

EMERGENT EMERGENCIES IN COMPLEX ECOSYSTEMS: REFLECTIONS ON
THE LIMITS OF NARRATIVE COGNITION AND A REVISITING OF MICHAEL
CRICHTON'S *JURASSIC PARK* (1990)

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Emergent Emergencies in Complex Ecosystems: Reflections on the Limits of Narrative Cognition and a Revisiting of Michael Crichton's *Jurassic Park* (1990)

Abstract

This article argues that 'emergent emergencies' in complex natural systems or 'ecosystems' can be understood as the ethical consequences of cognitive failure or "epistemological error" (Gregory Bateson). More specifically, I hold that complex systems display emergent behaviors, and that narrative cognition — our human default way of making sense of the world — is not particularly well suited for understanding emergence. Building on previous narratological work on the incompatibility of narrative and emergence (H. Porter Abbott, Richard Walsh), I argue further that narrative thinking and complex systems are each characterized by distinct types of 'agency,' or ways of conceptualizing agency. In its second half, the essay turns to Michael Crichton's classic *Jurassic Park* (1990), reading the novel as a fictional thought experiment which not only simulates an emergency situation, but also explores the reasons for the collapsing of the control system in the fictional theme park from the vantage of chaos theory. It will be shown that the emergent emergency staged in the novel is the result of cognitive failure on the part of the park managers, who are misled by a 'narrative of centralized control' (Abbott) in their attempts to control the park and a reductionist conceptualization of 'life.' Such reductionist approaches to life are contrasted with ecological frameworks in this article.

1_Introduction: 'Emergent Emergencies' as Ethical Consequences of Cognitive Failure

The felicitous concept of 'emergent emergencies,' as proposed by the editors of this issue, suggests a close interrelationship between an ethical and a cognitive problem.¹ It implies that states of emergency can arise out of cognitive inability to comprehend 'emergence' — a term used to describe the behavior of complex systems marked by "circular recursion" rather than straightforward linearity or mono-causality.² Because of the massively "interdependent interactions" of their elements,³ such systems display "a complexity of form not predictable from antecedent conditions."⁴ While it is certainly true that "[t]he systems of the world are [...] numberless"⁵ and that emergent behaviors can be observed in a whole range of natural and social systems,⁶ the specific phenomenon that this essay wants to look at more closely is that of the ecosystem. According to Stacy Alaimo, the notion of the 'ecosystem' can be regarded as the central concept in ecology because it paradigmatically captures the discipline's interest in "systems of exchange, which includ[e] the cycles of nutrients, energy and chemicals."⁷ But the concept also appeals to the interest of this issue in emergent emergencies as it inevitably raises the question of the human embeddedness in com-

plex natural systems. This not only entails the ethical aspect of how human beings act in such systems, often seeking to acquire control or mastery over them. It also includes the cognitive ways in which humans make sense of — or misunderstand — the workings of ecosystems, and these attempts necessarily rely on forms of knowledge that are always culturally mediated.⁸ Emergent emergencies will therefore be understood in the following as states of severity that have arisen from insufficient understanding of how complex systems operate.

One might wish to describe the dynamics that produce emergent emergencies in ecosystems a little more precisely. To this end, I briefly turn to a particularly topical issue that has received increased attention in ecosystem ecology in the last 15 years: the debate on the Anthropocene. The notion of the ‘Anthropocene’ as such is far from uncontested,⁹ but the term is usually used to designate “the present, in many ways human-dominated, geological epoch,” as the chemist Paul Crutzen proposed in a *Nature* article at the beginning of the new millennium.¹⁰ However, the idea of human domination of the Earth system is far from unproblematic, which is why the Anthropocene is also often evoked to stress that humans have left their mark on Earth to such an extent that the effects of their agency have become noticeably recursive — for instance in the form of global warming. In her dissertation on *Vital Reenchantments: Biophilia, Gaia, Cosmos and the Affectively Ecological*, Lauren Greyson therefore defines the Anthropocene as “the age of the human, in which we have acquired unthinkable influence at precisely the time that we realize just how small the world is and how unpredictable the consequences of our own activities are.”¹¹ What renders this background an interesting frame of reference for this essay is the tension between human cognition and action in the age of the Anthropocene. This tension is nicely illuminated by Greyson in the following way:

[T]he Anthropocene is disenchantment come to pass; we *are* now as gods. However, in the Anthropocene we are also gods that are consistently outwitted by the very forces we are supposed to have mastered. This is because the Anthropocene offers us no vantage point from the heavens with which to view that which we bring upon ourselves; in the Anthropocene, the human has its fingers in everything, but cannot possibly know the nature of all that it is *affecting*. The human is omnipresent, and very powerful indeed, but that power is always undermined and held in check by our embeddedness and inability to fully predict the dynamics of complex systems.¹²

The manner in which Greyson explains the logic of the Anthropocene — as a condition in which human beings “are consistently outwitted by the very forces [they] are

supposed to have mastered” — already indicates that emergent emergencies are narratively characterized by the structure of the turning point: Since such states of severity are fundamentally unpredictable in advance, the causes that have led up to them are usually only identifiable “with the benefit of hindsight” — a feature that Ansgar Nünning sees as typical of turning-point narratives.¹³ The interest of the present essay is thus in the dialectics of reversion that are at work when a narrative of presumed control over nature is suddenly ‘breached’¹⁴ and replaced by an emergent state of “out-of-controllness,” to adopt the term Nigel Clark uses in an essay on “panic ecology.”¹⁵

In order to shed more light on the emergence of ‘out-of-controllness’ in natural systems, I will later revisit Michael Crichton’s popular novel *Jurassic Park* (1990) as a classic literary fiction which presents an emergency situation in an ecosystem as the result of the fictional characters’ inability to comprehend emergence. The novel not only lends itself well to the overarching interest of this essay because of the inclusion of ideas from chaos theory — a scientific paradigm which has strongly contributed to the study of emergence in natural systems since the 1970s.¹⁶ It also presents genetic engineering as “the culmination of the modern drive to master the natural world.”¹⁷ In fact, the wish to control nature with the help of state-of-the-art technology is so omnipresent in *Jurassic Park* that Søren Brier posits the novel as a classic text engaging with the paradigm of ‘cybernetics’ in his article on the discipline for the *Routledge Companion to Literature and Science*. Understanding cybernetics as “a theory of control of the behavior of machines, organisms, and organizations by the way of feedback circuits,” Brier reads *Jurassic Park* as a text that “dramatize[s] the consequences of dispensing with cybernetic thinking in the effort to control complex non-linear systems by computers.”¹⁸ In staging the collapse of the park’s safety system, the novel issues a “powerful renouncement of the deterministic control paradigm” and contrasts this fantasy with the paradigm of chaos theory: “nature is non-linear, fractal, and complex.”¹⁹ The interpretation of Crichton’s text advanced in this essay largely subscribes to this reading, but seeks to reframe the emergency situation in the park as the result of a conceptual failure in narrative imagining. This is because the park creators repeatedly fall back to the cognitive stance of what H. Porter Abbott (2008: 231) calls “the narrative of centralized control,” which prevents them from coming to terms with complexity and emergence. As a result, they also fail to take into account

the different agents in the emergence of life, which all impact the complex operations of the park's ecosystem on different levels of biological organization.

