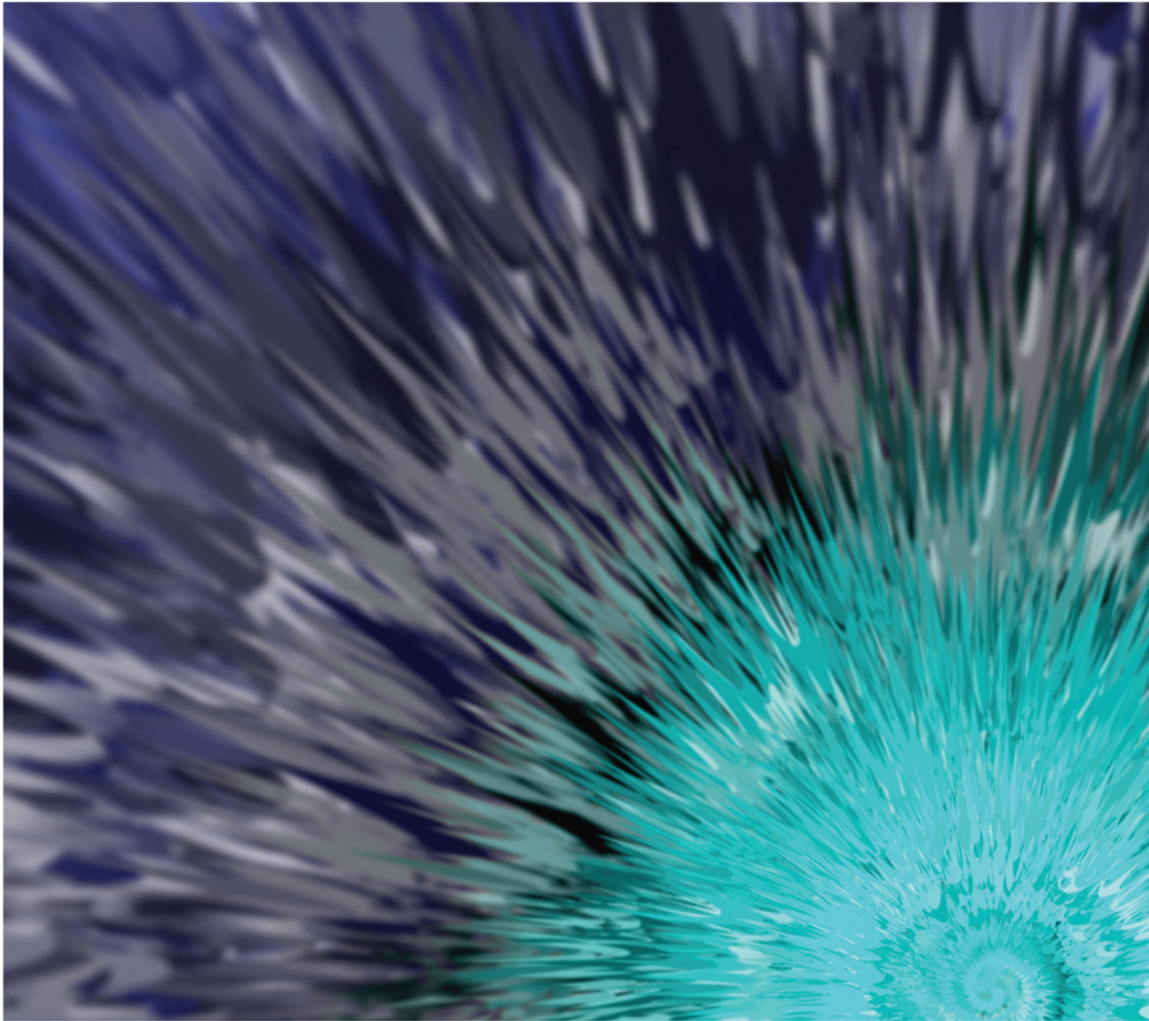


The Routledge Companion to Literature and Science



Edited by Bruce Clarke with Manuela Rossini

THE ROUTLEDGE COMPANION TO LITERATURE AND SCIENCE

With forty-four newly commissioned articles from an international cast of leading scholars, *The Routledge Companion to Literature and Science* traces the network of connections among literature, science, technology, mathematics, and medicine. Divided into three main sections, this volume:

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PREFACE

It is commonly thought that the divorce between literature and science became final a while back, and since then they have been permanently settled into separate and incommunicative professional cultures, literature in its cozy academic bungalow and science in its flashy mansion on the hill. In 1959, British scientist and novelist C.P. Snow delivered his famous Rede Lecture, “The Two Cultures,” providing a durable catch-phrase for and launching a raft of further commentaries on this intellectual separation. However, as contributor Emma Gee rightly remarks to begin her chapter on Greece and Rome, “Snow’s opposition between literature and science may seem more naive to us than to his audience of 1959; to the Greeks and Romans it would have been incomprehensible. The concept of antipathy between representatives of the two poles, as it operates today, was unavailable to ancient thinkers.” And fifty years after Snow’s lecture, we no longer see as stark a split between literature and science. To some extent this more nuanced view is the result of efforts by scholars, such as those gathered in this volume, dedicated to address and overcome, at least on the side of literary knowledge and scholarship, the more glaring deficits of humanistic fluency in scientific matters. But from both sides of this divide, efforts have been made to develop finer-grained understandings of the interrelations of natural research and cultural discourse, of scientific theory and experiment on the one hand, and of literary meditation, fictionalization, and popularization on the other.

Since the Renaissance, humanistic letters in the West have been framed by worldviews that we now, since the mid-nineteenth century, call “scientific” – for instance, the Copernican model of the solar system. At the same time, what we now call “scientists” have inevitably worked with models of reality formed or informed by what we now call the “humanities” – for instance, the literature and philosophy of “the Enlightenment.” If modern knowledge confronts schisms, it is nothing so pat or “naive” as a two-cultures divide. Nonetheless, to frame the situation in Jean-François Lyotard’s idiom, it is the case that there is no longer a credible metanarrative that could bind the current profusion of academic cultures and their specialized disciplines into an ordered hierarchy, let alone a unity. The rift Snow observed at mid-twentieth century was in fact an early diagnosis of our postmodern condition. “Two cultures” marks a popular recognition of what contemporary systems theory terms the operational differentiation of modern social sub-systems. In other words, knowledge production in the modern world increasingly proceeds through the specialized or technical

languages that enclose separate disciplinary spheres. Under these conditions, perhaps ironically, cross-disciplinary contact has had to become a discipline in its own right.

The field of literature and science has come about precisely as a scholarly response to these social conditions at the interface of scholarly discourse and literary production, academic and popular communication. Indeed, the contents of this *Routledge Companion* present a range of dynamic contact zones, fields of intensive cognitive and conceptual encounters between the humanities and the natural sciences in general, and between literature and various domains of science in particular. The literature and science scholarship gathered here has been authored largely (but not exclusively) by humanities scholars – literature specialists, historians, cultural theorists, students of media and the fine arts, and communications scholars – intent on addressing “two-cultures” disparities and opportunities within their home disciplines. But many of them are also intent on complicating the issues that attach to disciplinary boundaries.

For instance, consider – as viewed from an influential perspective within literature and science scholarship, that of French sociologist of science Bruno Latour – the common separation of “science” from “technology.” Undoubtedly there are proper distinctions to be made between them. One can say that the sciences seek to know natural objects while the technologies aim to make artifacts that are instrumental for cultural purposes. It is nevertheless the case that neither practice can be adequately contemplated in the absence of the other. One is always already concerned, in Latour’s coinage, with *technoscience*. Only technological artifacts allow the sciences to construe natural objects scientifically, and this inscribes the objects that science describes (and most certainly, those it creates) with significant cultural traces. Similarly, the discipline of literature and science theorizes texts as technologies of communication and meaning embedded in some material medium of discourse or narration. Books and textual media are matrices for the formal and historical interplay of cultural inscriptions. Machines and their products – material and textual artifacts – are complexly legible as allegories of technoscience. A recent work of literature-and-science pioneer Katherine Hayles is titled *Writing Machines*, and this redescription of the literary text in the digital era follows directly from the postmodern confrontation of literature and science. In sum, the discussion of technologies is broadly dispersed throughout this *Companion* tracking the intersections of literatures and sciences.

