> As passage, music can be experienced only “in terms of sensibilities, tensions, and emotions.” In turn, since feeling is reserved for living beings, the logic of all symbolic forms must obey the logic of living organisms. That logic is rhythm.<sup>50</sup> Human experience, which appears to us as a unity, is actually the experience of a “rhythmic continuity.” That is, rhythm continually produces new resolutions of the tensions we experience. It integrates those tensions into a unity only by resolving them into the new tensions of the future.<sup>51</sup>

The moment of discontinuity that Langer saw as bringing forth

tension and thus rhythm was also the point of departure for Gaston Bachelard. Bachelard's *Dialectique de la durée*, published in 1950, is concerned with repose as "something to which thought has a right" and "an element of becoming."<sup>52</sup> Here, Bachelard opposes Henri Bergson's philosophy of *durée*, which demarcated lived time from the time of clocks and science. Bachelard, in contrast, imagines lived time as a rhythmic alternation between action and repose, since all the "phenomena of duration are constructed by rhythms."<sup>53</sup> In Bachelard's work, the point of rest, the pause, is thus constitutive of the experience of continuity. The figurations that integrate the flow of motion and its interruption are rhythms, which Bachelard also calls "systems of instants."<sup>54</sup> A fundamental component of human experience, rhythm brings the necessary element of order to the thinking and feeling of human beings: through rhythm, the disparate components of experience can be unified in the "reliability [*fidelité*] of rhythm."<sup>55</sup> In other words, human beings have to construct the unity of their experience using rhythms. Hence, for Bachelard — unlike for Bergson — duration is not simply given; it is produced.<sup>56</sup> No human experience of time can exist outside of rhythm.

Early French sociologists and anthropologists such as Émile Durkheim and Marcel Mauss also addressed rhythm as a fundamental element of human experience. As Durkheim put it in *The Elementary Forms of the Religious Life* (1912), "since a collective sentiment cannot express itself collectively except on the condition of observing a certain order permitting co-operation and movements in unison, these [collective] gestures and cries," as social practices, "naturally tend to become rhythmic and regular."<sup>57</sup> Writing in 1926, Mauss even regarded the human being as a "rhythmic animal,"<sup>58</sup> and rhythm as "the direct union" not only of the social and the psychological, but of the sociological and the physiological.<sup>59</sup> The physiological nature of rhythm assumed by Mauss was the starting point for the work of the French paleontologist André Leroi-Gourhan. In *Gesture and Speech* (originally published in 1964), Leroi-Gourhan proposed a theory of human behavior as a "physiological aesthetics," holding that all forms of interaction with the environment take place on the basis of "physiological cadences" as bodily rhythms "create a fabric upon which all activity is inscribed."<sup>60</sup> In the course of evolution, this formed the conditions for human beings' aesthetic interaction with the environment to arise. Artistic products, then, are also subject to the

rhythmic constitution of the body. Regardless of human progress, all art remains bound to the physiological *dispositif*.

This tradition of French philosophy remains relevant in the post-modern era. A figure of rhythm can be identified, for example, in Jacques Derrida's notion of *différance*. The term *différance* brings together two images: that of "temporization" (in the sense of deferring) and that of spatialization or "spacing" (in the sense of differing). Derrida speaks of *différance* as an "'active,' moving discord of different forces, and of differences of forces."<sup>61</sup> Without wishing to become mired in the detail of Derridean terminology, it is fair to say that the concept of *différance*, which combines distinguishability or differentness with temporal deferral or detour, is thought in the categories of a rhythmic episteme. This interpretation seems useful, given Derrida's approach to *différance* as a "displaced and equivocal passage of one different thing to another," as "the sameness of difference and repetition in the eternal return,"<sup>62</sup> or as a "movement of signification," as long as "each so-called 'present' element, each element appearing on the scene of presence, is related to something other than itself, thereby keeping within itself the mark of the past element, and already letting itself be vitiated by the mark of its relation to the future element."<sup>63</sup>

In very recent times, there has been a revival of interest in rhythm.<sup>64</sup> New media and art forms are prompting the question "What is rhythm?" among the younger generation of media and art theorists, in particular. Because rhythm opens up a field of tension between "a quasi-rhythmic a priori in nature" and a "scientific or aesthetic construct,"<sup>65</sup> it is a privileged object of transdisciplinary study, fostering reflection on the interplay of art, science, and nature. In addition, the complexity, paradoxes, and very breadth of the concept of rhythm allow fundamental questions of aesthetics to be formulated and to be translated into new contexts: rhythm's oscillation between repetition and variation, uniformity and diversity, its tension between "continuity and disruption," can be discussed as a "creative potential" and a "condition of aesthetic experience" in light of new forms of performativity, of music, dance, and literature.<sup>66</sup> At the same time, the multiformity of rhythm permits the body to be located afresh — aesthetically, anthropologically, and sociopolitically — in the urban, artificial, and virtual world of the twenty-first century, between nature and culture, physiological disposition and

sensual perception, individuality and collectivity, completion and provisionality, memory and blueprint.<sup>67</sup>