Before this argument can be developed in more detail, I will first clarify Abbott's concept of the 'narrative of centralized control' in section 2 and explain why this cognitive stance is in severe danger of misrepresenting the kind of emergent behavior that complex natural systems display. For that matter, I will draw on the work of narratologists who have emphasized the general incompatibility of narrative cognition and emergence, and discuss some features of both narrative and complex systems that account for the tension between their distinct logics. The analysis of Crichton's literary text in section 3 of this essay will then argue for the epistemic value of creative fictional narratives in mediating knowledge about emergence and complexity. While my reading of the novel is not entirely uncritical when it comes to aspects of form (especially with regard to its coherent ending), *Jurassic Park* will be presented as a 'thought experiment' that employs some innovative literary means to simulate the emergent emergency constituted by the collapse of the park's control system.²⁰ As will be shown, these devices include the use of 'metafictional metanarration' as well as the multimodal integration of semiotic resources other than verbal language, which are used not least to invite critical reflection about the limits of narrative in representing emergent developments. Finally, in section 4, the understanding of 'life' as a fundamentally emergent phenomenon, which Crichton's novel implies, will concisely be summarized.

2_Resisting the 'Narrative of Centralized Control': On the Problem of Understanding Emergence

The study of the nexus between narrative and emergence can itself be regarded as an emergent topic in the study of culture, as is documented by the groundbreaking essays by H. Porter Abbott and Richard Walsh.²¹ Narratology has acquired a central role in research on emergence because narrative is frequently looked at as the human default way of making sense of change in the world. Thus, it is commonly assumed that we possess "a genetic predisposition to grasp events in time through story form" (Abbott 2008: 230) and that narrative is "our principal way of understanding our experience of reality by articulating patterns in time" (Walsh 2011: 84). However, what Abbott's and Walsh's work stresses is that human beings encounter considerable cognitive difficulties in comprehending emergence because humans display a "propensity for

narrative misrepresentation of complex phenomena” (ibid.: 75). This section therefore wants to explore some of the reasons for the restrictions of narrative cognition (also: ‘narrative thinking’) in understanding complex living systems and the emergent behaviors these systems bring forth. To this end, I will argue that narrative sense-making and complex systems are characterized by distinct kinds of agency (or ways of conceptualizing agency).

My basic understanding of narrative, to begin with, follows David Herman’s “intentionalist approach to narrative understanding,” as put forward in his recent study on *Storytelling and the Sciences of Mind*.²² According to Herman, narrative is a cognitive tool that facilitates “reasoning about one’s own and others’ reasons for acting” and is therefore particularly suitable for conceptualizing intentional action.²³ It is already in his earlier work on *Story Logic* that Herman calls upon narratologists to recognize “the interconnectedness of the very notions of *narrative* and *action*.”²⁴ According to Herman, human attempts to make sense of actions are barely distinguishable from the construction of an explanatory narrative: “Action theorists themselves have compared analyzing actions with telling narratives about what agents have done. [...] Stories, in other words, rely implicitly on the same conceptual systems that action theorists strive to make explicit through philosophical argumentation.”²⁵ A position repeatedly cited by Herman in this context is that of the philosopher Georg Henrik von Wright: “To understand behavior as intentional [...] is to fit it into a ‘story’ about an agent.”²⁶ According to this view, it makes sense to distinguish the domain of ‘action’ (and narrative) from the more general domain of ‘behavior’: actions are always goal-oriented and intentional — a feature that cannot be attributed to emergent behavior, as we shall presently see.²⁷ A central feature of narrative that can be derived from this brief sketch, then, is that “human narratives [...] almost inevitably begin to suggest teleologies, purposes, and ends,” as Patricia Waugh concisely puts it.²⁸ This position is also consistent with the theories of ‘plot’ advanced by thinkers like Frank Kermode, Peter Brooks and Paul Ricœur, who have all suggested that narratives transform mere successions of events into a meaningful totality that is striving for an end-point.²⁹

The way in which narratives transform ‘mere behavior’ into ‘intentional action’ is incompatible with the kind of agency that complex systems display. The problem is not that there are no agents in such systems — quite the reverse: In fact, one can ar-

gue that one major reason for our human difficulties in understanding the behavior of complex systems is “a massive distribution of cause among agents, [...] each of which lacks any preeminent role in the emergent behavior of which it is a part” (Abbott 2008: 233). In order to describe the phenomenon of emergence in complex living systems more accurately, it is generally helpful to differentiate between two distinct analytical levels: In such systems, emergent behavior arises on a *superordinate level*, whereas the interactions between the numerous agents mentioned above take place on a more basic level, i. e. the *level of the system* itself (cf. Walsh 2011: 77). The agents on the systemic micro-level can, but need not be, intentional beings; it generally suffices to assume that they all follow fairly simple rules, which might even be genetically prescribed. However, the complex behavior exhibited by the system on the higher (or ‘macro’) level is not simply describable as the sum of its parts. On the contrary, it “require[s] description at a level of organization above that which provides the base-level description of the system itself” (ibid.: 73). The micro-level, on the other hand, operates completely independently of the macro level (cf. Abbott 2003: 147). While it plays an undeniable part in the production of emergent behavior on the macro-level, it is important to stress that the actors on the micro-level do not have the creation of such behavior *as a goal*. The phenomenon of emergence as such, the gradual realization or ‘coming into being’ of the complex behavior on the macro-level, is located between the two levels. As the following diagram — loosely adapted from Abbott (2008: 235) — illustrates, complex systems can be thought of as “bottom-up systems,” which “get their smarts from below.”³⁰

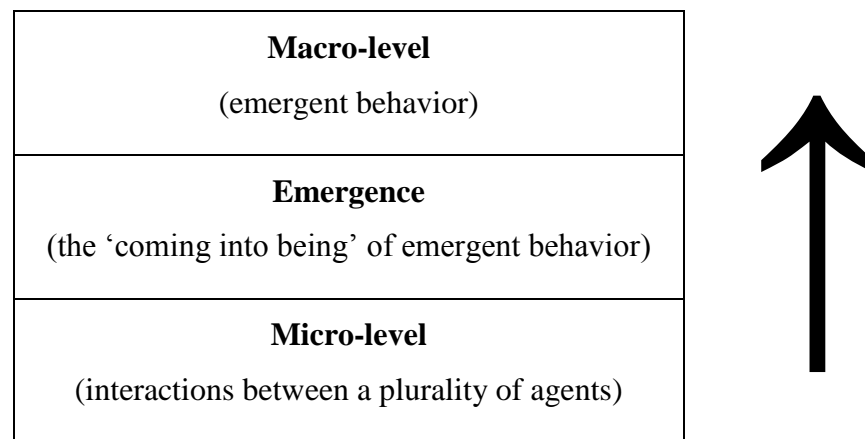


Fig. 1: Emergence as bottom-up phenomenon

Both Abbott and Walsh have convincingly argued in their works on narrative and complexity that both the micro- and the macro-level pose specific challenges to narrative imagining, also rendering description a difficult task:³¹ The first problem with the macro-level of emergent behavior is that there actually *is no* agency driving the process. Agents are located on the micro level of the system, not on the higher level brought forth by the system. Strictly speaking, then, the emergent behavior that we observe in the “game of Life” simulations discussed by Walsh (2011: 75) only persists as a “pattern in time”; it is not guided by an intentional entity with a clear-cut, ontological status. Secondly, we encounter difficulties in describing the level of the system itself because of the “multiple simultaneous recursive operations” (ibid.) that take place on this level. While narrative thinking is well suited to understanding chains of successive actions and events, in this case all the actions that simultaneously unfold on the micro-level mutually impact one another and hence re-determine outcomes in everlasting feedback loops. The special difficulty of understanding (or ‘narrativizing’) emergence thus pertains to the fact that “emergent processes [...] occupy a narrative blank between the micro and macro levels” (Abbott 2008: 235). Whereas the micro-level encompasses such a multitude of agents that keeping track of their simultaneous behaviors becomes a cognitive impossibility, the macro-level displays coordinated behavior but does not actually constitute any discrete agency in the strict sense of the term.

