ABSTRACT

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This dissertation investigates literary responses to environmental change in nineteenth-century England. Two tropes, chaos in narrative and the microcosm in lyric poetry, suggest how literary works may have been precursors of ecological science. I argue that literary epistemology in the long nineteenth-century developed precocious theories of the way nature operates based on contingent narrative and microcosm systems. These ideas were adopted as empirical strategies once scientific ecology emerged in the twentieth-century, and both tropes are prominent in twenty-first century ecological science. Ecology appeared late among scientific disciplines partly because it relies on cooperation between reduction and holism: climate change theory, for example, uses microcosm models to develop narratives of environmental contingency. Five chapters consider these two tropes from historical, literary, and scientific perspectives. The first chapter is a historical introduction to nineteenth-century science that traces the development of environmental awareness from

industrial pollution and early studies of nature in microcosm, especially in the work of Charles Darwin and Stephen Forbes. Chapter two investigates four narratives of environmental chaos spanning the long nineteenth-century: Gilbert White, Mary Shelley, Richard Jefferies and H.G. Wells emplot the radical new notion of a post-apocalypse environment in narratives that rely on chaotic discontinuity, rather than the coherent gradualism that marked evolutionary theories of the time. Chapter three examines microcosmic imagery in the work of several important poets, including William and Dorothy Wordsworth, John Clare, Percy Shelley, and Matthew Arnold. I argue that the imagination and close observation of nineteenth-century poets helped the nascent sciences conceive of ways to simplify nature without dismembering its complex structures. Chapter four, devoted to the ecological thinking of John Keats, traces his abandonment of teleological narrative in *Hyperion* in preference for the microcosmic Odes. Finally, chapter five reconciles the two tropes with an excursion into modern ecosystem science, paying particular attention to our contemporary strategies for investigating climate change. This chapter serves as a summation of the dissertation by complicating the dichotomy between chaotic narrative and model-microcosm, and it brings the study into concerns of the present day.

CHAOS AND THE MICROCOSM:
LITERARY ECOLOGY IN THE NINETEENTH-CENTURY

By

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Dedication

To Colleen, who never tires of mixing disciplines over breakfast.

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Table of Contents

Dedication ii
Acknowledgements iii
Table of Contents iv
Chapter One: History and Theory of a Post-Classical Environment 1
I: General Introduction 1
II: The Critical Terrain 15
III: “Dehistoricized” Humankind 22
IV: Chaotic Industrial Skies 36
V: Early Ecological Microcosms 49
Chapter Two: Chaotic Dynamics in Four Ecological Narratives 64
I: Introduction 64
II: The Natural History of Selborne 76
III: The Last Man 91
IV: After London, or, Wild England 101
V: The Time Machine 119
Chapter Three: Lyrical Microcosms of the Nineteenth-Century 132
I: Introduction 132
II: The Medical Microcosm 139
III: The Psychological Microcosm 147
IV: The Ecological Microcosm 161
Chapter Four: Keats’s Ecological Visions: A Tropology 185
I: Introduction 185
II: The Early Poems 194
III: Narrative Chaos in Hyperion 199
IV: Microcosmic Odes 211
V: Frayed Epics and Reconciliations 226
Chapter 5: Models and Narratives in the Ecological Sciences 233
I: Introduction 233
II: Empirical Microcosms 236
III: Science Non-Fiction 250
IV: Ecological Futures 265
Epilogue 270
Bibliography 273

Chapter One: History and Theory of a Post-Classical Environment

I: General Introduction

It is summer 1855. Down on the street level of a fictional London, the Stink has settled. Effluvia of industry drains into a black-snaking Thames, smoke rises from stacks to collude with the fog. The stinging smog wafts in sheets between tarnished buildings, and Londoners of all classes cross paths in confused alarms compelling each to her own scheme of urban exodus. A particularly cruel, freakish summer has grown to maturity: the rains are absent and cholera skulks in the lacunae of medical knowledge. Parliament's only redress of the Stink is to force the closure of myriad factories in the bowl of greater London, but those extreme measures will only prevent a thicker accumulation of foul air; for true relief, London needs its rains back.

Today, the Prime Minister Lord Byron is dead, and the hegemony of his political party, the Industrial Radicals, hangs in the balance. His successor Charles Babbage is contending with an obscure revolutionary force headed by the enigmatic Captain Swing of the neo-Luddites. Byron's daughter Ada Lovelace, Queen of Engines and mathematical genius, has contrived with a savant named Mallory to conceal the skeleton key to computation, a stack of machine code cards, in the skull of a Brontosaurus in London's museum of Practical Geology. 4,000 miles to the west, Professor Coleridge and Reverend Wordsworth are settled in pantisocratic peace, having spent long philosophical lives in Pennsylvania, just north of the Confederate States of America. The radical atheist Percy Shelley is living his final

years of imprisonment at the side of Napoleon Bonaparte on the isolated island world of St Helena, a few pixels of tropical green in the mid-Atlantic ocean.

I have just summarized an alternative "steam punk" history of the nineteenth-century, rendered from the imaginations of two prominent twentieth-century science fiction writers, William Gibson and Bruce Sterling. The Difference Engine (1991) needs to throw only a few historical switches to realize its dystopian vision of hyper-industrial England: the first generation of Romantics pursues its youthful ideals in the New World, the second generation is spared the fevers and drowning that curtailed their creative genius, and Babbage's Mechanical Notation presented to the Royal Society in 1826 actually results in public dissemination of the Analytical Engine and its industrial offspring. Ada Lovelace, the world's first computer programmer, shares credit for Babbage's epiphany, and is treated as England's first lady even as her conscience stings from the environmental defects of industrial Britain, and her gambling addiction fed by the number machines.

The fictional hero Edward Mallory, paleontologist, explorer, fellow of the Royal Society and foe to the philistine neo-Luddites, acts as a centering piece to this spin on history. He is an avatar of geological catastrophism, and has developed a radical new theory on the Cretaceous extinctions that carried off the dinosaurs, or "Land Leviathans": a massive comet impacted Earth 65 million years ago, and set global ecology on a dusty, dark, polluted tailspin for decades, and perhaps hundreds or thousands of years. In scientific history, this is the Alvarez Impact hypothesis formulated in 1980. Mallory's wanderings through the streets of alternate-1855 London evince a theory of applied catastrophism that links human industrial activity

with a chaotic chain of environmental events in the modern day. He muses, mid-wheeze, about how things fall apart:

> These Londoners were like a gas, thought Mallory, like a cloud of minute atomies. The bonds of society broken, they had simply flown apart, like the perfectly elastic gassy spheres in Boyle's Laws of Physics…they were merely reckless, now, stripped by Chaos to a moral vacuity. Most of them, Mallory thought, had never seen any event remotely like this one. They had no proper standards left for judgment or comparison. They had become puppets of a base impulse…the good men of civilized London had surrendered themselves to primitive madness. (243)

Environmental chaos has swept away all of the government's rational contingency planning, and the social niceties of the world's premier industrial power have fallen prey to an apotheosis of instinct. Chaos, though, was a concept for which the precocious Mallory had already developed a modern understanding. From the fifteenth-century until the middle of the twentieth-century in etymology, *chaos* generally denoted a formless, volumeless void of primordial matter that defined elemental disorder, a mythological trope. God's work in Genesis was to organize chaos into the coherent world; Satan sought to manage chaos to his advantage in *Paradise Lost*, as did the fallen Saturn in Keats's *Hyperion*.

Mallory's chaos, however, derives from advanced mathematical modeling, which the scientific world came to conceptualize on a larger scale in the 1960s. Its earliest origins are found in the billiard ball experiments of Jacques Hadamard, from 1898. Scientific chaos denotes the behavior of a deterministic system that appears to behave randomly because of its extreme sensitivity to initial parameters. The system spontaneously organizes as a result of these initial conditions, and its non-linear behavior provides models for the possible behavior of complex, hierarchical systems in the real world: cosmic oscillation in the solar system, biological population

dynamics, and patterns in climatology. Mallory's anachronistic understanding of chaos holds a characteristically nineteenth-century debt to the imagination:

> There are tumults of the mind, when, like the great convulsions of Nature, all seems anarchy and returning chaos; yet often, in those moments of vast disturbance, as in the strife of Nature itself, some new principle of order, or some new impulse of conduct, develops itself, and controls, and regulates, and brings to an harmonious consequence, passions and elements which seem only to threaten despair and subversion. (192)

Eventually, Mallory observes the spontaneous order that will lift the London miasma and return rule to its streets; that organization depends, in true Victorian style, on the patriotic pith of the people: "they had rallied in instinctive defense of their scientific institutions and the civil values of law and property…the lurching madness of Chaos had reached its limit. Within the faltering maelstrom, a nucleation of spontaneous order had arisen!" (258). As fits a fictionalized historical drama, the weather catalyzes the initial chaos in the streets, but then complies with the social control imposed by ruling powers: as Mallory assassinates the revolutionary Captain Swing, the blessed rains return to wash down a beleaguered city. The nineteenth-century rides down its industrial rails, and Mallory is given the additional kudos of authoring the theory of Continental Drift, which in reality gained the status of paradigm only in the 1960s, after decades of debate on Alfred Wegener's introduction of the idea in 1912. Gibson and Sterling's novel abbreviates industrial history by a full century: London's "Great Smog" was to occur in the winter of 1952, and it killed 4,000 people in 4 days (though a "Great Stink" resulting from the unwitting disposal of organic sewage occurred in summer 1858). The types of 'order' that result from such chaotic environmental events are often legislative: the Clean Air Act of 1956 was a direct

redress of the calamity, and the Great Smog is viewed as one crucial stimulant of the environmental movement in the twentieth-century.