***Nature and Culture: Methodological Remarks***

This detour into the history of concepts indicates the potential inherent in the concept of rhythm as an epistemological and historical category. For the purposes of this book, however, “What is rhythm?” is the wrong question. Of interest here is not the concept’s possible definition, but its historical substance and provenance. Put another way: this study asks not what rhythm is, but which actors conceptualized it around 1800, how, and in what contexts.

This highlights a peculiarity — and at the same time a difficulty — of my investigation. Rhythm as a *word* was conspicuously present in the field of aesthetic reflection, poetics, and philosophy around 1800, but without an agreed single meaning. In the music theory of the time, for example, the terms “rhythm” and “meter” were used differently by different authors, and not necessarily in the sense we use them today. In biological and physiological settings, the situation was even more complicated. Around 1800, the word “rhythm” was not common currency in physiology and in fact was used very rarely. Nonetheless, in this book, I will come back again and again to rhythm in biology, in the beginnings of developmental thinking, and in other contexts. In what sense, then, is “rhythm” meant here?

To speak of rhythm does not mean retracing the word’s use within its various semantic fields, disciplinary contexts, or applications. I refer to a rhythmic episteme around 1800 on two other grounds. First, I use rhythm as an analytical category. My study shows that the modern concept of development, introduced to biology by epigenetic theory around 1800, is a fundamentally rhythmic one. The core elements of rhythm — repetition, variation, regularity, period, modification, alternation, relation — are also those of the new episteme of organic development circa 1800. They can be found in the work of historical actors such as Caspar Friedrich Wolff, Ignaz Döllinger, Carl Friedrich Kielmeyer, Christian Heinrich Pander, and Karl Ernst von Baer as ways of describing generation, formation or transformation, metamorphosis, and emergence or for physiological metabolic processes. Rhythmic structures also formed the basis of a new iconography of development, one still prevalent today. Second, I argue historically, showing that imagining living processes

as fundamentally rhythmic structures was a defining feature of the historic configuration of the period around 1800. It was the rhythmic episteme that enabled a modern science of embryological development to emerge.

In search of the episteme of rhythm, this study travels between various and very different domains and forms of knowledge. They include music theory, literary theory, philosophy, aesthetics, and embryology, as well as physiology and botany. All these are arenas in which a new way of dealing with organic life was taking shape around 1800 — through description, illustration, and action. Methodologically, this book therefore applies a form of the history of concepts, or *Begriffsgeschichte*, to which Reinhard Koselleck contributed so importantly in the 1960s, but expands it by absorbing methods and epistemological questions from cultural history, visual studies, and the history of science.<sup>68</sup> Tracing the origins and changing meanings of concepts in the natural sciences leads us back to the experimental systems, research practices, and technologies of observation that both shape concepts and are shaped by them. Observation and experiment, text and image, concepts and material objects are all part of this understanding of how a concept is constituted as a category.

The category of rhythm indicates the unity between culture and nature before the nineteenth century split them into the separate spheres of science and the arts. Since my objective is not to identify the field of knowledge where the concept of rhythm originated, I do not address migrations, adaptations, or mutual influence — the episteme of rhythm was an event taking place in numerous theaters at the same time. My study attempts to go beyond the trope of transfer in discussing the relationships between literature and science, between aesthetic and scientific thinking, between biology and culture in Romanticism.<sup>69</sup> The emergence of the rhythmic episteme in the period around 1800 was not the transfer of an aesthetic perspective onto natural history, a “poetization of science” (Hegener) or “poetization of nature” (Mahoney), or a “procreative poetics” (Holland).<sup>70</sup> Neither was the poetological and philosophical discussion of rhythm merely a “reception” of scientific concepts or vice versa. Rather, the idea of rhythmically organized nature rested on an episteme of rhythm that *simultaneously* formed the foundation of new aesthetic concepts in literary and music theory and was articulated in scientific theories — whether in the epigenetic theory of generation,

Goethe's model of the metamorphosis of plants, or the growing currency of the physiological concept of the alternation or transformation of matter, in the contemporary German discourse *Wechsel der Materie*.