Because of the incompatibility between narrative and complex systems as it has been outlined here, we may conclude that attempts to narrativize emergence run the risk of becoming “gross misrepresentation[s]” (Walsh 2011: 75) at the cost of a more

interactive and multi-layered picture of the phenomenon. Due to their specific way of conceptualizing agency, narrative accounts of complex processes tend to attribute intentionality to agents that, on closer inspection, resist this role (cf. *ibid.*). Abbott (2008: 231) has described our human temptation to narrativize complex behavior with his concept of “the narrative of centralized control,” defining the latter as “a distinct subclass of narrative” (*ibid.*) resting on the assumption “that collective behavior must be under the control of some guiding entity of an order distinct from the mass” (*ibid.*: 230).

That such narratives are in danger of misrepresenting the ways in which natural systems actually operate has also been pointed out by scientists. In an article on “The Force of the Pacemaker Concept in Theories of Aggregation in Cellular Slime Mold,” Evelyn Fox Keller, a feminist philosopher of science and trained biologist, reflects on her research on the behavior of a slime mold, called *Dictyostelium discoideum*, which she conducted in the late 1960s together with her colleague Lee Segel.³² *Dictyostelium* has acquired a considerable degree of popularity in the study of emergence, and it has even been suggested that it “may someday be seen as an equivalent of the finches and tortoises that Darwin observed on the Galápagos Islands.”³³ The remarkable property of the slime mold is that it can act as either a single organism or as a swarm of “thousands of distinct single-celled units, each moving separately from its other comrades.”³⁴ The cells, all of which are fairly simple on their own, display a stunning degree of intelligence when behaving as an organism. It is precisely such behavior that secures the survival of the slime mold under hostile environmental circumstances, allowing *Dictyostelium* to find solutions to concrete threats of starvation. As a ‘complex adaptive system,’ the slime mold thus exhibits a kind of behavior that is emergent and self-organizing.

The case of *Dictyostelium* is instructive here because Keller reports in her essay how she and Segel initially came up with an incorrect explanation to the question of what triggers the aggregation of the single cells. At first, the biologists assumed the existence of one special cell — a ‘founder’ or ‘pacemaker cell’ — which they held to be in charge of the coordination of the swarm as a whole. In spite of convincing evidence against the concept, the pacemaker view was embraced with enthusiasm by the scientific community, as Keller recalls in her essay: “The assumption of pacemaker cells was felt to be so natural, it so readily explained the phenomena, that the question

I had begun with simply disappeared.”³⁵ The pacemaker idea turned out to be an extremely resilient one in the scientific community, a “fait accompli,” but in fact it was altogether wrong. In particular, it failed to take into account the “more complex internal dynamics of the individual cells.”³⁶ Keller therefore sends out a cautionary message in the final paragraph of her text:

More generally, I am suggesting that we might learn from the pacemaker story to be wary of imposing causal relations on all systems that seem by their very nature to be more complexly interactive. [...] In our zealous desire for familiar models of explanation, we risk not noticing the discrepancies between our own predispositions and the range of possibilities inherent in natural phenomena. In short, we risk imposing on nature the very stories we like to hear.³⁷

With Abbott’s (2008) work on narrative and emergent behavior in mind, one might reframe Keller’s words as a warning against premature applications of the ‘narrative of centralized control’ in the explanation of natural systems. More recently, N. Katherine Hayles has articulated a message similarly cautionary in tone:

The same faculty that makes us aware of ourselves as selves partially blinds us to the complexity of the biological, social, and technological systems in which we are embedded, tending to make us think we are the most important actors [...]. As we are discovering, from climate change to ocean acidification to greenhouse effects, this is far from the case.³⁸

Within the “faculty” that Hayles is talking about here — human consciousness — narrative thinking plays a pivotal role. However, as this section has attempted to show, this way of making sense of the world is also restricted in grasping the complexity inherent in natural systems, several of which Hayles alludes to.

In concluding this section, it seems important to underline once again that narrative thinking is conceived of in this essay as a fundamental interpretative strategy on the part of human observers. As such, it must be distinguished from the semiotic artifacts that we conventionally refer to as ‘novels,’ ‘short stories,’ ‘films,’ ‘graphic novels,’ or simply as ‘fiction.’³⁹ The crucial epistemic value fiction can adopt is that it can function “as the exercise of our narrative understanding, as distinct from its application,” as Walsh has submitted in his study on *The Rhetoric of Fictionality*.⁴⁰ By conceptualizing it as a form of cognitive ‘exercise,’ Walsh argues that fiction is able to “extend the scope of our narrative understanding, not least by appealing to quite different ways of making sense” than are suggested by the causal and intentionalist logic of narrative action.⁴¹ I fully agree with this assertion but would like to add that one central reason why fictions are able to engage with the faculty of narrative think-

ing self-reflexively is that they are themselves never ‘thoroughly narrative.’⁴² Instead, literature usually incorporates a wide range of symbolic forms that may invite mental operations other than narrative cognition. It is the task of interpretation, then, to shed light on the highly versatile ways in which literary fictions configure their elements into (more or less linear) plots, thus either encouraging narrative thinking or foregrounding its restrictions. What one is concerned with, in any case, is the analytical level that structuralist narratologists like Genette, Chatman and others have called the ‘discourse’ of a given fictional artifact. The epistemic potential of literary fictions in advancing understanding of emergence and complexity will come under scrutiny in the following section, in which I turn to Michael Crichton’s *Jurassic Park*. The text makes for an interesting discussion in the present context as it displays strong interest in the restrictions human beings face in understanding emergent behaviors in complex natural systems — even if we will see that the critique of narrative cognition issued in the novel is somewhat compromised as a result of its own form.

3_“Linearity is an artificial way of viewing the world”: Revisiting Michael Crichton’s *Jurassic Park* (1990)

Since the fiction of *Jurassic Park* is a highly popular one (not least because of its adaptation into a Hollywood blockbuster movie by Steven Spielberg in 1993), a brief introduction of the novel’s plot should suffice to provide the necessary context for the following argument. The story is set in an ecosystem that the ‘International Genetic Technologies (InGen)’ corporation has established under the guidance of CEO John Hammond in the form of a theme park on an island off the coast of Costa Rica. The so-called ‘Jurassic Park’ is spectacular, as it features real dinosaurs rather than animatronics. To recreate the extinct animals, InGen’s scientists have extracted paleo-DNA from the blood of insects fossilized in amber. The genetic information is restored with the help of computerized sequencers; gaps in the genetic code are closed by using supplementary amphibian, reptilian or avian DNA. Apart from the complex computer system and the electrified fences, it is also part of Jurassic Park’s safety system that all dinosaurs are created as sterile females so that the geneticists are (supposedly, as it turns out) the only agents who can control the animals’ reproduction. After some disconcerting events, Hammond must put his Japanese investors at ease in order to open Jurassic Park on schedule. The team of scientific experts that is to review the park includes the mathematician Ian Malcolm. Based on his knowledge of chaos theory,

Malcolm warns that the park's safety system will collapse unpredictably — not *in spite of* but *because of* its complex design, which not only includes “the dinosaurs in their complex ecosystem” but also “the humans with their individual investments.”⁴³ Malcolm, whose intellectual role in Crichton's original novel is much more pronounced than in Spielberg's film, is proven right: Jurassic Park's safety system increasingly reveals itself as flawed on many levels, which jeopardizes the lives of the human characters on the island. In particular, it turns out that the dinosaurs have begun to breed — in spite of their genetically controlled design. After the total human loss of control over Jurassic Park, the events on the island go fully awry and several people die in the process. While the few lucky survivors who have managed to contact the mainland are waiting for a ship, Hammond is finally punished for his hubris: Having fallen down a hill, he is attacked and eaten by a pack of *Procompsognathids* or ‘compies,’ the small dinosaurs that were the first to reproduce in Jurassic Park.