We need not fictionalize the literary history of the nineteenth-century in order to recognize patterns of narrative chaos, and emergent tropes of control, in the writing of environmentally-minded philosophers of that new industrial age. This study will read the works of Gilbert White, Mary Shelley, John Keats, Richard Jefferies, H.G. Wells, and several lyric poets as they grapple with new ways to conceptualize nature, especially the anthropogenic nature of the new industrial age. My century-long survey of writing (from 1789 with Gilbert White to 1895 with H.G. Wells) is selected to trace the evolution of literary thought about natural systems during industry's initial advances; all the writers I discuss have innovative ways of imagining natural organization and contingency. In this post-Classical era of the nineteenth-century, moments of ecological disaster, such as earthquakes and volcanoes, aligned with a growing consensus that human industrial activity was changing the atmosphere in industrial hotspots. These epistemological junctions serve as a rationale and a foundation for this study of literary responses to environmental change in nineteenth-century England.

My study is organized around two tropes: *chaos*, which involves the disruption of traditional narratives and the rise of a surprising new order, and the *microcosm*, which provides a coherent, simplified model system that is used to comprehend the dynamics of less tenable, larger systems. Both figures of thought have been adopted as empirical tools in contemporary ecological science, and they lend contrasting epistemological routes towards addressing climate change. This

milestone in human history, the point at which anthropogenic emissions are actively reorganizing global systems, exemplifies how scientific theory can be untenable without cooperation between models, in the microcosmic vein, and chaotic narratives of the future, both utopian and dystopian. My suggestion is that the aesthetic roots of ecological insight, the seed of imagination that anticipated scientists' studies of discreet parcels in nature as isolated worlds at the empirical level, was sown by literary intellects of the nineteenth-century who consciously drew spheres around their perceptions in order to make sense of spots of time, moments of place, amid the incoherent larger world.

Chaos theory has come to occupy a central role in the many sciences devoted to predicting the future affect of global climate change. Prediction, or modeling, most often takes the form of complex computer simulations using many variables; a complementary form of narrative modeling emerges from fiction writers using their expertise to plot out plights of future generations in the twenty-first century and thereafter. The intellectual aim of these contrasting epistemologies is to imagine, quantify, and qualify future courses, to calculate the new threats to society and the environment posed by industrial surprises such as global climate change. We might legitimately expect that literary works become environmental only insofar as the science of the time is publicly elucidating an ecological problem. But the phenomenon of a dynamic and degraded environment sunk its roots into human consciousness early in the Industrial Revolution, and literature was at the vanguard of imagining uncanny worlds of ecological malaise.

As I read literary texts as works of ecological chaos, I do not mean to claim that they achieve anything as formal or specific as the mathematical chaos discovered in the 1960s. The vogue of chaos theory as a new way to read patterns in many disciplines from the fine arts to literature to law has resulted in some grumpiness from mathematicians who would like to sequester chaos theory within their own discipline.[1] I am using the chaos trope as a metaphor for how writers began to imagine their natural surroundings during the industrial shifts of the nineteenth-century. There are intriguing moments when writers anticipate ecological concepts that have been formalized under mathematical chaos theory, such as population dynamics and meteorology, but in general my use of the chaos trope indicates an author's vision of the natural world that falls between perfect order and utter randomness. In arguing for the power of metaphor in the creation of meaning, I take the "interaction" view espoused by Max Black (1962) wherein metaphors have a cognitive function that is distinct from any literal comparison between two material entities: tenor and vehicle are systems set in tension with one another, and their mutual influence is the engine that generates meaning.[2]

[1] Stephen Kellert's Borrowed Knowledge (2008) provides a balanced survey of the non-scientific applications of chaos theory by focusing on its recent use in literary theory, legal theory, and economics. Kellert discerns among legitimate and illegitimate uses of formal mathematical chaos in these fields, and discusses the ways in which metaphorical chaos is an alternative approach to analyzing processes with enigmatic patterns. In effect, chaos as a metaphor allows for a third vision of emergent structure that was invisible in the classic dichotomy between order and disorder: "the restructuring produces three terms instead of two, bringing a new conceptual organization to an existing field" (116). This third option can be understood using rhetorical theory as a kind of "flanking move on an antithesis" (Kellert 116, quoting Fahnestock 1999, 89).

[2] Kellert quotes Max Black and his discussion of interaction metaphor is enlightening. It is the view he takes for his survey of the chaos trope as an alternative to more negative views of metaphor such as dismissive (any metaphor is deceiving) and comparative (metaphor can be replaced by literal equivalence) (104-120).

Literary critics have not sufficiently investigated the roots of ecological science in the writing of the nineteenth-century. This might be explained by the fact that the science of ecology was not formalized until early in the twentieth-century, and so true interdisciplinary relationships only become explicit after 1900. But the environmental apocalypse narrative, originally borne on early nineteenth-century geological insights of chaotic upheaval in deep time can be seen as a metaphorical predecessor to scientific chaos. Nineteenth-century advances in biology stimulated imaginative interest in the natural complexity of living things of very modest proportions, and the microcosmic worldview brings the aesthetics of minutiae into a theoretical proposition about congruent scales in nature. The philosophy of studying a parcel of nature as its own self-regulating system, coherent within its bounds, is a premise that permitted biology to expand beyond its initial mainstays of taxonomy, dissecting and cataloging, towards a distinct science of ecology.[3] This concentration on the *oikos* or dwelling place, a scientific inquiry into natural systems that requires cooperation between reductionism and holism, established a formal place in ecological science over the course of the twentieth-century. The denotation of microcosm evolved away from purely metaphysical ideas towards a theory of scalar relations in the natural world, and my contention is that the literary imagination ushered this evolution over the course of the nineteenth-century. The chaotic narrative and the microcosm effectively organize disparate strands of environmental

[3] Later in this chapter I will survey the work of historian Richard Grove (1995), who shows how colonial islands held by England and France became incidental microcosm experiments during the eighteenth-century, but without any overt theorizing of the ecosystem-based dynamic of material and energy interrelation.

thinking in nineteenth-century literature, and bring the nascent ecological sciences into a clearer relationship with literary prophecy.

Both tropes have a philosophical legacy from the Ancients; these conventional images were adopted by writers again in the early Modern period, as I will show in chapters two and three. The environmental broil of the nineteenth-century worked a metamorphosis on quiescent convention, and writers wrought new secular figures out of the old, Theistic conceptions. From the archetypal elemental jumble of God's pre-creation, chaos evolved into a trope of simultaneous dissolution and the new synthesis that might grow into a higher level of organization. The microcosm was transformed from a little world of the body or brain, a philosophical construct that aligned the individual with his Creator, into a small-scale natural system that could be studied as a model of ecological organization. The tropes' nineteenth-century evolution, when viewed through a literary lens, will explore an imaginative debt that subsequent ecological science bears to nineteenth-century literary imagination.

At a surface level, the two tropes appear as aesthetic complements whose relationship is based on essential contrast, and to a certain extent they are. Revising one of Blake's proverbs: "the microcosm contains, chaos overflows." The microcosm is insulating, even isolating, and chaos breaks through perceived boundaries in unpredictable ways. Little worlds are self-sufficient, coherent and modest; chaotic systems engulf formerly-independent matter and energy to force rapid transformations. But once we kick a little deeper into the conceptual pool, we find strange currents that confuse and conjoin these tropes. Microcosms in ecology, as semi-closed systems, are always susceptible to major shifts if certain players gain

greater dominion. A shallow lake can shift from pellucid clarity to a phytoplankton-choked morass if that autotrope receives just a bit more sun, or a few more nitrogenous nutrients, than the average year. An aquarium will be overcome by algae when its detritivorous snail perishes. Delicate balances, while provisionally self-sustaining, are perilously close to dissolution; both balance and rapid degeneration are vying fates in microcosmic systems.[4] While we may not find aesthetic pleasure in the slimy aquarium or the weedy pool, an ecologist can show how this system has spontaneously evolved to a different scheme of self-organization, or alternative stable state, where a new complement of species has gained dominion over its organic and inorganic components.

On the other hand, chaotic dynamics provide a matrix of higher organization and eventual coherence based on minute, unpredictable variations in an initial system exhibiting particular parameters. I'll move to an entirely different realm of inquiry in order to display the prevalence of the quasi-chaotic dynamic: the socio-political phenomenon of industrialism.[5] Thomas Newcomen devised an "atmospheric engine" in 1712, which was the first practical application of mechanical steam technology. Humphrey Gainsborough and James Watt improved his design over the course of a

[4] Though many biochemical systems have buffering agents that help control for the wild disequilibria that might result from small variation, experimental microcosms, which can be clumsy by virtue of simplicity, are less likely to have the evolutionary adaptation of buffering.