All of these counter-trends toward transdisciplinary convergences-in-difference between the discursive, technical, and natural disciplines have been accelerating for several decades. Marking a decisive moment of consolidation in the evolving scholarly relations of literature and science, the *Routledge Companion to Literature and Science* aims, first, to provide undergraduate majors and graduate students across the curriculum with access to the most advanced thinking at the nexus of

literature and science, and second, to document the range and diversity of this work for the use of professional scholars. However, this is not a “top-down” edition: except for length, we did not issue or enforce comprehensive editorial constraints. Each author was encouraged to contribute a chapter reflecting his or her predilection and special expertise while representing their usual focus and discursive style.

Taking literature in English as a paradigmatic but not exclusive example, Part I highlights specific scientific specializations with regard to their literary connections. Part II details the current range of disciplinary and theoretical approaches in and around literature and science scholarship. Part III approaches the divisions of scholarly labor in literature and science along the axes of world-historical units and global cultural location. This wide-angled approach makes the *Routledge Companion to Literature and Science* an especially useful guide and point of orientation for diverse departments and programs in literature and related discursive and cultural disciplines. It is also part of the ongoing growth of larger networks for cross-disciplinary teaching and research.

We also see this *Companion* as an important resource for researchers in science and technology studies, cultural studies, and narrative studies; for fields like narrative ethics and narrative medicine, already institutionalized in Medical Humanities programs; for programs pursuing a transdisciplinary agenda, involving non-academic expertise; for science journalists and creative writers; and last but not least, for scientists themselves. There has been an ongoing imperative to turn literary studies toward cultural studies, while maintaining a strong focus on literature as an important medium and form of cultural production. This tendency has been accompanied by a widening of the terms “literature” and “text” to refer to the narrative nature of all writing, including scientific writing, and the concomitant emergence of a “poetics of knowledge.” Moreover, the explicit encouragement, if not enforcement, of inter- and transdisciplinarity has also led to more integrative projects where literature has been joined by the fine and media arts as partakers in discussions about developments in technology, medicine, and science.

Our readers may consult the *Routledge Companion to Literature and Science* for detailed overviews of how various writers, theoreticians, and disciplines at large have conceptualized and dealt with the coevolutionary dependencies among literature, science, technology, mathematics, and medicine. While science fiction has recently increased in cultural importance and cachet, for some centuries now canonical and mainstream literary writers have been seriously engaged with the sciences, spreading as well as questioning constructions of scientific knowledge. Literature and its scholarship are also formidable forms of knowledge production and key contributors to the episteme of a culture. At the same time, here scientists as well can learn more of their own disciplines’ cultural histories, for instance, the many ways that their works have been appropriated and popularized or criticized through literary texts and so rendered productive of further

social effects. For anyone needing authoritative, accessible, and succinct treatments of particular scientific disciplines in their literary dimensions, or of contemporary theoretical paradigms that engage the sciences within wider cultural frameworks, the *Routledge Companion to Literature and Science* will be a valuable resource.

Part I

LITERATURES AND SCIENCES

One hears occasionally that “Science” has made a new discovery or that, “according to science,” this or that social policy or form of personal hygiene is to be preferred over another. Unlike German usage, which calls all scholarly disciplines “sciences” (*Wissenschaften*), then stipulating further between *Naturwissenschaften* (the natural sciences) and *Geisteswissenschaften* (the humanities), “science” took on a more specialized application in English. Perhaps this bias or restriction also helped to obscure how science in the singular, with or without a capital S, has always been a bit of a misnomer. Despite whatever methodological regularities may apply, the singularity of Science is a nominal idealization, a handy abstraction. Students of literature and science, already trained to dissect such linguistic formations, have kicked the habit of referring to “Science,” or its reflexive variant, “science itself,” as a monolithic enterprise or singular practice. In his chapter on Japan in Part III, Thomas Lamarre notes how “those who wish to stress the impact of the sciences on the formation of modern societies tend to posit a unified, almost deterministic historical force, whether their intent is to extol science or to rue its excesses.” The drive for a unitary Science does not necessarily derive from scientists themselves; it can also come from certain kinds of historiography or social commentary. Lamarre continues: “Yet we get a better sense of the efficacy and impact of the modern sciences when we think in terms of specific fields of rationality rather than a massive overarching rationalization or modernization.”