This short plot summary could almost fully suffice to point at the issue some commentators on the *Jurassic Park* fictions have taken with Crichton's novel and, even more pointedly, with Spielberg's film: For a text that is fundamentally concerned not only with emergence but also with the restrictions of narrative thinking, the overall form of Crichton's sci-fi techno-thriller, and especially the development of its plot in the second half, is surprisingly linear. The novel's ending, in particular, is in danger of re-inscribing a teleological trajectory of poetic justice into its plot structure, which does not sit too well with the awareness of emergent developments in complex systems that the text otherwise seeks to advance. The late evolutionary biologist Stephen Jay Gould, who liked Crichton's book, was among the first reviewers to give voice to this “theoretically fatal inconsistency” in its message:⁴⁴ Apart from the punishment the morally flawed characters suffer for their actions, the fact that all of the likeable protagonists happily prevail against all odds is surprising given that “not a human soul in the park should have stood a chance of proceeding harmless through such a sequence.”⁴⁵ Nevertheless, even if it shies away from executing the apocalyptic vision it projects, the fictional text develops epistemic potential to the extent that it manages to invite meta-cognitive reflections about the limits of narrative cognition in comprehending emergence on the part of the reader. The concerns *Jurassic Park* expresses with regard to ideologies of centralized control, which it frames as both a

cognitive and an ethical problem, are worth considering in the context of this essay's more general interest in the ethical consequences of cognitive failure.

Above all, it is Malcolm's chaos theory that not only serves as a framework for theorizing emergence on the story level but also as a permanent critique of 'linear' thinking and control fantasies. Chaos theory has contributed to the study of emergence because of its interest in self-organizing systems, in which states of disorder can spontaneously turn into structures of order and vice versa. As Hayles explains: "At the center of chaos theory is the discovery that hidden within the unpredictability of chaotic systems are deep structures of order. 'Chaos,' in this usage, denotes not true randomness but the orderly disorder characteristic of these systems."⁴⁶ In line with what was pointed out about emergence in section 2, chaotic systems do not rely on centralized agents to bring about spontaneous changes. On the contrary, it is the complex interaction between a multitude of agents that marks such systems as "rich in information,"⁴⁷ but also as unpredictable and fundamentally recursive.⁴⁸ The significance of non-linear recursion also manifests itself in the interest chaos theorists display in self-similar patterns — so-called 'fractals' — in nature. With the rise of chaos theory, as Ira Livingston explains, "[e]verything had become *fractal* — that is, patterned at multiple scales — and *self-similar*, with patterns recurring at every scale, like a feather, each arm of which is shaped like a miniature feather in turn."⁴⁹

Such fractals are also featured in Crichton's novel, where they appear in the form of seven 'iterations' that are interspersed in the narrative discourse.⁵⁰ The iterations reveal a fractal curve, drawn and commented upon by Malcolm, which serves to illustrate the principle of emergence. The fractal begins with an initial structure in the first iteration, in which "*few clues to the underlying mathematical structure will be seen*" (JP: 9), moving to the fourth iteration, in which "*underlying instabilities begin to appear*" (JP: 179), and then to the sixth iteration, at which stage "[s]ystem recovery may prove impossible" (JP: 315). The steady revealing of the 'big picture' underlines the shift from the seemingly random behavior of the curve on the micro-level to the stunning emergence of ordered patterns on the macro-level. By the seventh iteration, "*the mathematics will demand the courage to face its implications.*" (JP: 365) As a result of their strategic interspersal, the iterations document the loss of control over the park in a more abstract form and remind the reader again and again of the omnipresence of recursive operations in complex systems. InGen's efforts to regain power

over Jurassic Park are likewise turned into a repetitive principle, insofar as they are narrated in a series of chapters entitled “Control.” In narrative terms, then, Crichton juxtaposes InGen’s ‘control narrative’ with the emergent properties of complex ecosystems, which follow their own rules. This second narrative — if it can be called such, given its lack of discrete agents — is latent in the text: Instead of being explicitly told, the ‘narrative of emergence’ is only implied by the fractals as well as the mathematical graphs and diagrams in the novel, all of which contradict InGen’s control narrative by showing that the dinosaurs have long begun to breed.

As *Jurassic Park* thus integrates semiotic resources other than verbal language, the text can be classified as a “multimodal novel” — a novel that “incorporates and represents a wide range of verbal and non-verbal signifying practices as well as narrative and non-narrative modes and ways of world-making.”⁵¹ One important function Hallet ascribes to this type of novel is the integration of non-verbal modes that can be utilized to “bear witness to the shortcomings of verbal language and narration.”⁵² Following up on my initial thesis about the incompatibility of narrative and emergence, one could argue that emergence is among the phenomena that “can hardly be conceived of as, or translated into, verbal information.”⁵³ It therefore calls for a mode of representation other than verbal language. This is the case with the seven iterations in *Jurassic Park*, which clearly privilege the mode of showing over telling and, in so doing, contribute to the production of ‘tacit knowledge’ about emergence on the part of the reader.⁵⁴

Multimodality is not the only device employed by the novel to represent emergence, or to call attention to the restrictions of narrative and language in this endeavor. There are also several reflections about chaos theory, which are interspersed in various parts of the narrative in the form of dialogues between characters (cf. *JP*: 245–248, 283–285, 305–307, 311–314, 367–369). A particularly interesting case is the introduction to ‘chaotics’ Malcolm gives the paleontologist Grant (cf. *JP*: 170–171). After a short explanation of the concept of fractals and their omnipresent place in nature, Malcolm sets out to strike a blow against the Western belief in linear progress, which marginalizes “sudden change as something that happens outside the normal order of things” (*JP*: 171). His reflection can be read as a critique of narrative thinking insofar as narrative *is* what facilitates linear reasoning: “[C]haos theory teaches us”, the mathematician goes on,

that straight linearity, which we have come to take for granted in everything from physics to fiction, simply does not exist. Linearity is an artificial way of viewing the world. Real life isn't a series of interconnected events occurring one after another like beads strung on a necklace. Life is actually a series of encounters in which one event may change those that follow in a wholly unpredictable, even devastating way. [...] That's a deep truth about the structure of our universe. But, for some reason, we insist on behaving as if it were not true. (JP: 171)

This passage is both 'metanarrative' and 'metafictional' in its effect: Its critical potential lies in the fact that it raises awareness of the limits of linear (narrative) reasoning in understanding life as the complex emergent phenomenon that it actually is.⁵⁵ It becomes clear in the further course of the novel that Malcolm's critique of linearity is leveled at two 500-year-old "Western attitudes" (JP: 312) in particular: the master narratives of scientific progress and control. As the chaos theorist puts it in a later passage: "Ever since Newton and Descartes, science has explicitly offered us the vision of total control. Science has claimed the power to eventually control everything, through its understanding of natural laws" (JP: 313). However, cracks in the manner in which modern science conceives of its own activities have become apparent after the logical problems raised by Heisenberg's uncertainty principle and Godel's theorem (cf. JP: 313) at the beginning of the twentieth century, "[a]nd now chaos theory proves that unpredictability is built into our daily lives" (JP: 313). As a result, Malcolm concludes, "the grand vision of science, hundreds of years old — the dream of total control — has died, in our century" (JP: 313).

Needless to say, Malcolm's rants are directed, first and foremost, at InGen's all too naive fantasy of being able to control the complex ecosystem they have erected on the Costa Rican island. One may certainly find that the novel is too polemic or Manichaean in how it posits the 'good' paradigm of chaos theory against the 'bad' science of genetic engineering, which ultimately brings chaos theory paradoxically close to playing the role of a master narrative in its own right.⁵⁶ However, as a fictional thought experiment, *Jurassic Park* is interesting because of the way in which it stages InGen's loss of control over the park as an emergent emergency, dismantling the corporation's 'narrative of centralized control.' But what exactly is the narrative to which the InGen geneticists and Hammond fall victim?