[5] Ilya Prigogine (1984) uses an example of steam ships succeeding sailing ships over the course of the nineteenth century to demonstrate how new technologies sometimes *create* their own niches in economic ecology. This can have runaway environmental implications, as well: "Such innovations transform the environment in which they appear, and as they spread, they create the conditions necessary for their own multiplication, their 'niche'" (196). In close succession, Prigogine uses chaotic modeling to demonstrate how patterns of urbanization and rural depopulation are directed by "strong feedback and nonlinearities" (197). Chance factors, such as where a technology or resource is first employed, break the symmetry of a population distribution based purely on diffusion. "Enterprise" works like a force of gravity in population, and results in a set of positive (destabilizing) feedbacks: "the expansion of such enterprise depends on a demand that this expansion itself helps to create and for which it competes" (197).

few decades, and by the late eighteenth-century, steam engines established an indispensable economy of production, rapidly organizing the new industrial society along a new set of parameters: urban settlement, industrial work time, accelerated fuel consumption, revised class dynamics, mass transportation, and the modern conception of empire based on productiveness.[6] The initial conditions of the early eighteenth-century were disposed to allow these effects their subsequent evolution, but one small technological input proved the precedent of a massive ontological shift from agrarian to industrial life. London and Manchester of the nineteenth-century came to serve as models for myriad cities worldwide in the twentieth, and even twenty-first, centuries, and the models for studies of industrial ecology.

With such a progressive history, there is a danger in reading chaos narrative as teleological or inevitable; such is the bent of most heroic narrative histories of imperial and industrial Britain.[7] But this false telos involves inadequate factoring of the enabling initial conditions, what Keats lamented as "the van of circumstance" into which some pernicious seed is sown. A less celebratory account of chaotic dynamics could be (and has been) read in the epidemiology of measles through the ranks of urban populations, another offspring of industrial life.[8] Both tropes, then, participate

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[6] For an analysis of this socio-economic shift in relation to literature, see Raymond William's The Country and the City (1975).

[7] Jared Diamond effectively reorganized the conceptual terrain of anthropology by integrating the importance of initial environmental conditions with social evolution in his esteemed study Guns, Germs and Steel (1997). The three titular factors, he argues, were the organizing principles explaining why Western culture and technology dominated the imperial age rather than Eastern cultures, or various indigenous peoples. The book delivers a single-handed knockout punch to social Darwinism, which glorifies Western genius at the expense of 'under-developed' cultures.

[8] Alan Bewell's Romanticism and Colonial Disease (1999) is a comprehensive study of literary reactions to the threat of tropical invasion in the British imperial corpus. Though his book does not concentrate on urban epidemiology, he traces the active alteration of 'wet' ecosystems based on the

in one another's dynamics while retaining essential contrasts. And both tropes came, by the end of the nineteenth-century, to denote a quite different concept from their meanings only a century earlier; these ideas live at the epistemological center of modern ecology.

The narratives and poems selected for this study each demonstrate a specific way in which a returning trope can serve to organize the thoughts of a culture struggling with new phenomena. A literary trope is a returning theme or motif that helps not only to aid in the communication of ideas, but tropes have also frequently been identified as constitutive of experience.[9] Conceptually-crucial tropes of the imagination inform the development of inchoate sciences lacking foundations in theory, such as ecology of the nineteenth-century. I stop short of claiming an actual causal relationship between the evolution of literary tropes in the nineteenth-century and their subsequent adoption into scientific epistemology. However, I maintain that British culture, in order to develop a discourse around the natural world newly altered by industry, had first to create theoretical scenarios and frames of reference using the literary imaginary; these chaotic environmental narratives and microcosmic visions became tools shared by an intellectual culture developing reactions to the

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paranoia of miasmic conditions, and convincingly defends his thesis that "anxiety about disease is rampant in the period" (20).

[9] In Metaphor and Thought (1979), Andrew Ortony discusses the long philosophical tradition of theorizing tropes as necessary for our cognitive processes of learning and social understanding. Though "trope" originates from the Green "turn" or "twist," and Plato was skeptical about the value of poetic tropes in inquiries of philosophy and science, scholars including Quintilian, Ramus, and Vico have argued that tropes lie at the heart of our conceptualization of experience, and their ideas have been borne out by cognitive and linguistic studies through the twentieth century (252-3). Figures of thought including metaphor, synechdoche, and metonymy are so ingrained in our language because, Ortony argues, "human cognition is fundamentally shaped by various processes of figuration," and "our ability to conceptualize experience in figurative terms must also explain why nonliteral speech is normally understood so effortlessly" (253).

environment under industrialism.[10] The science of ecology is only the most recent method we have developed to examine nature.

The nineteenth-century is evolutionary theory's period of birth and adolescence. Lyell's geological gradualism, Malthus's economic analysis of population, and Darwin and Wallace's identification of natural selection revolutionized narratives of past and future change in the biological world. Historians of science and literary critics alike have feasted on the intellectual pabulum resulting from the public debates on ontological and religious qualms, and the aesthetics, bloody or blooming, of natural selection. Gillian Beer's respected study of narratives in evolutionary theory, Darwin's Plots (1983), clarifies the relationship between the qualities of a culture's discourse and the type of thought that can develop in such a context. She introduces her study with this crucial, epistemic notion: "'Darwin's plots' refers both to the narratives Darwin grew up amid and the narratives he created to change the face of cultural discussion…how Darwin said things was a crucial part of his struggle to think things, not a layer that can be skimmed off without loss" (xxiv-xxv). She identifies the two great nineteenth-century themes that the theory of evolution unites: growth and transformation (97). Where growth is akin to organicism, and is a scheme of inter-organization set in *space*, transformation is a concept of change set in *time* (101). My selection of two complementary tropes, microcosm and chaotic narrative, is congruent with this binary

[10] Richard Dawkins has gone so far as to label certain tropes as a kind of cultural genetics, or 'memes'; units of cultural currency that evolve and propagate through further communication and application – see his work The Selfish Gene (1976). While the tropes of chaos and the microcosm are probably too broad in circumference to qualify as Dawkins's cultural memes, they remain figures of thought that have evolved through many permutations of scientific and literary experiment.

of organicist growth and narrative transformation as central nineteenth-century ideas that both ushered in and were reinforced by evolutionary theory. My focus, however, will not lock in on evolutionary theory specifically; my interest lies in the foregrounding of scientific ecological methods by selected literary uses of the chaos and microcosm tropes.

The dissertation will progress through five chapters. This first chapter will serve as a historical introduction to conditions in the nineteenth-century, paying specific attention to the development of environmental awareness from industrial effect, and the beginnings of self-contained studies of nature in a systems-based epistemology. Chapter two investigates four narratives of chaotic environmental disruption spanning the long nineteenth-century, and develops an argument around specific ways that writers chose to emplot the radical new history of a human-altered environment. Chapter three moves into the manifold usefulness of microcosmic imagery in poetry, from the psyche to the circumscribed plot of land, and theorizes how the microcosm evolved from its metaphysical roots into an empirical strategy. Chapter four, devoted exclusively to Keats's brief poetic career, traces his abandonment of teleological narrative amid a new belief in the chance-driven world, and his final dwelling place the little worlds of the Odes. Finally, chapter five will aim to reconcile the two tropes with an excursion into modern ecosystem science, showing how narrative might be recuperated in empirical practice, how modeling systems remain a mainstay of prediction, and concluding with a discussion of strategies for investigating the climate change phenomenon.

II: The Critical Terrain

Literary criticism more often relies on the history of science in relation to literature than on affinities between the epistemologies of the sciences and humanities. The spirit of the "two cultures" worldview expounded by C.P. Snow in the middle of the twentieth-century still haunts us, but it is not the first exposition of essentialist exclusion. Romantic-era scientists like Humphrey Davy divided the imaginative poet from the deductive scientist in terms of disciplinary opposition, and Wordsworth acquiesced to this arrangement, dressing poets as social, diplomatic thinkers and scientists as isolated ascetics.[11] Davy wrote,

> Men of science, instead of worshipping idols existing in their own imaginations [as poets do], have examined with reverence and awe the substantial majesty of nature. Discovery has not visited them and disappeared again, like flashes of lightning amidst the darkness of night; but it has slowly and quietly advanced, as the mild luster of the morning promising a glorious day. (In Heringman 2003: 40)

Interdisciplinary intellects constantly attempt to break down these assumed inherent binaries between science and the humanities; surprisingly, these diplomats more frequently come from scientific disciplines. E.O. Wilson, whose Consilience aims toward the unity of knowledge by hierarchy, writes in a philosophical essay "On Art":

> Scientific innovation sometimes sounds like poetry, and I would claim that it is, at least in the earliest stages. The ideal scientist can be said to think like a poet, work like a clerk, and write like a journalist…the two vocations [science and poetry] draw from the same subconscious wellsprings and depend upon similar primal stories and images. (Cooke and Turner 1999: 76)

Wilson's description of the ideal scientist does not necessarily discount Davy's scheme of opposition, rather it involves and complicates their reciprocal relationship.

[11] For a comprehensive reading of this generally friendly rivalry, see Catherine Ross's chapter in Heringman's Romantic Science: Literary Forms of Natural History (2003).

The scientist who thinks like a poet is visited with lightning flashes of inspiration, which she can sustain through the many rounds of experimentation (like a clerk), and record clearly without embellishment (like a journalist). Wilson's identification of "similar primal stories and images" is well-noted, too: the common culture supporting ideas in all of the various professions is assuredly as important a unifier as disciplinary divisions are potential dividers.