In other words, rhythm circa 1800 formed a deeper epistemic stratum. It responded to the quest for rules according to which both nature and human creativity — poetry, music, the visual arts — in equal measure bring forth their works, for the law according to which they are internally ordered and that governs their constantly changing configurations. With the help of the rhythmic episteme, the particularity of the living world seemed within reach for the very first time: its capacity for infinite plenitude while remaining bound to an existing framework. With rhythm, the temporal dimension of nature acquired a rule, development was ascribed to a law that gave rise to newness, to the multiplicity of nature, as a rhythmic repetition of what already existed. Development became both rule and variation — and that is what constituted its aesthetic and epistemological momentum.

### **Content**

This book traces the emergence of the rhythmic episteme in three sections. The first of these shows how rhythm arose as a central epistemic category in theoretical writings on literature, art, and music in the period between 1760 and 1830 and how it was proposed as a physiological category. Chapter 1 examines the broad cultural discourse of rhythm around 1800.<sup>71</sup> Literary theory was key to this, starting with Friedrich Gottlieb Klopstock's theories of rhythm. The transitional figure of Klopstock is particularly interesting: he worked with existing classical rhythm theories, yet he was already beginning to advocate a physiological notion of rhythm. The turn becomes more obvious in the case of Friedrich Hölderlin, with his theory of the modulation or alternation of tones (*Wechsel der Töne*) and his thoughts on the "artistic and formative drive."

Karl Philipp Moritz's concept of the autonomy of artistic works was also modeled on the rhythmic ordering of nature. His aesthetics of autonomy is exemplified by language, which only as rhythmic language can become poetry and thus a work of art. In Moritz's view, just as rhythmic motion is the developmental law of poetic language, rhythmic motion in the organic world is the developmental law of

emerging life. A few years later, August Wilhelm Schlegel formulated an anthropological theory of rhythm in which poetry was seen as an expression not of human artistic skill, but quite the contrary, of man's fundamental, physiological nature. For Schlegel, the arts — even in their most elaborate form — remained tied to the physiology of the body, and their basic ordering structure was rhythm. In the “universal poetry” proposed by Novalis, too, rhythm was seen as the order according to which nature constantly transforms itself, but also within which man integrates the fragmented knowledge of the disciplines into an ever-changing image of the world.

The second chapter addresses music theory. Music historians long ago identified the period around 1800 as a turning point in musical theories of rhythm. As I will show, this rupture was not the product of music theory alone. Theorists aimed to grasp the “vitality” of music correctly — and this was the source of the contemporary interest in rhythmic structures.

The role of rhythm in Schelling's system of absolute philosophy is the focus of the third chapter. Schelling is important for my argument because his system ascribes to rhythm the key function of mediating between the spheres of art and nature. For art, rhythm is a way of representing nature as it essentially is. Conversely, for nature, rhythm is a way of manifesting itself in the forms of art.

The second section of the book is dedicated to three aspects of the emerging biological sciences: theories of generation, botany, and physiology. I begin with Caspar Friedrich Wolff, who brought to the modern debate the concept of epigenesis as the gradual emergence of forms out of the egg's originally formless mass. Chapter 4's study of Wolff's groundbreaking works, from his 1759 dissertation *Theoria generationis* (Theory of generation) to *Über die Bildung des Darmkanals* (On the formation of the intestinal canal) of 1812, shows that he conceptualized the embryo's coming into being and subsequent formation as an interplay of repetition, regularity, and variation — thus, as a rhythmical process. These elements not only marked out the parameters of rhythm, but were also core components of the new episteme of organic development around 1800.

The focus of the fifth chapter, on the concept of metamorphosis, is Johann Wolfgang von Goethe's 1790 study *The Metamorphosis of Plants*, which describes the gradual formation of the plant out of a single leaf. Goethe's work is especially interesting in the present

context because he approached the question of metamorphosis from a simultaneously scientific and aesthetic or poetological angle. Chapter 5 shows that rhythm played a pivotal role in his treatment of metamorphosis in terms of both scientific theory and poetic art.

Examining several scientific treatises that may be seen as exemplifying the physiological imagination of the period around 1800, Chapter 6 discusses the decisive role that the new way of understanding organic development played in physiology — for example, in Johann Christian Reil’s notion of the life force, formulated in an influential text of 1795, or in the idea of physiological secretion proposed by Ignaz Döllinger at the beginning of the nineteenth century. If physiology in this period wished to become a science of life, it would have to make the “form of becoming” its object. Physiological knowledge was to be found not only in knowledge of the qualities of substances, but also in knowledge about what happens when one form changes into the next. Motion alone seemed to be what creates forms from formlessness, life from matter. And this organic motion was not a simple flow, but a rhythmical oscillation, named in the contemporary notion of *Wechsel der Materie*, in which rhythm orders the passage of forms, the states and processes of life, and gives them a temporal choreography.