Students of literature and science need to become adept in the specificities of the various sciences – their separate if variously interrelated histories, the particularities of their disciplinary objects, their different schools of thought, and the range of issues and debates that roil their immediate ranks. A decisive opening move for our interdisciplinary and transdisciplinary investigations is to gain clarity both on the current framework of disciplinary distinctions within the sciences, and on the wider histories that render them mobile and relative to specific times and places. For instance, contributor Noah Heringman notes that “Romantic science was predisciplinary. ... By attending to *predisciplinarity* we can see that there were in fact multiple ‘ways of knowing’ and that the shift to

modern disciplinarity was neither sudden nor uniform nor (even now) complete.” In addition, innovative approaches in literature and science place trans-disciplinary pressures on the sciences at hand. For instance, Arkady Plotnitsky’s chapter on Psychoanalysis does not rehearse yet again the history or terminology of that discipline, but rather proceeds directly to a position of post-Kantian philosophical mediation between Sigmund Freud’s orientation toward biology and Jacques Lacan’s orientation toward mathematical physics, in order to rethink the relations among science, literature, art, and the Real.

Part I sets forward the primary sciences as discrete disciplines, but also subdivides or supplements a number of them. For instance, there are chapters on both Physics and one of its sub-disciplines especially rich in literary traffic, Thermodynamics; on Biology, but also on Ecology, Evolution, and Genetics; on Chemistry, but also on its historically important precursor, Alchemy; on Geology, and also on its significant current spin-off, Climate Science. Other chapters in Part I range from classical disciplines, such as Mathematics and Medicine, to modern and contemporary amalgamations of discrete scientific strands. One might call these *synthetic* disciplines. Integrating both scientific and technological developments into powerful new formations, these newer “fields of rationality” have already produced profound cultural and creative consequences: Artificial Intelligence and Artificial Life, Chaos and Complexity Science, Cognitive Science, Cybernetics, Information Theory, Nanotechnology, Psychoanalysis, and Systems Theory.

This more complex tableau of scientific disciplinary differences enables one to think more precisely about their connections to matters of *literary* consequence. For instance, certain sciences are more conducive to or apt for literary treatment than others. Biology is especially favored in that many of its objects of study – such as animals – yield easily to sympathetic identification, and reside at or near the human scale of things. Contributor Sabine Sielke adds: “The biosciences’ growing cultural visibility and prestige is partly due to the fact that they can be narrativized more easily than mathematics and physics.” As often as not, the literature in “literature and science” will come forward, as one would expect, as literary works – poems, novels, plays, songs, or scriptures – significantly inflected by ideas or images we now call scientific. Sketching the prehistory of Nanotechnology, Colin Milburn comments that “In the early decades of the twentieth century, a wave of stories depicting molecules, atoms, and subatomic particles as worlds unto themselves flooded the literary marketplace.” And Stacy Alaimo points out how the study of ecology and literature could “include all cultures, all time periods, and all sorts of texts, including oral literatures and ceremonies (such as Shalako, the Zuni world renewal ritual).”

Matters of literary consequence will vary according not only to scientific distinctions but also to the different phases of the “literary” – for instance, as discourses of literary criticism in its commerce with scientific concepts, or as the literatures canonized or produced by philosophical, theoretical, popular-scientific,

or other non-fictional fields. Alaimo continues that, with regard to the literature and science of ecology, “It would draw not only upon the disciplines of literary studies, ecology, science, and science studies, but also anthropology, sociology, political theory, history, cultural studies, and postcolonial studies.” Similarly, Jay Labinger suggests that “We might even consider the origins of chemistry as primarily literary, not scientific, since the core concept of atomic theory was initially expounded by the ancients (Democritus, Epicurus, Lucretius, etc.) with little if any appeal to observational (let alone experimental) support.” And as Ira Livingston writes on Chaos and Complexity Theory, “Part of the conversion to chaos involves learning to see structures not as structures but as systems, events in process. This recognition is part of what makes chaos and complexity theory full partners with poststructuralist theory generally.” We see, too, that the discourse of literature and science has broken another habit, that of appealing to Literature with a capital L. There are literatures and there are sciences, and the range of scholarly interests in their interconnections derives from this double manifold of significant differences.