Literary ecocriticism has a mission to foster interdisciplinary ties between science and literature. In the last twenty years ecocritical scholars have begun developing a body of scholarship dedicated to the analysis of literature in the context of modern science and the late industrial environment of the twenty-first century. This diachronic approach signals a shift from more familiar paths of literary historical studies, which consider writers in their own scientific or environmental milieu without much reference to subsequent thought. The beginning of mainstream environmentalism in the 1970s ushered in an imperative of reading nature-inspired literature with the valence of modern ecological philosophy, even when the literature in question was not overtly critical of industry's or capitalism's view of nature as pure resource (as it was with the Americans Muir, Emerson, Thoreau, Abbey). The ecocritical model is particularly adept at interpreting British Romantic naturalism as a set of ideas and concerns about the state of the early nineteenth-century environment, and ecocritics initially relied on a traditional pairing between the historical perspective and a good mind for literature.[12]

[12] Several of the best-known ecocriticism studies, important works in their own right, frame the conjunction of historical science and literary close readings within a particular theoretical school. Carolyn Merchant's Death of Nature (1980) became full-fledged with the feminist movement, Raymond Williams's The Country and the City (1975) is a Marxist critique of historical land-use

By taking the further step of integrating modern science into a reading of nineteenth-century texts, I hope to demonstrate that the tropes manifested at literary and cultural levels provide a foundation for subsequent empirical design concepts; it is not outlandish to claim that scientists' imaginations, as well as artists,' are stimulated and set into focus by tropes in their cultural economy. Beginning with the final decade of the twentieth-century, scientific chaos found a small place in literary studies.[13] Using the energy of a new public enthusiasm for the concept, scholars, most prominently Katherine Hayles (1991), carved out a narrative literary theory around the paradox of chaotic order. She admits the reciprocal influence of cultural and scientific moments, which form a philosophical feedback loop of information and new ideas. Part of the cultural receptivity to chaos was the condition of postmodernity, which literary deconstruction had outlined as an "emergent awareness of the constructive roles that disorder, nonlinearity, and noise play in complex systems" (5). Higher levels of understanding can emerge from disrupting linear narrative and identifying absences and omissions as new ways to organize complex thought. As such, chaos

> provides a new way to think about order, conceptualizing it not as a totalized condition but as the replication of symmetries that also allows for asymmetries and unpredictabilities. In this it is akin to poststructuralism,

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patterns, Jonathan Bate's Song of the Earth (2000) has an ethical thesis set in deep ecology ("earth for earth's sake," the touchstone of many subsequent studies and disciplinary outlines of the project of Green studies). Among the more diachronic studies, James McKusick's Green Writing (2000) is sensitive to Blake and Mary Shelley's awareness of industrial effect, which he briefly directs towards global warming ontology (109). His study integrates the thought of modern scientists like Stephen Jay Gould in its conclusive moments. Alex Argyros's A Blessed Rage for Order (1991) develops a critique of deconstruction using the new science of chaos, which is an approach that this dissertation takes example from, though my interest is not in deconstruction per se.

[13] Though there are a few studies of the microcosm in the history of philosophy, most notably Leonard Barkan's Nature's Work of Art (1975), I have uncovered no studies of the literary microcosm that consider its modern scientific parameters in a humanist context.

> where the structuralist penchant for replicating symmetries is modified by the postmodern turn toward fragmentation, rupture, and discontinuity…iteration and recursion are seen as ways to destabilize systems and make them yield unexpected conclusions…small causes can lead to large effects. (10-11)

The project of Hayles and her contributors in Chaos and Order was to identify the several ways in which this new form of the chaos trope informs our readings of coherence in the postmodern world. The trope belonged to both science and literature, and had evolved through a series of exchanges which eventually brought the insight that chaotic systems were "rich in information rather than poor in order" (6). The perceived poverty of order in a chaotic worldview was merely the myopia of reading into a narrative that it *ought* to be linear, coherent, and causal. Once this essentialist imperative was divested, the richness enabled by chaos theory emerged following a shift in the circumference of perspective. Postmodern narratives like Borges's "Garden of the Forking Paths" narrativize endless regressions and strange intersections, themselves new perspectives on the nature of time and place.

Turning chaos into a perspective on the environment involves seeing the beauty in contingent dynamics in nature, recognizing their ubiquity, and welcoming a third alternative between rigid order and wanton disorder. The nonlinear systems that help define chaos also identify minute motions and variations in the most quotidian of occurrences, such as wind gusts and water whorls. Hayles is careful to maintain that balance makes an idea like chaos particularly useful: chaos does not obviate order, it merely reorients our understanding of how order is wrought in the natural world by signaling the prevalence of slight variations. She invokes images of increasingly evident environmental problems brought into focus by the trope of chaos:

> Industrial pollutants are released into the atmosphere; along with carbon dioxide, also a by-product of technology, they create the greenhouse effect; the resulting climate changes wreak havoc with the global ecosystem. Cascading effects from initially small causes could, and have, been observed at any time. But whereas in earlier epochs they tended to be seen as anomalous or unusual, now they are recognized as paradigmatic of complex behavior. (15)

With this quasi-ethical perspective, it is surprising that none of the twelve essays in her volume display any concern with environmentalism in literature; the entries, most of which are limited to twentieth-century works, approach chaotic dynamics largely through established literary theory, especially deconstruction. Perhaps this omission is an emblem of the book's age (published in 1991); only in the intervening years has the evidence for global climate change become unassailable, both in scientific circles and in any reasonable public sphere. I believe a new moment for literary chaos has arrived. Within the continuum between its ancient and modern denotations, chaos holds a cache of insight to bring fresh perspective to nineteenth-century environmental narratives.

Chaos in science grew out of the theoretical advances in thermodynamics required to increase efficiency in industry. The best-known avatar of modern scientific chaos, Nobel Prize winner Ilya Prigogine (1984), dates the beginning of complexity in science with the work of nineteenth-century physicist Jean-Joseph Fourier, who also first theorized the greenhouse effect. Complexity analyzes the interaction among a large number of particles acting as a system, and requires a factoring of boundary conditions, the inside and outside of a liminal vision. Complexity posits the irreducible interdependency of parts of a hierarchical system, signaling emergent and self-organizing behaviors; it makes scientific chaos a

conceptual possibility. It is an epistemological offspring of industrialism, borne of the need to make industrial systems, like steam engines, more efficient. In 1811, Fourier presented to the French Academy of Sciences a mathematical description of the propagation of heat in solids (Prigogine 104). Fourier's ideas opened up a new idea of irreversible processes in nature, distinct from the Newtonian view of eternal cycles of regeneration and temporal reversibility. In Prigogine's important formulation, this advent of complexity represents the epistemological break between *being* and *becoming* (209).[14] Thermodynamics, the science of becoming, aims to predict how systems will react to outside inputs; it opposes the closed system of Newtonian mechanics, which circles around static, eternal forces such as gravity (106). The difference between an ideal cycle of thermal energy and the actual cycle, which progressively loses energy depending on the efficiency of the system, depended on the bracing new concept of entropy, nature's tendency to become less energetic, and more disorganized, through time.[15]

Humanists may appear too glib in applying these highly specified mathematical principles to literary epistemology. "Chaos" itself is a sensational term, and is at least half misnomer: the feature that distinguishes scientific chaos from mythological chaos is the spontaneous order that arises from the seemingly-random

[14] The evolutionary counterpart to the entropic "becoming" of thermodynamic systems is held in the idea of *natura naturans*, nature continually creating a new self out of the old. Beer identifies *natura naturans* as one of the myth-like Earth mother concepts that Darwin inherited from his precursors to counter the static notion of the created cosmos; conceptually it assisted his scheme of continual momentum under the scrutinizing watch of natural selection. Victorian poets Arthur Hugh Clough and Constance Naden would vary the theme playfully by introducing evolutionary erotics into the endless possibilities of 'becoming'; Clough's *Natura Naturans* is an evolutionary update to the Renaissance *carpe diem* theme.

[15] Entropy is the second law of thermodynamics, formalized in 1865. In poetry it has been invoked and paraphrased by Yeats in *The Second Coming*: "Things fall apart: the centre cannot hold; / Mere anarchy is loosed upon the world" (ll. 3-4).

behavior of the system. The word chaos, then, indicates how a system looks before an epistemology has arrived at the proper level of perspective to recognize its organizing principles and emergent patterns. While students of literature are rightly intrigued by the discourse of chaos, its paradoxes, strange attractors, and fractals, the willy-nilly application of mathematical chaos to any narrative or poem that behaves strangely might seem to cheapen interdisciplinarity.

However, literary scholars are under no obligation to play by scientific epistemology's rules in their analyses, and in fact a certain amount of cross-reading can have a freshening effect on a quantified, overly-rigid paradigm. Part of the present project is to recover two highly-formalized scientific tropes from their twenty-first century denotations towards their originary homes in interdisciplinary philosophy. Therefore, my use of *chaos* and *microcosm* throughout the analysis gestures to the evolution of a set of connotations associated with these concepts over the course of the nineteenth-century. From mythological chaos, the epitome of vile incoherence, arose the intriguing paradox of higher levels of order; one of these structures is biological life itself. Analogously, from an idealist philosophical construct of little worlds resembling the larger cosmos arose the concept of an isolated, coherent biological microcosm that could serve to model larger processes.

III: "Dehistoricized" Humankind

The nineteenth-century in England was an era of acceleration. In geology, the great time-parsing science that took off during the turn-of-the nineteenth-century, older, intuitive aesthetics of a stable and static nature made room for schemes of catastrophic and sudden change; the two visions share ground in today's life sciences. In Chemistry, a proliferation of competing paradigms emerged to explain the molecular basis for all matter, organic and inorganic, and scientific consensus aligned behind Dalton's atomic theory, supported by Davy's insight that chemical bonds were electrical in nature (Bowler and Morus 2005: 72). Natural history, with the aid of a geological perspective, began to formalize theories on the dynamics of organic life; from among a complement of evolutionary theories, Darwin's omniscient principle of natural selection emerged as sovereign by the century's end. Biology turned its attention to minutiae, and cell theory circumscribed organic life into a confederacy of basic, semi-autonomous units. Louis Pasteur's germ theory permitted an understanding of disease based on the transmission of microorganisms. Travel narratives from around the world stunned the domestic public with accounts of the world's variety; from the barren polar extremes to tropical imbroglios, from the "Hindoo" cultures of the East to the native Americans of the West, the British scrambled to keep their theories of biology, anthropology and geography adapted to the known entities of the day. From the exchange of tubercular bacteria to the economy of spices and exotic species, the British mind took on the hazards and pleasures of global interchange as the new worldwide commerce they had actively solicited, and that they strove to celebrate even in its most bewildering turns. The

human sciences aligned behind a mechanical understanding of the body and our behavior, which cleared the way for medical and pharmacological advances, while inevitably reducing mysterious organic complexity to corrective mechanics.