On the plot level, one of the major emergent emergencies is the discovery that the dinosaurs breed — despite the fact that they were genetically created as sterile females. Since this spontaneous development was unpredictable from the point of view

of the scientists, an explanation can only be given long after it has occurred. It is finally offered by the paleontologist Grant, who assumes that a “[g]ender transition” (*JP*: 375) must have enabled the animals to reproduce. To recapitulate, the Jurassic Park scientists used “supplemental DNA sequences of anachronistic species,”⁵⁷ particularly avian, reptilian and amphibian DNA, to make complete strands out of the fragmentary DNA they had extracted from the dinosaur blood preserved in amber (cf. *JP*: 168, 210). Grant’s explanatory hypothesis, now, is that the gender switch must have occurred as a result of the use of the DNA of West African frogs:

[A] number of plants and animals were known to have the ability to change their sex during life — orchids, some fish and shrimp, and now frogs. Frogs that had been observed to lay eggs were able to change, over a period of months, into complete males. They first adopted the fighting stance of males, they developed the mating whistle of males, they stimulated the hormones and grew the gonads of males, and eventually they successfully mated with females. (*JP*: 375)

This explanation has intriguing implications for the conceptualization of life in the novel and reveals severe shortcomings in InGen’s agenda. Crichton’s fictional bioengineers obviously subscribe to an understanding of life that Sarah Franklin has described with the following formula: “nature becomes biology becomes genetics, through which life itself becomes reprogrammable information.”⁵⁸ This definition of ‘life as information,’ which emerged in the mid-twentieth century (not least in the context of early cybernetics), entails a significant transformation: The shift from ‘nature’ to ‘reprogrammable information’ is also one “from observation to experimentation, that is, from representation to intervention to, most significantly, control.”⁵⁹ And yet, in their attempt to control life, bioengineers are confronted with a dilemma, insofar as “genetic engineering works both with and against the telos of DNA,” as Stephanie Turner astutely remarks.⁶⁰ This means that, while trying to modify genetic information, scientists paradoxically also rely on the chemical agency of DNA to build organisms — and this very agency, the fact that “the DNA molecule is self-authoring and therefore not completely accessible to the scientific gaze,” is obviously underestimated by InGen’s geneticists.⁶¹ To the extent that they reproduce or ‘copy’ their information, the genes of the Jurassic Park dinosaurs do appear ‘selfish,’ to use the metaphor from the title of Richard Dawkins’ popular scientific book *The Selfish Gene* — a highly gene-centric account of evolution by natural selection.⁶² The paradigm that is re-invoked in *Jurassic Park*, then, is the view of “the DNA molecule as

autotelic, that is, as an entity working toward its own self-contained end.”⁶³ The dinosaurs’ genomes are, in this sense, among the non-human agents in Jurassic Park’s ecosystem that ‘outwit’ the human actors and thus bring about the very turning point typical of emergent emergencies by breaching InGen’s control narrative.

However, we would not be dealing with an emergent phenomenon if a mono-causal explanation of the emergency situation in the park, with the dinosaurs’ genes featuring as the only relevant agents, were to suffice.⁶⁴ In fact, Grant’s above-cited hypothesis about the animals’ reproduction already suggests that superordinate levels of biological organization cannot simply be dispensed with. Hence, whereas it is safe to say that the frog DNA enables the “transsexual switch,”⁶⁵ the agent that changes from ‘female’ to ‘male’ and subsequently begins to reproduce with other (female) dinosaurs in the park is the organism as a whole. The animals’ transitioning is a truly emergent behavior, as Grant further explains that “the change is stimulated by an environment in which all the animals are of the same sex. In that situation, some of the amphibians will spontaneously begin to change sex from female to male” (*JP*: 375). This explanation accounts for the phenomenon in question, at least in a sense, but it poses challenges to narrative cognition: There is obvious change without intentional action. While the way in which our language works suggests that the animals are able to change their sex at will, this observable behavior is actually a result of an agency that is much more distributed, arising from interactions between genes, organisms and environments. The basis of the sex change is genetic, but the switching-on of the respective gene is caused by an environment made up of a plurality of actors none of which can meaningfully be assumed to orchestrate the ‘demographic’ change taking place in the animal population.

InGen’s failure thus lies in a category mistake in the understanding of life: In their obsession with recreating life by means of genetic engineering, they seem to have overlooked that a living organism cannot be controlled at the level of the genome and that its emergent (sexual) behavior is more than the sum of its parts. Since reproduction is a feature of living entities, one cannot wish to “make an animal and not expect it to act *alive*” (*JP*: 284), as Malcolm puts it. Consequently, Walsh (2011: 75) stresses that “genes, organisms, species, ecosystems, and the whole of natural history” are actually all “emergent phenomena,” caught up in highly recursive loops that foreclose the possibility of discrete agencies. The problem, again, is that “[n]arrative accounts

of evolutionary processes attribute agency to one or other of these phenomena and so inevitably traduce the way the laws of natural selection operate” (ibid.). InGen’s ‘agent narrative,’⁶⁶ which reduces life to the micro-level of genes and DNA, is therefore too short-sighted in the way in which it suggests controllability of a complex ecosystem. As Sabine Sielke puts it: “By projecting a sense of life as a spontaneous force which resists codification *Jurassic Park* actually undoes the paradoxical notion of DNA as both code-script and self-possessed agent.”⁶⁷ In the final section of this essay, I will try to assess the “sense of life” Crichton’s novel projects by deducing some general conclusions about ecological understandings of life from my reading of the text.

4_Ecological Understandings of Life as Emergent Phenomenon

Because of the critique of gene-centric definitions of life that Crichton’s novel issues, *Jurassic Park* ultimately provokes the question of what kind of agent life is. By approaching this question from an ‘ecological’ vantage point, broadly speaking, I mean to reconnect it to my initial interest in “the limits of our narrativizing intelligence” (Abbott 2008: 241) when confronted with the cognitive challenge of comprehending emergence. Put simply, the difficulty of understanding the agency of life is that we are dealing with a phenomenon that paradoxically resists the idea of discrete agents. The problem with gene-centric accounts of life is that they reduce its complexity by re-introducing genes or DNA as centralized agents, which are then regarded as the stuff of ‘life itself.’⁶⁸ In her sketch of “(posthuman) environmental ethics,”⁶⁹ Stacy Alaimo has problematized the shortcomings of such “genetic fetishism.” Her critique concludes that “the presumption that humans can master the genetic code leads us to ignore multiple material agencies and the unpredictable transformations that these living forces will effect.”⁷⁰ Moreover, “the overemphasis on genes places ‘the environment’ — the entire material fabric of life, in other words — in the distant background where it plays little, if any, role.”⁷¹

According to my reading of the text, *Jurassic Park* is continuous with this critique. As an emergent phenomenon, life manifests itself on various levels in Crichton’s novel. These comprise the level of the gene (most notably in the form of the frog DNA), the organism (the reproducing dinosaurs, the human genetic engineers) and the ecosystem as a whole (represented, for instance, by Malcolm’s drawings of the

fractal curve and the self-similar patterns they gradually reveal). The novel is therefore also in line with “the idea of defining life as an emergent property of particular kinds of complex systems,” as discussed by Bruce Weber in his entry on “Life” for the *Stanford Encyclopedia of Philosophy*.⁷² Assuming that “self-organizational phenomena pervade biology,” Weber specifies that “[s]uch phenomena are seen not only in cells and organisms, but in ecosystems,” which calls for “a broader systems perspective” in the study of life.⁷³ What Alaimo’s ecological and Weber’s systems approach to life have in common is that they consider the idea that life is reducible to a simple ‘agent narrative’ at the level of the gene as insufficient.