The seventh and eighth chapters depart from this broadly chronological structure. They open the third section of the book, “Serial Iconography,” which addresses the emergence of embryology in general and the use of pictorial series to depict development in particular. It is based on a conviction that the history of developmental thinking cannot be written without attending to the forms and conventions employed to visualize development. The establishment of embryology was thus inextricably entwined with a new iconography in the life sciences, which I will call “epigenetic iconography.” By this, I mean the visual convention of depicting developmental processes in a series of images, each showing a different stage of embryogenesis, that taken together convey the complete process of development from homogeneous matter to a fully differentiated organism. It remains the standard iconography for visualizing organic processes even today.

Whereas these specific conventions arose in tandem with the new discipline of embryology, however, the serial form of representation more generally has its own long history. Chapter 7 locates the

beginnings of serial representation in the visual format of pictorial instructions for bodily movements. Teaching the correct execution and training of physical moves, these can be found in treatises on military drill, fencing, riding, and dancing from the seventeenth century on. The culture of the drill, which defined movement behavior in seventeenth-century and eighteenth-century Europe, was an aesthetic culture of motion. More precisely, drills were rhythmic arts of movement. For embryology, my argument is that the serial form of representing human motion was adopted around 1800 and became constitutive for the explanation of epigenetic developmental processes. In Chapter 8, I consider the history of pictorial representations of biological development, beginning with the works of Fabricius and Malpighi in the seventeenth century and ending with the epigenetic theories of generation around 1800. I unpack the transition from a “chronological” pictorial tradition to the “epigenetic” iconography characterized by its deployment of rhythmic developmental sequences. This distinction is exemplified by the Haller-Wolff debate, here examined from the perspective of the two scientists’ use of pictures.

The ninth and tenth chapters focus on Christian Heinrich Pander and Karl Ernst von Baer. Considered the founding fathers of modern embryology, both were pupils of Ignaz Döllinger, under whose aegis they began their first experimental investigations of chick embryos. The theories of Pander and von Baer, I argue, share a crucial epistemological dynamic that has hitherto attracted little scholarly attention: both regarded the entirety of embryonic formation as a rhythmic transformation of membranes through bending and folding. These movements and shifts of the membranes are complex formations in space — each movement of a membrane is repeated in the others; they are staggered in time and spatially differentiated so that the movements take place in various directions, on various levels, and at various points on the membranes. Rhythm is the rule that orchestrates a myriad of movements, coordinating them into an ordered course. In this case, again, the use of images is vital. I show how Pander (Chapter 9) and von Baer (Chapter 10) worked with pictures in their experimental studies of chick embryos and how they built their theory of embryological development on the foundation of pictures and pictorial series. In their work, the series constitutes a new observational regime where development is at once synthesis

and analysis. It is both the individual form and the sequence of forms, both stasis and flux. This inherent order of time is the rhythm of the pictorial series.

### ***In Conclusion***

This book is dedicated to the idea of development around 1800 and the process by which development became framed within an episteme of rhythm. Each chapter describes one facet of the rhythmic episteme as it crystallized in various guises and fields of knowledge at this time. Following the sequence of the chapters and contemplating the emergence of embryology as embedded in the diversity of the era's knowledge, thinking and representation, seeing and describing, it becomes clear how rhythm — as an ordering of the human body's externally visible movements — moves inward into the body. There, it remains an order that can be grasped immediately by the human senses, but it is now also the measure of the body's physiology, of its interior, of its becoming, of a process of flow along the cadences of regularity and counterplay.

Recently, I have learned that for development to give rise to new forms, cells must not only divide, multiply, and move in a carefully orchestrated, rhythmical way — equally, they must die. Explaining his research on apoptosis or programmed cell death in *Tupaia* species, the anatomist and embryologist Wolfgang Knabe told me that modern three-dimensional visualization techniques reveal patterns of apoptosis within the developing embryo that are highly regulated in space and time. Apoptosis flows from dorsal to ventral parts of the embryo in waves, demarcating different placodes to lay down the foundations for the organism's future sense organs.<sup>72</sup> Clearly, rhythm is a theme for twenty-first-century developmental biology as much as it was for the eighteenth century. Not only does rhythm give order to flux and build the future upon the past, it also reconciles proliferation with apoptosis, life with death.