In practical chemistry, James Prescott Joule quantified the relationship between heat and work, pushing scientific conceptions of energy towards an industrial ideal of nature as a massive steam engine, capable of prodigious energetic outputs from modest masses of coal. Transportation by rail brought the industrial and population centers in temporal proximity, and large parts of the population exchanged their rural subsistence existence for the monetary and time-regulated work imposed by urban industry. More energy per capita was released from fossil fuels, and more consumers traveled to and fro with little inhibition.

Thermodynamics' theory of the universal degradation of mechanical energy introduced a whole new set of concerns to public thought by mid-century, concerns well beyond the industrial baron's desire to get maximum work per energy input. The relationship between order and disorder was no longer a simple distinction between elements within a system and those outside of it. Defining boundaries, which is a more difficult and arbitrary task in ecosystem ecology than in industrial engineering, became an essential part of understanding the organization of a system through time. Biology of the nineteenth-century would only serve to complicate the relationship, as evolution by natural selection demonstrates the increasing articulation of complex forms through evolutionary time. The nineteenth-century mind, then, was faced with the incongruent trends of chemical and mechanical dissolution based on entropy at the same time as biological science was substantiating its central theory of

progressive organic structuring at higher-order levels. Entropy and biological evolution were in concord, however, by the common principle of becoming, of dynamism through time. If nature was a machine, then thermodynamics theorized energetic senescence and structural decay over time. But there was also little doubt that *Homo sapiens* were a more "advanced" form of biological life than the trilobites and mollusks of geological antiquity. If the principle of organization was organic, was each individual life an island of negentropy that would eventually be recycled in the great ocean of elements?

Critics of the new industrialism sprouted from the soil of all social classes, and the cool calculations of empiricists were assailed by thinkers less devoted to ratio, and more to imagination, as the principle by which knowledge advances. Critics suggested that science of the eighteenth-century took natural order and coherence for granted as a foundation on which to build organizing systems like taxonomy. Empirical science assumes the world is inherently knowable. While scientific thinking welcomes an ideal of brightening the dark corners of the unknown using the light of empirical science, it assumes that the darkness engulfs some knowable entity in the physical world, rather than a gap or a loop or a lasting enigma.

Michel Foucault's theory on the fate of natural history after the Classical age of the eighteenth-century is a valuable referent here. In the "Classifying" chapter of The Order of Things (1970), Foucault identifies the Classical reliance on the continuity of nature as the only scheme that "can guarantee that nature repeats itself and that structure can, in consequence, become character" (147). Foucault argues that there is a fundamental rift between eighteenth- and nineteenth-century worldviews in

which the Classical Great Chain of Being breaks under new geological evidence that catastrophe and extinction are determining factors in natural history. Cuvier is Foucault's figure for the post-Classical natural philosopher who used comparative anatomy as evidence to counter deistic design. Though Cuvier did not believe in species mutability, his way of reconstructing historical evidence of the pre-human world was enormously important to the thinking of his contemporaries (including his rival Lamarck) and his intellectual inheritors. Foucault's thesis about the post-Classical nineteenth-century helps us comprehend the nature of the ontological shift from deistic determinacy towards secular indeterminacy, both in our outside environments and within ourselves. Although the Enlightenment brain could consider a dialectic in which interruption and dispersal (catastrophist ideals), as well as gradual erosion and accretion (gradualist ones), were inherent principles in the geological history of the planet, the conceptual leap to identify time as an agent of internal restructuring, of biological evolution, constitutes a shift in the order of things from nature-as-outside to nature as the wild without *and* within. The "complex operations" behind encoding nature as subject to coherent order, which Foucault would call an "episteme" of Classical thought, coveted teleology as a necessary complement to mutability, if God (or any reassuring creative genius) was to remain central to human origins (158). This acceptance of dynamism through time is not equivalent to a modern acceptance of biological evolution: when change is guided by a telos, it is merely a refiguration of "preformationism" set to time. The Classical mind was constrained to suppose that

> the upheavals or catastrophes of the globe were arranged in advance as so many opportunities for the infinite chain of being to continue its progress in

> the direction of infinite amelioration…The universe in its entirety has been larva; now it is a chrysalis; one day it will, no doubt, become a butterfly. Such a system, it is clear, is not an evolutionism beginning to overthrow the old dogma of fixism; it is a *taxinomia* that includes time in addition – a general classification. (152)

Assigning species a taxonomic place in the network of life involves translating phenotypic similarity into schematic proximity. The older notion could nevertheless accommodate the new geological imperative of change through time by distributing extant species along a visual metaphor, the tree of life. Instead of independently-created clusters of greater and lesser physical similarity, the tree organized life phylogenically, through time. But to science of the Classical age, Adam and Eve did not yet have atavistic doppelgängers preserved in fossil layers, evidence that would fundamentally change our relationship with a faith of Creation and the assumed static dominion of humans over subordinate species. Natural philosophy still possessed a peace of mind based on the internal soundness of human essence.

The ambivalence about humanity's involvement in ontological change produced some fascinating literary efforts to elucidate the bizarre past realities suggested by geology. These narratives are met with the challenge of capturing the essence of deep time, which is outside easy comprehension of a rational creature who lives only half a century, and whose Biblical world assured a more manageable 6,000 year parcel of past time. Erasmus Darwin was one of the earliest British thinkers to take on the prickly implications of evolution. His widely-read poems brought the concept of human evolutionary mutability, at least in a retrospective view, to public attention. He was a prominent though not perfectly respectable philosopher because his literary work relied on science, and his science lurched forward in tetrameter

couplets. Historian Peter Bowler has called Darwin one of the first "transmutationists," philosophers who accepted spontaneous generation as truth, and therefore were "forced to postulate a process by which living structures become progressively more complex" (2003: 84). Darwin's ideas were influenced by his medical training, and like his contemporary Lamarck he believed that living things were self-improving and passed on these "acquired characteristics" to their offspring (86). Both men were innovators in the post-Classical construction of dynamism in the natural world, and along with (mainly French) radical materialists including Buffon, Le Mettrie, Diderot, and d'Holbach, Darwin brought the color and vigor of an evolutionary worldview into English debate (81-86).

Erasmus Darwin was elected to the Royal Society in 1761, and he contributed to that group's signal journal, *Philosophical Transactions*; he proved himself a social radical among the English by supporting the French Revolution, and proved a son of the Enlightenment by his enthusiasm for the new Industrial order (Weber 2000: 26). Like his grandson of greater historical fame, Darwin was most beguiled by the elaborations of natural history, which proved to be his indulgent muse. In the long poem *The Temple of Nature* (1803), he invokes bio-geological catastrophism within an explicitly Biblical frame. The section is titled "The Production of Life," and original sin, in this scheme, is the literal agent of environmental downfall:

> Where Eden's sacred bowers triumphant sprung,
> …the fair Bride, forbidden shades among
> Heard unalarmed the Tempter's serpent-tongue;
> Eyed the sweet fruit, the mandate disobey'd…
> Now rocks on rocks, in savage grandeur roll'd,
> Steep above steep, the blasted plains infold;
> The incumbent crags eternal tempest shrouds,
> And livid light'nings cleave the lambent clouds;

Round the firm base loud-howling whirlwinds blow,
And sands in burning eddies dance below. (ll. 33-52)

The prelapsarian world, an all-provisioned garden explicitly created by the benevolent One, was an environmental relic of sinlessness, our enduring trope of Paradise. That much is Biblical. Darwin's rhetoric of the sublime ruination of Eden as a *result* of original sin, though, elaborates on both Genesis and Milton by incorporating geological catastrophism without requiring human mutability. His language manages not to offend those accustomed to the violent strokes of an omnipotent Old Testament deity, but Darwin is slipping scientific content into this otherwise-compliant account of the Fall.

For understandable polemical reasons, Erasmus Darwin begins his long poem with a commonplace, original sin and the expulsion from Paradise. But his underlying aim is to interrogate earlier biogenic mysteries, and implicitly he must dismiss the static creation of Adam and Eve in order to make a non-Biblical narrative retrogression anterior to Eden. Here, Darwin is on shaky speculative ground, and not only because of the challenge to Biblical literalism. He is lyrically advancing the newest theories about the common origin of life, which prizes a teleological notion of evolutionary elaboration through deep time. Darwin's poetry is heavily inflected with scientific terms, which reflects how the language of the new science held imaginative valences and helped to legitimate, by its own specialized discourse, the validity of its theories:

First Heat from chemic dissolution springs,
And gives to matter its eccentric wings;
With strong Repulsion parts the exploding mass,
Melts into lymph, or kindles into gas.
Attraction next, as earth or air subsides,

> The ponderous atoms from the light divides,
> Approaching parts with quick embrace combines,
> Swells into spheres, and lengthens into lines.
> Last, as fine goads the gluten-threads excite,
> Cords grapple cords, and webs with webs unite;
> And quick Contraction with ethereal flame
> Lights into life the fibre-woven frame. –
> Hence without parent by spontaneous birth
> Rise the first specks of animated earth;
> From nature's womb the plant or insect swims,
> And buds or breathes, with microscopic limbs. (ll. 235-250)

There is a physical, gravitational appeal to this account of the spontaneous generation of atoms, which invokes the complementary movements of attraction and repulsion, contraction and expansion, and the gathering vitality of biological life from the more elemental impulses of physics and chemistry. Darwin is taking the essential conceptual steps of linking the solidity of a Newtonian physical world with the higher-order lyrical grace inherent in the biological organization of even the most basic life forms. And, only 200 lines later, he has moved well beyond (or well before) any acceptable Biblical convention of the natural history of creation. It moves past Classical thought while still holding the quasi-determinist notion of organic teleological succession.