A further feature Malcolm’s chaos theory shares with ecological understandings of life is the suspicion it casts upon the idea that human beings could ever control life. Thus, when Malcom argues that “[o]ur planet is four and a half billion years old” (*JP*: 367), that “[t]here has been life on this planet for nearly that long” (*JP*: 367), and that, therefore, “life on earth can take care of itself” (*JP*: 369), one feels reminded of the title of an essay by the late evolutionary biologist Lynn Margulis: “Gaia is a Tough Bitch!”⁷⁴ Accordingly, what Malcom stresses is that the history of life on Earth is littered with turning points, and that the only agent that has prevailed through all the crises and catastrophes of extinction suffered by individual species is ‘life itself.’ This view also entails the thought formulated at the beginning of this essay that the agency of life reveals itself in the very moment that human actors believe to have mastered it (e. g., by means of genetic engineering). In Malcolm’s words: “[T]he history of evolution is that life escapes all barriers. Life breaks free. Life expands to new territories. Painfully, perhaps even dangerously. But life finds a way” (*JP*: 159). I believe that what follows from this insight is that human beings can still engage in genetic engineering for all sorts of different (and good) reasons, but they had better abandon those language games that suggest mastery over an elusive agent that constantly redefines the preconditions for its own existence.

In more general terms, it should finally be emphasized that the understanding of ‘ecology’ that has been advanced in this essay subscribes to a broad definition of the term. In his paper “Pathologies of Epistemology,” which is part of his monumental *Steps to an Ecology of Mind*, Gregory Bateson has clarified what a broad understanding of ecology entails: “Ecology, in the widest sense, turns out to be the study of the interaction and survival of ideas and programs (i. e., differences, complexes of differ-

ences, etc.) in circuits.”⁷⁵ The important point made in this definition is that ecology includes “ideas and programs,” which is why cultural studies must partake in ecological questions, such as the problem of ‘emergence/emergency’ probed in this issue. The argument put forward in this essay — that emergent emergencies often reveal themselves as ethical consequences of cognitive failure — therefore also corroborates a statement Bateson makes at the end of his text: “I believe that [the] massive aggregation of threats to man and his ecological systems arises out of errors in our habits of thought at deep and partly unconscious levels.”⁷⁶ In line with this assumption, I have argued that “threats” or emergencies in complex systems can result from “epistemological errors.”⁷⁷ The particular errors focused upon in this essay are the misunderstanding of emergence through misplaced ‘narratives of centralized control’ and reductionist conceptualizations of life, as exemplified by the “popular sense of the gene as an isolated, controlling, and controllable entity.”⁷⁸ Bateson’s statement that “[t]here is an ecology of bad ideas, just as there is an ecology of weeds,”⁷⁹ therefore points at an inherent connection between epistemological and ethical facets: It reminds us that any attempt to conceptualize the world is already a form of ‘acting’ in the world.⁸⁰ Because of the significance this insight attributes to our “cultural ways of worldmaking,”⁸¹ we may finally conclude that the weeding out of bad ideas to prevent emergencies is also a task for scholars in the study of culture.

Endnotes

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- ¹ In parts of this article, I draw on individual sections from my forthcoming book, *Narrating Evolution: Agency, Narrative Thinking, and the Epistemic Value of Contemporary English and American Novels* (Trier: WVT, 2016). An earlier sketch of my thoughts on the incompatibility of narrative and emergence can also be found in my article on “Understanding Biological Form(ation)s of Life: Incommensurabilities of Life and Human Observation” in E. O. Wilson’s *Anthill: A Novel*, in *Emergent Forms of Life in Anglophone Literature: Conceptual Frameworks and Critical Analyses* (Trier: WVT, 2015), 295–312. In addition to the two anonymous reviewers, I am also grateful to Daniel Hartley for having made valuable comments on an earlier version of this essay.
 - ² Bruce Clarke, “Systems Theory,” in *The Routledge Companion to Literature and Science*, eds. Bruce Clarke and Manuela Rossini (London/New York: Routledge, 2011), 214–225, here: 220.
 - ³ Clarke, “Systems Theory” (cf. note 2), 220.
 - ⁴ H. Porter Abbott, “Narrative and Emergent Behavior,” in *Poetics Today* 29.2 (2008), 227–244, here: 228 (hereafter abbreviated as ‘Abbott 2008’).
 - ⁵ Clarke, “Systems Theory” (cf. note 2), 214.

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- ⁶ Abbott (2008: 228) explains that the study of emergence “includes among many other things the behavior of ant trails, the stock market, the immune system, termite mounds, traffic, mobs, hurricanes, landslides, flocks of birds, schools of fish, the growth of cities, the neurology of thought, the construction of beehives, and the movement of slime mold.” See also Steven Johnson, *Emergence: The Connected Lives of Ants, Brains, Cities and Software* (London/New York: Penguin Books, 2001).
- ⁷ Stacy Alaimo, “Ecology,” in *The Routledge Companion to Literature and Science*, eds. Bruce Clarke and Manuela Rossini (London/New York: Routledge, 2011), 100–111, here: 104.
- ⁸ Cf. Alaimo, “Ecology” (cf. note 7), 109.
- ⁹ Cf. Bruce Clarke, “‘The Anthropocene,’ or, Gaia Shrugs,” in *Journal of Contemporary Archeology* 1.1 (2014), 101–104.
- ¹⁰ Paul Crutzen, “Geology of Mankind,” in *Nature* 415.3 (2002), 23.
- ¹¹ Lauren Greyson, *Vital Reenchantments: Biophilia, Gaia, Cosmos and the Affectively Ecological* (Justus Liebig University, Giessen, unpublished dissertation, 2015), here: 144. For a similar assessment of the situation of the human in the Anthropocene, see also Bruno Latour, “Agency at the Time of the Anthropocene,” in *New Literary History* 45.1 (2014), 1–18, here: 5: “The traces of our action are visible everywhere! And not in the older way that the Male Western Subject dominated the wild and savage world of nature through His courageous, violent, sometimes hubristic dream of control. No, this time we encounter, just as in the old prescientific and nonmodern myths, an agent which gains its name of ‘subject’ because he or she might be *subjected* to the vagaries, bad humor, emotions, reactions, and even revenge of another agent, who also gains its quality of ‘subject’ because it is also *subjected* to his or her action.”
- ¹² Greyson, *Vital Reenchantments* (cf. note 11), 195–196.
- ¹³ Ansgar Nünning, “‘With the Benefit of Hindsight’: Features and Functions of Turning Points as a Narratological Concept and as a Way of Self-Making,” in *Turning Points: Concepts and Narratives of Change in Literature and Other Media*, eds. Ansgar Nünning and Kai Marcel Sicks (Berlin/New York: de Gruyter, 2012), 31–58, here: 33.
- ¹⁴ Cf. Jerome Bruner, “The Narrative Construction of Reality,” in *Critical Inquiry* 18.1 (1991), 1–21, here: 11–13.
- ¹⁵ Nigel Clark, “Panic Ecology: Nature in the Age of Superconductivity,” in *Theory, Culture & Society* 14.1 (1997), 77–96, here: 88. By ‘panic ecology,’ Clark (*ibid.*: 92) means the idea of “nature being deliberately driven to the verge of a nervous breakthrough,” holding that “the ‘natural’ catastrophe is both our greatest fear and our greatest desire” (*ibid.*: 93). According to Clark, the secret excitement of natural catastrophes lies in the fact that they promise otherwise unattainable knowledge about the workings of complex ecosystems, even if that knowledge can only be acquired a posteriori, i. e. at a point when a catastrophe may have brought about disastrous consequences.
- ¹⁶ Overviews of chaos theory are provided by N. Katherine Hayles, “Introduction: Complex Dynamics in Literature and Science,” in *Chaos and Order: Complex Dynamics in Literature and Science*, ed. N. Katherine Hayles (Chicago: The University of Chicago Press, 1991), 1–33, and Ira Livingston, “Chaos and Complexity Theory,” in *The Routledge Companion to Literature and Science*, eds. Bruce Clarke and Manuela Rossini (London/New York: Routledge, 2011), 41–50.
- ¹⁷ Clark, “Panic Ecology” (cf. note 15), 77.
- ¹⁸ Søren Brier, “Cybernetics,” in *The Routledge Companion to Literature and Science*, eds. Bruce Clarke and Manuela Rossini (London/New York: Routledge, 2011), 89–99, here: 89, 96.