1

AI AND ALIFE

John Johnston

I

What is life, and what makes human life unique? With the rise of the life sciences and Darwin's theory of evolution by natural selection in the nineteenth century, new answers to these questions were proposed that were deeply at odds with traditional understandings and beliefs. With the advent in the twentieth century of new, life-altering technologies like genetic engineering, and life-simulating sciences like Artificial Life (ALife), these questions became even more insistent. Moreover, after World War II, efforts to build fast, intelligent machines and the subsequent development of the computer made the assumption of human intellectual superiority seem uncertain and sure to be challenged, especially since the new science of Artificial Intelligence seemed to lead inexorably to the construction of superhuman machine intelligence. Indeed, both ALife and Artificial Intelligence (AI) dramatically encouraged the thought that the opposition between the natural and the artificial, the born and the made – an opposition dating back to that of *phusis* versus *technē* in ancient Greek culture – was no longer so hard and fast, and certainly not inevitable. Yet this philosophical conundrum was hardly the central issue or worry. Rather, it was the nagging possibility that henceforth the evolutionary dynamic might begin to act on a biosphere soon active with non-natural life forms and that its crowning achievement – namely humanity itself – might eventually be displaced and superseded by its own technical invention. In short, many feared that the future would be determined by some cyborgian, post-biological form of the posthuman, or that the human species might be eclipsed altogether as evolution's torch of life and intelligence passed to its artificial progeny.

It was inevitable, therefore, that the possibilities of both ALife and AI would begin to be explored, variously and even idiosyncratically, by literary writers. Here, "ALife" will simply refer to new and non-natural forms of life brought into existence through external and technical means at least initially under human control; similarly, "AI" will refer to some kind of human-constructed machine intelligence (usually an advanced computer) capable of performing

actions of such complexity that they require a level of intelligence comparable to that of humans.¹ As we might expect – given that life has always been assumed to be a precondition for intelligence – ALife was of interest to imaginative writers long before AI.

Specifically, ALife became possible as a fictional interest with the beginnings of the properly scientific study of life, that is, with the emergence of biology in the late eighteenth and early nineteenth centuries, whereas AI, with rare exceptions, became a serious fictional interest only after the birth of the computer.² Interestingly, the official births of the professional scientific disciplines devoted to ALife and AI – in 1987 and 1956, respectively – reverse this chronological order. However, in regard to ALife and AI as fictional themes, the most important background influence was not only the computer but also the immense transformation of biology and the life sciences by cybernetics, information theory, and modern genetics (specifically, the discovery in 1953 of how DNA functions). For many readers, in fact, the contemporary emergence of these themes in fiction will be associated with the historical amalgamation of technics and science in what has become known as technoscience and its more recent condensation, cyborg science.³

No doubt the first modern narrative about ALife is Mary Shelley's novel *Frankenstein*. It was followed by a number of well-known literary classics that, from the contemporary perspective that now post-dates the official inauguration of the new science of ALife, could well be said to be concerned with ALife *avant la lettre*. Specific examples would include H.G. Wells's *The Island of Dr. Moreau*, Karel Capek's *R.U.R.*, Aldous Huxley's *Brave New World*, and Philip K. Dick's *We Can Build You*. However, with the accelerated development of computer technology, machine intelligence as a source of worry or "problem" theme becomes more prominent, particularly in the rapidly growing new popular genres of science fiction and film. Nevertheless, although ALife and AI can be clearly distinguished as two new sciences of the artificial, they do not always operate as distinctly different fictional interests, but are often intricately related in a number of interesting ways. For example, in Astro Teller's novel *exegesis* (1997) a computer program – specifically, a data miner called "Edgar" – unaccountably becomes "smart"; in the special terms of AI, he or "it" is smart enough to pass the Turing test. However, the protagonist Alice, the human with whom Edgar regularly communicates, openly doubts that he is in any real or biological sense "alive."⁴ Conversely, Michael Crichton's novel *Prey* (2002) combines both ALife and AI: the nano-swarms engineered by the company Xymos Technology, while clearly of unnatural origin, seem "alive" by any standard biological definition – they require food, reproduce, and evolve – and thus are a form of ALife. But they are not especially intelligent. In fact, their intelligence is based exclusively on a few algorithms that model simple predatory and learning behaviors. Thus the swarms never display anything approaching human intelligence and remain a very limited form of AI.⁵

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