His challenge to orthodoxy would be faint-hearted if he left humans austere in this account of the earliest motions of spontaneous generation. Plants and insects, perhaps, derive their forms from a simple atomic impulse to create a web, but acculturated humanity? Here is where Darwin proves his radical bent. He has no moral objection to placing humans along a teleological continuum with mere rudiments, with bursting the Edenic bubble that insists on a superhuman event of creation. In Genesis, the walls of Eden are metonyms for the ontological

circumference of static humankind: God created Adam with a useful tongue, thus rendering Man austere above animals and plants. Darwin's account is a wrecking ball to our Edenic insulation:

> Thus the tall Oak, the giant of the wood,
> Which bears Britannia's thunders on the flood;
> The Whale, unmeasured monster of the main,
> The lordly Lion, monarch of the plain,
> The Eagle soaring in the realms of air,
> Whose eye undazzled drinks the solar glare,
> Imperious man, who rules the bestial crowd,
> Of language, reason, and reflection proud,
> With brow erect who scorns this earthly sod,
> And styles himself the image of his God;
> Arose from rudiments of form and sense,
> An embryon point, or microscopic lens! (ll. 303-315)

Darwin's rhetoric appeals to his readers' sense of a noble nature, full of admirable beasts that prosper in their contrastive environments, with an appeal to solid English patriotism in the Oaks, a well-known synechdoche for the mighty British navy. He selects animals that are most often used in theriomorphism, and though he allows that man "rules the bestial crowd," he discernibly demurs from physical predetermination as man "styles *himself* the image of his God." He boldly renders God as an imaginative construct that has been useful in organizing human narratives and explaining the elaborate order we observe in ourselves, as members of the natural order. With this dismissal of the self-primacy that is a commonplace of monotheism, Darwin draws the connection: humans, alike with all the animals and plants we both admire and malign, arose from rudiments, tiny points of chemical affinity set in the dark reaches of past time.

Though we may have come a long way from those elemental rudiments, Darwin's radical scheme of biological origins requires a rupture from the Classical

assumption of ontological latency. The living world outside of us has indeed changed through time, but Darwin's *Temple of Nature*, itself explicitly an ideological dwelling place erected by the author as a substitute for the church of God, brings evolution inside the human skin. His scheme allows nature's energetic fluctuations the crafting primacy that had been the assumed, unassailable work of God. Darwin is preparing the field of nineteenth-century evolutionary debate by laying down the lines of physics and chemistry, and pushing the scrum towards a higher-order goal of evolutionary biology, which includes humanity in the creative process. Though Darwin's poem falls short of a full reconciliation between evolutionary dynamics and environment (the "evolutionary ecology" that synthesizes the relationship between genetics and environmental circumstance through time), it begins to illuminate the necessary continua among distinct species through evolutionary time, the articulation of phenotype by virtue of ecological niche, and the possibility that human action, rendered symbolically in the eating of the fruit of knowledge, can have devastating effects on the environment.

His poetic narrative is teleological, rather than chaotic, but it destabilizes the static, concrete foundation of creation that had been the cultural paradigm of human self-conception. It gestures towards all-important contingency. Many of the seeds of the new evolutionary biology are contained within this temple, and Darwin was to influence later poets as well as descendent scientists over the course of the century. His literature begins the conscious steps away from the Classical mindset of pre-formation and begins the modern work of understanding the human condition as an evolutionary affect. And yet the work displays none of the narrative trepidation that

would later emerge through a more careful interrogation of the dynamic between human industry and a dissolute environment. These connections were to become charged in subsequent decades.

In the chapter "The Limits of Representation," Foucault writes of "the great upheaval in the Western episteme," the cultural moment when

> it was discovered that there existed a historicity proper to nature; …man found himself dispossessed of what constituted the most manifest contents of his history: nature no longer speaks to him of the creation or the end of the world, of his dependence or his approaching judgment; it no longer speaks of anything but a natural time; its wealth no longer indicates to him the antiquity or the immanent return of a Golden Age; it speaks only of conditions of production being modified in the course of history…The human being no longer has any history: or rather, since he speaks, works, and lives, he finds himself interwoven in his own being with histories that are neither subordinate to him nor homogeneous with him. By the fragmentation of the space over which Classical knowledge extended in its continuity, by the folding over of each separated domain upon its own development, the man who appears at the beginning of the nineteenth century is 'dehistoricized.'" (367-369)

Like the fossil record that first met with so much scrutinizing energy in Erasmus Darwin's time, humanity itself was beginning to reckon with a spotty, discontinuous and seemingly unauthored history of the natural world, and the most intrepid thinkers were beginning to accept humanity's ontological immersion in the scheme. Perhaps more alarmingly, the fossils held evidence that humans were only an infant species set against the long evolutionary history of the natural world. Erasmus Darwin's quip, "Omnia ex Conchis" (all from oysters), cut deeply at the consciousness of primordial origins that became the source of agony for so many nineteenth-century intellects. As Gillian Beer describes,

> Evolutionary theory implied a new myth of the past: instead of the garden at the beginning, there was the sea and the swamp. Instead of man, emptiness – or the empire of mollusks. There was no way back to a previous paradise: the primordial was comfortless. Instead of fixed and perfect species, it showed

> forms in flux, and the earth in constant motion, drawing continents apart. This consciousness of the fluent, of the physical world as endless onward process, extended to an often pained awareness of human beings as slight elements within unstoppable motion and transformation. Nostalgia was disallowed, since no unrecapturable perfection preceded man's history. Ascent was also flight – a flight from the primitive and the barbaric which could never quite be left behind. (2000: 119)

Though we still held a place in natural history, it was no longer so solidly the position of the sovereign, intellectual collector musing over a cabinet of curiosities as though it were God's inscrutable jigsaw puzzle created for our amusement. Much of the nineteenth-century history of science involves crafting reconciliations between religious belief and scientific insight, as many thinkers were able to exercise negative capability on the subject, and were understandably loathe to shred the elaborate cultural curtain of Christianity with undue haste. But the new information yielded by a scientific investigation of nature's inner workings sent waves of suggestive questions over the face of the formerly-reflective waters. When we looked at ourselves with scientific frankness, we began to see another thing altogether embedded in the deep past, and that thing was alien to anything extant in the world. Also, it preceded us; it was our mother. The objective evidence for human evolution began to make more sense than graceful mother Eve and the fantasy of an animated rib.

Foucault's "dehistoricized" humanity of the post-Classical age helps to clarify some of the questions that innovative writers of the nineteenth-century raised in their work. If our species was understood as a child of evolution, whether teleological or random, what was to come after us; would our phylogenic offspring look as bizarre as our ancestry? Was the origin of cognitive sophistication, of imagination and reason, a

mere chance of evolution? If God was not inexorably laying down our future path, could we trust our barely post-monkey brains to pursue a wise course? How could the personal indulgences of industrial materialism be justified in the natural order of things? What happens downstream of environmental catastrophe?

None of these new questions, of course, has a monolithic or stable answer. But nineteenth-century intellects balanced the cultures of science and literature in their consideration of modern purpose. The narratives that I will investigate in chapter two, a purposely diverse selection, are generally indebted to an aesthetic of fragmentation as one of the primary methods of capturing the nineteenth-century cultural spirit. Disjuncture, as a figure both of human fate and of human action, became (in a gentle irony) the organizing principle of narrative: chaotic dynamics allowed for surprising new schemes of organization, as well as dissolution.[16] For a precious while, the imagination and conscience of the humanistic literati held a common economy with the reason and science of the empirical schools. Novels and narrative poems practiced their own experiments on the mode and tempo of environmental change through deep time.

The literary microcosm shows an alternative commitment to understanding nature in the post-Classical world. Where narratives most often lend themselves to the form of prose, or blank verse (poetic prose), the trope of the microcosm appears in lyric poetry throughout the century. During the nineteenth-century, the microcosm turned from an ancient philosophical concept to a modern scientific model used to

[16] Shelley's *Ozymandias* concisely represents the emotional force of environmental upheaval resulting in historical fragmentation. The sonnet's ironic moment, "Look on my works, ye mighty, and despair!" divides Ozymandias's teleological vision of history from its actual realization in rubble and dust. The Romantic fascination with antiquity and ruins feeds upon the wild sensations of chance-driven history.

comprehend the dynamics of simplified systems, and conceptual microcosms were frequently articulated in literature. The trope also appeared in holistic scientific studies beginning with Stephen Forbes's 1887 coinage of microcosm ecology. His scientific efforts relies on imagination for its persuasive power, which is grounded as much in the successful defense of an investigative method (or a way of looking at things) as in the hard empirical evidence that results. I will discuss Forbes's pioneering work at the end of this chapter and return to it in the final chapter, which discusses modern ecology. Environmental ethics are enriched by an active appreciation of scalar congruence from the microbiological (the atom and the cell) to the macrobiological (the ecosystem and the earth). With such elucidating power, the microcosm has been used by empiricists with equal success as it has animated the imaginations of environmental philosophers. The degree of proximity between those two paths is revealed in the contentious debates surrounding the concept of earth as Gaia, a macrocosmic ideal formalized to science by James Lovelock in the 1970s.[17]

[17] The Gaia theory has been lauded and marauded since it was first introduced. It has become an organizing trope of environmentalist philosophy; its formulation occurs, probably not coincidentally, just after the first image of Earth taken from space by NASA, one of the loneliest pictures conceivable. The critics of the Gaia hypothesis as a material description of the geo-climate system are myriad and voluble. This resistance continues an anti-teleological tradition in the modern sciences.