- ¹⁹ Brier, “Cybernetics” (cf. note 18), 96.
- ²⁰ On thought experiments in fiction, see Katherine Z. Elgin, “The Laboratory of the Mind,” in *A Sense of the World: Essays on Fiction, Narrative, and Knowledge*, eds. John Gibson, Wolfgang Huemer, and Luca Poggi (New York: Routledge, 2007), 43–54, and Ansgar Nünning and Michael Basseler, “Literary Studies as a Form of ‘Life Science’: The Knowledge of Literature,” in *New Theories, Models and Methods in Literary and Cultural Studies*, eds. Great Olson and Ansgar Nünning (Trier: WVT, 2013), 189–212.
- ²¹ Apart from Abbott (2008), see also H. Porter Abbott, “Unnarratable Knowledge: The Difficulty of Understanding Evolution by Natural Selection,” in *Narrative Theory and the Cognitive Sciences*, ed. David Herman (Stanford, CA: CSLI Publications, 2003), 143–162 (hereafter abbreviated as ‘Abbott 2003’), and Richard Walsh, “Emergent Narrative in Interactive Media,” in *Narrative* 19.1 (2011), 72–85 (hereafter abbreviated as ‘Walsh 2011’). Walsh is also a key figure at the ‘Narrative and Complex Systems (NarCS)’ group based at York University, which began its work in 2012. For further information, see <<http://www.york.ac.uk/narrative-studies/research-themes/complex-systems>>, accessed January 7, 2016.
- ²² David Herman, *Storytelling and the Sciences of Mind* (Cambridge, MA: MIT Press, 2013), 16. It is important to stress that my present concern is not with literary fiction but rather with the mental human faculty I refer to as ‘narrative thinking’ or ‘narrative cognition.’
- ²³ Herman, *Storytelling and the Sciences of Mind* (cf. note 22), 236.
- ²⁴ David Herman, *Story Logic: Problems and Possibilities of Narrative* (Lincoln: University of Nebraska Press, 2002), 73.
- ²⁵ Herman, *Story Logic* (cf. note 24), 55.
- ²⁶ Georg Henrik von Wright, *Practical Reason: Philosophical Papers*. Volume I (Ithaca, NY: Cornell University Press, 1983), 42. See Herman, *Story Logic* (cf. note 24), 55, 72.
- ²⁷ For an understanding of action as goal-oriented behavior, see also Paul Ricœur, *Time and Narrative*. Vol. 1 (Chicago: The University of Chicago Press, 1984), here: 55: “Actions imply goals, the anticipation of which is not confused with some foreseen or predicted result, but which commit the one on whom the action depends. Actions, moreover, refer to motives, which explain why someone does or did something, in a way that we clearly distinguish from the way one physical event leads to another. Actions also have agents, who do and can do things which are taken as *their* work, or *their* deed. As a result these agents can be held responsible for certain consequences of their actions. [...] To identify an agent and to recognize this agent’s motives are complementary operations.”
- ²⁸ Patricia Waugh, “Just-so Stories? Science, Narrative, and Postmodern Intertextualities,” in *Symbolism: An International Annual of Critical Aesthetics* 5 (2005), 223–263, here: 255.
- ²⁹ Cf. Frank Kermode, *The Sense of an Ending: Studies in the Theory of Fiction* (Oxford: OUP, 1967), Peter Brooks, *Reading for the Plot: Design and Intention in Narrative* (Cambridge, MA/London: Harvard University Press, 1992 [1984]), and Ricœur, *Time and Narrative* (cf. note 27).
- ³⁰ Johnson, *Emergence* (cf. note 6), 18.
- ³¹ Abbott’s (2003, 2008) prime example of an emergent phenomenon is evolution by natural selection, in which ‘species’ have an emergent status. Walsh (2011) discusses computer simulations — especially the cellular automaton known as the “game of Life,” created by the British mathematician John Horton Conway in 1970 — as an example of rule-based systems that produce emergent behavior.

- 32 Cf. Evelyn Fox Keller, “The Force of the Pacemaker Concept in Theories of Aggregation in Cellular Slime Mold,” in *Reflections on Gender and Science*. 10th Anniversary Edition (New Haven: Yale University Press, 1995 [1985]), 150–157.
- 33 Johnson, *Emergence* (cf. note 6), 12.
- 34 Johnson, *Emergence* (cf. note 6), 13.
- 35 Keller, “The Force of the Pacemaker Concept” (cf. note 32), 153.
- 36 Keller, “The Force of the Pacemaker Concept” (cf. note 32), 155.
- 37 Keller, “The Force of the Pacemaker Concept” (cf. note 32), 157.
- 38 N. Katherine Hayles, “Cognition Everywhere: The Rise of the Cognitive Nonconscious and the Costs of Consciousness,” in *New Literary History* 45.2 (2014), 199–220, here: 204–205.
- 39 The importance of this terminological differentiation has long been recognized by narratologists. In Walsh’s words, the distinction to be made is between narrative as “the *object* of interpretation” and narrative as “a *means* of interpretation.” Cf. Richard Walsh, *The Rhetoric of Fictionality: Narrative Theory and the Idea of Fiction* (Columbus: The Ohio State University Press, 2007), here: 105. Herman has proposed similar conceptual differentiations, for example in his *Storytelling and the Sciences of Mind* (cf. note 22).
- 40 Walsh, *The Rhetoric of Fictionality* (cf. note 39), 50.
- 41 Walsh, *The Rhetoric of Fictionality* (cf. note 39), 51.
- 42 This idea acquires further plausibility if one recalls that the more radical postmodernist experiments with narrative form have sometimes been thought of as ‘anti-novels.’
- 43 Sabine Sielke, “Science into Narrative, or: Novelties of a Cultural Nature,” in *Literatur, Wissenschaft, Wissen seit der Epochenschwelle um 1800*, eds. Thomas Klinkert and Monika Neuhofer (Berlin/New York: de Gruyter, 2008), 355–377, here: 362.
- 44 Stephen Jay Gould, “Dinomania,” accessed March 15, 2016, <<http://www.nybooks.com/articles/1993/08/12/dinomania>>. For a similar critique of *Jurassic Park*’s fairly linear plot, see also Sielke, “Science into Narrative” (cf. note 43).
- 45 Gould, “Dinomania” (cf. note 44).
- 46 Hayles, “Introduction: Complex Dynamics in Literature and Science” (cf. note 16), 1.
- 47 Hayles, “Introduction: Complex Dynamics in Literature and Science” (cf. note 16), 6.
- 48 Livingston (cf. note 16, here: 45) defines ‘recursion’ as “the product of a process being fed back into the process again” in his sketch of chaos and complexity theory.
- 49 Livingston, “Chaos and Complexity Theory” (cf. note 16), 41.
- 50 Cf. Michael Crichton, *Jurassic Park* (New York: Ballantine Books, 1990), here: 9, 29, 81, 179, 269, 315, 365 (hereafter abbreviated as ‘JP’).
- 51 Wolfgang Hallet, “The Multimodal Novel: The Integration of Modes and Media in Novelistic Narration,” in *Narratology in the Age of Interdisciplinary Narrative Research*, eds. Sandra Heinen and Roy Sommer (Berlin/New York: de Gruyter, 2009), 129–153, here: 149.
- 52 Hallet, “The Multimodal Novel” (cf. note 51), 147.
- 53 Ibid. (cf. note 51).
- 54 The notion of ‘tacit knowledge’ goes back to Michael Polanyi, who first developed it in his book *Personal Knowledge: Towards a Post-Critical Philosophy* (London: Routledge and Kegan Paul, 1962 [1958]). Stephan Freißmann takes up the concept in his study on *Fictions of Cognition: Rep-*

resenting (Un)Consciousness and Cognitive Science in Contemporary English and American Fiction (Trier: WVT, 2011), stressing the non-verbal nature of tacit knowledge. According to Freißmann (ibid.: 31), “[t]acit knowledge denotes a kind of knowledge that does not become conscious and remains unacknowledged in everyday reasoning processes, but which is nevertheless there.” This type of knowledge is also ‘procedural’ (cf. ibid.), as it cannot simply be translated into ‘that’-knowledge. One could argue that the way in which Malcolm’s fractal curve is gradually revealed in the course of the novel is procedural in precisely this sense.