IV: Chaotic Industrial Skies

We're accustomed to thinking of climate change as a scientific theory of relatively recent advent - it has received widespread attention in scientific communities since the 1970s. But the history of human-induced climate change begins almost as early as the Industrial Revolution, the catalyst that ushered in the age of carbon emissions.[18] The first Industrial Revolution relied on the power of coal, which drove steam engines in a number of fixed-place tasks, particularly in textiles and agriculture. The advent of moving industry, the kind that would power railways and steamships, came later in the nineteenth-century, and finally the internal combustion engine, driven by petroleum rather than coal, individualized the advantages of a motorized society. The superior energy density of petroleum molecules to earlier forms of energy (coal, wood, turf, hay) permitted a greater ease of carrying the fuel source long distances; only since the early twentieth-century has it become commonplace for an individual to drive 6,000 pounds of metal, rubber, and human at 60 miles per hour simply by depressing a pedal, and in America for only 10¢ of fuel per mile. This massive release of energy on a quotidian basis drives developed nations, and indeed it is difficult to imagine a return to older forms of transportation after these sanguine machine-driven decades.

At the beginning of the nineteenth-century, none of these fundamentals of modern existence in a developed nation had yet been insolubly installed in nearly

[18] William Ruddiman (2001) is the most conspicuous among scientists who claim that the history of human-induced climate change begins much earlier with the massive transformations in land-use brought about by the agricultural revolution, dating back at least 8,000 years. This "early anthropocene" hypothesis suggests that the natural Milankovitch cycles of climate that correspond to Earth's orbital variations in the Milky Way have long been affected by human activity, and that an observed delay in the onset of the next ice age is traceable to deforestation and animal husbandry beginning with widespread agriculture.

every aspect of existence: human settlement patterns, food systems, military, medicine, work and play. This dissertation will be limited to the exposition of British literature that addresses personal reactions to the new industrial ontology. But its measured scope nevertheless gestures at a much broader vanguard of concerns pushed forward by the rapid environmental changes induced by industrialism in England. This particular study of Romantic and Victorian literature hopes continually to inform the modern environmental reader not only of our philosophical ancestry in preservation and sustainability, but also of the various complementary epistemologies, scientific, literary, and hybrid, that have assisted our progress towards awareness of the current tenuous state of environmental affairs.

The first scientific theory that could be identified with modern global warming came from the experiments of Joseph Fourier, a French physicist who pursued a theory of heat conduction, and the same man who chaos science's Prigogine identified with complex nonlinear systems. His "General Remarks on the Temperature of the Terrestrial Globe and Planetary Spaces," published in the *Annales de Chimie et de Physique* in 1824, envisions Earth as a giant greenhouse (Christianson 1999: 12). Fourier's vision of natural atmospheric insulation is one of cosmic benevolence: the gasses and water vapor that collect at the outer reaches of the earthly sphere provide essential incubatory warmth for the plant and animal life on the surface. While the gasses emitted by human industrial activity were self-same as those naturally occurring in the stratosphere, Fourier did not pursue a theoretical connection; the Earth system seemed simply too large and humans altogether insignificant in the volume of their carbonic contributions. Fourier also had the

reassurance of religious faith, and scientific theory based on a designed global environment served as reciprocal reinforcement both of human passivity and active divine benevolence.[19]

In 1861, John Tyndall furthered Fourier's ideas by demonstrating the high absorbent power of gasses in the atmosphere, including carbon dioxide and ozone. But his conclusions, like those of his contemporaries, tended to place value on the insulating power of naturally-occurring ozone gasses, which seemed to keep the known ice ages of deeper geological history at bay. While pollution on local levels was a palpable, even choking, concern, an overall trend of warming seemed merely utopian to the chilled blood of northern European scientists.

Indeed, the very notion of global greenhouse grew into a prosperous cultural trope in England of the nineteenth-century. The literary transition period of mid-century witnessed the advent of architectural engineering towards impressive glass domes such as the Crystal Palace, erected for the 1851 Exhibition. Joseph Paxton owed his architectural ingenuity to the physical structure of an exotic water lily at Kew Gardens, the *Victoria regia*. The engineer placed his infant daughter on one of the floating leaves, and instead of sinking under her weight into the shallow water, the leaf proved strong and buoyant enough to support the child on the surface (Christianson 79). Paxton deduced that the geometrical venation on the undersurface of the leaves could be recapitulated as transverse girders in an otherwise glass structure. His fusion of a slender iron skeleton supporting expanses of dermal glass became both an environmental metaphor of the microcosm and a literal triumph of

[19] The term "greenhouse effect," which is first to make a stigma of Fourier's global shell, was coined by University of Wisconsin professor Thomas Trewartha in 1937.

engineering in the new Victorian age: the structure housed botanical and cultural collections from the outer circumferences of imperial reach.

At the same time, the greenhouse concept held more sinister implications. Denizens of England's new industrial megalopolises, particularly Manchester and London, were visual witnesses of a polluted industrial microclimate. As Elizabeth Gaskell records in North and South (1855),

> For several miles before they reached Milton, there was a deep lead-coloured cloud hanging over the horizon in the direction in which it lay. It was all the darker from contrast with the pale grey-blue of the wintry sky…Here and there a great oblong many-windowed factory stood up, like a hen among her chickens, puffing out black 'unparliamentary' smoke, and sufficiently accounting for the cloud which Margaret had taken to foretell rain. (59)

The 1844 legislation meant to curb industrial emissions went largely unheeded by libertarian factory owners (Gaskell's Thornton is one of them). By 1866 Manchester's medical representative identified the citizens as among the unhealthiest in Britain, as a consequence of their industrial atmosphere (Christianson 21).

By century's end, Manchester had cast an appreciable plague on its own flora, as well: in an 1893 essay on "The Air of Large Towns," Manchester researcher G. H. Bailey appeals to the populous in his preamble to the scientific data demonstrating the measurable pollutants. He writes, "general experience has shown that evergreens cannot be grown in the heart of our larger cities and even the more hardy deciduous trees make little progress and sooner or later succumb. The sulfurous and other noxious vapors and the deposits of soot, hydrocarbons, etc., which form on the leaves are the chief agents in the destruction of plant-life" (201). Trees are only a step removed from animals, and Bailey invokes Britain's famed urban fogs, "when the air is supercharged with such impurities," to unleash the full pathos of this industrial

environment: "The death-rate indeed from such [respiratory] diseases after foggy weather frequently increases to three-fold its normal value and is always exceptionally high in the densely populated districts" (201). Bailey's prescription to correct this miasmic condition is for the British to emulate futuristic Americans with "the substitution of gaseous fuel." He continues,

> though it may not get rid of fogs altogether, [natural gas] will doubtless mitigate in a very large measure their noxious character and in the era when lighting is done by electricity and heating by gas the whole aspect of our towns will be changed for the better…a signal service would be rendered and a distinct advance would be made in the direction of banishing the fog demon once and for all. (202)

The demon ought to be banished by the new century with the aid of better technology and cleaner fuel sources, Bailey suggests in this millennial passage that came somewhat true. Natural gas and petroleum occupied more of the twentieth-century energy market than it previously had, but petrol-driven automobiles in cities offset many of the gains. In 1910, as T.S. Eliot notes of urban modernity, the miasmic yellow fog still rubbed "its back upon the window-panes…lingered upon the pools that stand in drains…curled once about the house, and fell asleep" (*Prufrock*, ll.15-22). Strangely, like the new generations of urban workers, the demon was endemic and somnolent, a child of industry. It had settled in a sleepy command over its siblings' habitat.

Another view of Britain's rising conscience relating to industrial air pollution might be drawn on the statistics of average chimney height over the course of the nineteenth-century.[20] As the tallest of the remaining oaks were felled, these brick-lain

[20] Gale Christianson traces the growth of "Cleopatra's Needles" from an average somewhat below 300 feet before mid-century (some requiring over a million bricks), towards new records of 435.5 feet in 1841 and 454 feet in 1857 (58-59). Several stacks collapsed or became unsound long before they had

proxies came to adorn the skylines of urban centers, and great engineering effort was invested in making ever-taller stacks capable of distributing their effluent over a wider area. The "not in my back yard" instinct of environmental self-distancing directly informed the linear trend towards towering chimneys. An average of 100 chimneys rose each year in London between 1846 and 1853 (Christianson 56). Not merely taller chimneys, but legislative dispersal of industry was tried as a solution to the new atmospheric malaise. The House of Commons Select Committee on the Smoke Nuisance, created in 1843, recommended that manufacturers be removed from the city center to a radius of five or six miles (57). These measures effectively substituted a visibly apparent local environmental problem for an almost invisible but widespread trend towards the literal blacking of England.