⁵⁵ While ‘metanarration’ and ‘metafiction’ are sometimes used synonymously, I follow Birgit Neumann and Ansgar Nünning’s (2014) proposal to distinguish between the two concepts. This makes sense because, as Nünning (2004) has convincingly argued, metanarrative passages need not necessarily be metafictional or ‘anti-illusionistic,’ but can also support the production of an aesthetic illusion on the part of the reader. In the present case, however, Malcolm’s critique of linearity is explicitly directed at “fiction,” such that the passage as a whole is best understood as an example of ‘metafiction’ or ‘metafictional metanarration.’ Cf. Ansgar Nünning, “Towards a Definition, a Typology and an Outline of the Functions of Metanarrative Commentary,” in *The Dynamics of Narrative Form: Studies in Anglo-American Narratology*, ed. John Pier (Berlin/New York: de Gruyter, 2004), 11–57, and Birgit Neumann and Ansgar Nünning, “Metanarration and Metafiction,” in *Handbook of Narratology*, eds. Peter Hühn et al. 2nd ed. 2 vols. (Berlin/New York: de Gruyter, 2014 [2009]), 344–352.

⁵⁶ Cf. Sielke, “Science into Narrative” (cf. note 43), 365.

⁵⁷ Stephanie S. Turner, “Jurassic Park Technology in the Bioinformatics Economy: How Cloning Narratives Negotiate the Telos of DNA,” in *American Literature* 74.4 (2002), 887–909, here: 891.

⁵⁸ Sarah Franklin, “Life Itself: Global Nature, Global Culture,” in *Global Nature, Global Culture*, eds. Sarah Franklin, Celia Lury, and Jackie Stacey (London: Sage, 2000), 188–222, here: 190.

⁵⁹ Turner, “Jurassic Park Technology” (cf. note 57), 889.

⁶⁰ Ibid. (cf. note 57).

⁶¹ Turner, “Jurassic Park Technology” (cf. note 57), 898. Readers who are familiar with Spielberg’s first *Jurassic Park* film (1993) may recall the “Mr. DNA” sequence, which visitors of the park are shown as part of the guided tour. Mr. DNA explains that he (DNA) is the building block of life and, in this sense, a powerful agent. At the same time, though, his ‘cuteness’ and the fact that he features as the narrator of InGen’s self-flattering narrative imply that his agency is controlled by the Jurassic Park scientists. Being part of InGen’s agenda, the film sequence clearly suggests that genetic engineering works *with* the ‘telos of DNA’ — an assumption subsequently undermined by the events on the island.

⁶² Richard Dawkins, *The Selfish Gene*. 30th Anniversary edition (Oxford: OUP, 2006 [1989; 1976]).

⁶³ Turner, “Jurassic Park Technology” (cf. note 57), 888.

⁶⁴ This is a general problem that gene-centric accounts of evolution by natural selection are confronted with. For an insightful account of the ways in which theories of evolution have to mediate between different ‘agent narratives,’ see Debra Journet, “George C. Williams, Kenneth Burke, and ‘The Goal of the Fox’: Or, Genes, Organisms, and the Agents of Natural Selection,” in *Narrative* 19.2 (2011), 216–228.

⁶⁵ Clark, “Panic Ecology” (cf. note 15), 77.

⁶⁶ Cf. Journet, “George C. Williams, Kenneth Burke, and ‘The Goal of the Fox’” (cf. note 64), 218.

⁶⁷ Sielke, “Science into Narrative” (cf. note 43), 363.

- ⁶⁸ I use the concept of ‘life itself’ in Sarah Franklin’s sense (cf. note 58). Franklin (ibid.: 193) points out with reference to Michel Foucault’s archeology of knowledge that ‘life itself’ was basically a meaningless signifier “[u]ntil the advent of modern biology” in the course of the nineteenth and twentieth centuries. The relevant passage from Foucault’s *The Order of Things* reads: “Historians want to write histories of biology in the eighteenth century; but they do not realize that biology did not exist then, and that the pattern of knowledge that has been familiar to us for a hundred and fifty years is not valid for a previous period. And that, if biology was unknown, there was a very simple reason for it: that life itself did not exist. All that existed was living beings, which were viewed through a grid of knowledge constituted by natural history.” (Foucault 1970, qtd. in Franklin 2000: 193)
- ⁶⁹ Cf. Stacy Alaimo, *Bodily Natures: Science, Environment, and the Material Self* (Bloomington/Indianapolis: Indiana University Press, 2010), esp. 141–158.
- ⁷⁰ Alaimo, *Bodily Natures* (cf. note 69), 150.
- ⁷¹ Ibid. (cf. note 69).
- ⁷² Cf. Bruce H. Weber, “Life,” in *The Stanford Encyclopedia of Philosophy* (Spring 2015 Edition), ed. Edward N. Zalta, accessed January 7, 2016, <<http://plato.stanford.edu/archives/spr2015/entries/life>>.
- ⁷³ Weber, “Life” (cf. note 72).
- ⁷⁴ Lynn Margulis, “Gaia is a Tough Bitch,” accessed January 7, 2016, <<http://edge.org/conversation/lynn-margulis1938-2011>>. A detailed discussion of the ‘Gaia hypothesis,’ which the scientist James Lovelock first proposed in the 1970s and which he subsequently co-developed with Margulis, is beyond the scope of the present essay. My general impression, however, is that Malcolm’s intellectual position (cf. *JP*: 367–369) exhibits some striking similarities to Margulis’ view of life on Earth. Margulis was also always highly critical of gene-centric accounts of evolution. See also Clarke, “‘The Anthropocene,’ or, Gaia Shrugs” (cf. note 9).
- ⁷⁵ Gregory Bateson, “Pathologies of Epistemology,” in *Steps to an Ecology of Mind: Collected Essays in Anthropology, Psychiatry, Evolution, and Epistemology* (Northvale, NJ/London: Jason Aronson, 1987 [1972]), 484–493, here: 489.
- ⁷⁶ Bateson, “Pathologies of Epistemology” (cf. note 75), 493. Similar to Malcolm’s rants against Western thought, Bateson, too, finds that “[m]uch of Oriental philosophy is more sane than anything the West has produced” (ibid.).
- ⁷⁷ Bateson, “Pathologies of Epistemology” (cf. note 75), 484.
- ⁷⁸ Alaimo, *Bodily Natures* (cf. note 68), 147.
- ⁷⁹ Bateson, “Pathologies of Epistemology” (cf. note 75), 489.
- ⁸⁰ This also brings to mind Maturana and Varela’s dictum about the close connection between ‘cognizing’ and ‘acting’: “*All doing is knowing, and all knowing is doing.*” Cf. Humberto Maturana and Francisco J. Varela, *The Tree of Knowledge: The Biological Roots of Human Understanding* (Boston, MA: Shambhala Publications, 1998 [1987]), 26.
- ⁸¹ For “cultural ways of worldmaking,” see the contributions in Vera Nünning, Ansgar Nünning, and Birgit Neumann, *Cultural Ways of Worldmaking: Media and Narratives* (Berlin/New York: de Gruyter, 2010).