Industrial melanism is an illustrative case in point. That model case of evolution by natural selection and encryption physiology began in the UK with the revelation that a mutation for uniform darkness in a tree-dwelling moth, *Biston carbonaira*, was assisting the formerly-rare species in newfound competitive success with its rival, *B. betularia*. The *carbonaria* mutant was better adapted to the industrial world: its color matched the sooty trunks of trees, and predators targeted the more apparent *betularia*, whose mottled wings now stood out against a dark grey background. The revelation of industrial melanism is owed to a common collaborative scheme in the sciences: one naturalist named Edleston began collecting

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reached their planned heights: industrial chimneys had to contend with extreme heat, soft foundations, prevailing and buffeting winds, and minute asymmetries of construction that would quickly become exacerbated under the other stresses. Not only did the Victorians find *taller* stacks more tolerable for their emissive distribution, a discernable movement towards *aesthetic* chimney architecture, some of it patterned after the Egyptian prototype, served to show that chimneys were an indispensable feature of the Victorian age, and had to be involved in the culture's artistry as well as its industry.

and noting the prevalence of *carbonaria* in 1864, and a successive entomologist named J. W. Tutt synthesized the research towards the end of the century, and made use of a larger trend of melanism in insects now extant on the European continent to record the first proof of humans affecting biological evolution.

One other advance in environmental sciences of the nineteenth-century is worth noting here. Robert Angus Smith, a Scottish chemist and industrial adversary, discovered acid rain in 1852 in the environs of Manchester, and published the long-researched monograph Air and Rain: the Beginnings of Chemical Climatology in 1872. These rains had the alarming power of literally dissolving the facades of English architecture, which were already besotted with carbon emissions. Since the beginning of the nineteenth-century, industrial smoke, and particularly sulfur dioxide, has decreased the pH of rain from a balanced average of 6 to a marginally-acidic 4.5 or 4. Readings of 2.4, the acidity of vinegar, have occasionally been recorded in heavily industrialized areas ("Acid rain" by NASA). Events of the so-called *waldsterben*, the death of the trees, had been known to follow large volcanic eruptions, but die-offs in forests surrounding industrial areas (northern England, the Black Forest of southern Germany, parts of eastern Europe, China) only grew into human ken over the course of the twentieth-century. Acid rain's tendency to deface tombstones and public statues make the phenomenon a particularly bracing example of the self-annihilating side-effects of industrial emissions. Even names carved in stone, the Victorians discovered, were imperiled in posterity by the airborne appetites of sulfur dioxide and oxidized nitrogen compounds.

Denizens of the nineteenth-century did not come to realize the adverse effects of industry in a vacuum. Atmospheric sciences originated out of a combination of Enlightenment chemistry, which made great advances is elucidating the chemical nature of air, and the geological explorations of volcanoes at the turn of the nineteenth-century. Luminaries like Humphrey Davy, Alexander von Humboldt, and James Smithson scrambled around the calderas of the world's most active volcanoes in pursuit of applied information and material samples. Davy climbed Mount Vesuvius fourteen times in 1820 alone, inspired by his research in coal mines to test the various contemporary theories on volcanic action (Matthews 1957: 197). Measures of volcanic emissions, both quantitative and qualitative, became crucial data used to parse among many competing theories on the role of volcanoes and earthquakes in earth history. A deep time ruled by catastrophe captured the literary imagination, as well: volcanoes, earthquakes, and comets emerged as chaotic, world-ruling events, perhaps as substitutes for more conventional deism. In 1822 Byron raised catastrophic speculation to the level of a new, atavistic mythology: "Who knows whether, when a comet shall approach this globe to destroy it, as it often has been and will be destroyed, men will not tear rocks from their foundations by means of steam, and hurl mountains, as the giants are said to have done, against the flaming mass? – and then we shall have traditions of Titans again, and of wars with heaven" (quoted in Palmer 2003: 56). His wish for this sublime, techno-geological battle reveals the imaginative energy contained in catastrophe science, which glosses over Byron's more world-weary desire for the old realm to be forged anew.

Nor were environmental catastrophes merely the condition of an immature early earth, as Cuvier had insisted in the context of his geological catastrophism. Though Cuvier had succeeded in "bursting the limits of time" for the imagination hooked on geology, time present was providing ample evidence that the earth was engaged in an ongoing dynamic evolution; episodes of destruction and despoilment had to be factored into our understanding of environmental conditions. Great upheavals were the ongoing condition of existence on the planet, as recent history demonstrated. In 1755, a massive earthquake of magnitude 8.75 crumbled the Portuguese capital of Lisbon; it catalyzed a tsunami and a fire that colluded to kill at least 30,000 people (some sources place the number closer to 100,000) (Palmer 210). This event appeared in the writing of Voltaire, Rousseau, and Kant, particularly as relates to theories of the sublime. In 1783-4 the Icelandic volcano Laki erupted, releasing 120 million tons of sulfur dioxide over the northern hemisphere and triggering a series of famines, unseasonable cold, and a blood-red appearance of the sun over Europe; Gilbert White and Benjamin Franklin are among the natural philosophers that recorded the natural effects of such volumes of atmospheric pollution. In 1815 the Tambora volcano in Indonesia produced a similarly spectacular effect: its emissions caused the famous "year without a summer" in 1816, the coldest year in the northern hemisphere since 1601 (the year following a massive volcanic eruption in Peru) (Briffa 1998: 451). The average temperature anomaly shows a global cooling by about 0.5 degrees Celsius. Snow fell on New England that June, and the inhabitants of Villa Diodati on Lake Geneva, the Shelleys, Byron, and Polidori, used the gothic weather as an occasion for their famed ghost story contest.

In 1883, Krakatoa erupted in a series of booms, one of which is the loudest sound recorded in history (it was heard distinctly on Mauritius, 3,000 miles away). Following the typical patterns, Krakatoa's eruption triggered tsunamis, worldwide cooling (temperatures did not return to average until 1888), and bizarre, portentous optical effects such as the red sunsets and blue moons (Shelf 1981: 699). These catastrophic eruptions influenced the plots of chaotic literary narratives, a meteorological mandate that I will discuss in chapter two.

As G.M. Matthews (1957) has usefully noted, the comprehension of natural catastrophes, especially volcanoes, went hand-in-hand with the scientific elucidation of industrial pollution: the two inquiries were mutually-enabling. Alexander von Humboldt's copious research on South American geology, which forms the basis for early theories of species distribution and biogeography, also relied on observations of industrial affect, "for it was only after analogies had been drawn from industry that certain volcanic processes were explained" (197). Humboldt developed the 'cyanometer,' an object of Byron's gentle ridicule, in order to quantify the blueness of the sky. He measured the notably un-blue skies around active volcanoes, which had the additionally sublime effect of coloring the surrounding objects in lurid, unnatural hues. He recognized volcanic action as the key to opening new theoretical schemes in geophysics:

> Volcanic phenomena…considered in the totality of their relations, are among the most important topics in earth Physics. Burning volcanoes appear to be the effect of a permanent communication between the molten interior of the earth and the atmosphere that envelopes the hardened, oxidized crust of our planet…[volcanoes provide information on] that intimate connection between so many diverse phenomena. (From "Fragmens de Geologie et de Climatologie Asiatiques," 1831; quoted in Sachs 42)

These theoretical connections, though not fully explicit until continental drift theory unified geophysics under a new paradigm in the twentieth-century, were common to scientific discourse from the beginning of the nineteenth-century. G. M. Matthews quotes an *Edinburgh Review* essay from 1804, which marvels at the inherent soundness of an initial link between volcanic and industrial pollution: "it is wonderful how it so long eluded observation, when the slag of every furnace exhibits it in the most striking manner" (197).

The commonality between industry and volcanoes went well beyond observations of odd weather. Chemical analyses of volcanic emissions deconstructed the molecular cocktail behind the dull appearance of sooty smoke. James Smithson (whose legacy would be devoted to the establishment of Washington's Smithsonian Institution) revealed his analysis of Vesuvius soot in a paper for the *Philosophical Transactions* in 1813, in which he concludes, "This Vesuvian salt, considered in its totality, has presented no less than nine species of matters, and a more rigorous investigation, than I was willing to bestow upon it, would probably add to their number" (from "On a Saline Substance from Mount Vesuvius"; quoted in Ewing 266). Scientists were also dissecting the volcanic ash left behind in the lower, more primitive geological layers as evidence of ancient volcanic activity. The chemical complexity of these fiery byproducts was only beginning to find the light of empirical science, and Smithson was particularly accomplished with a blowpipe, that indispensable chemist's tool used in sciences from metallurgy to mineralogy to inorganic chemistry. Seeking evidence for the Plutonist theory of geology, which prizes volcanic activity as the energetic principle behind the creation of all rocks,

Smithson sought evidence supporting the notion that earth was an extinct comet or star:

> Every thing tells that a large body of combustible matter still remains closed within this stony envelope, and of which volcanic eruptions are partial and small ascensions. Under this point of view, an high interest attaches itself to volcanoes, and their ejections. They cease to be local phenomena; they become principle elements in the history of our globe; they connect its present with its former condition; and we have good grounds for supposing, that in their flames are to be read its future destinies. (Quoted in Ewing 2007: 74)

Its future destinies, indeed, where industry smells of the future. The identifiable compounds Smithson precipitated out of these Vesuvian salts are as follows, in decreasing abundance: sulfates of potash and soda, muriates of soda, ammonia, copper, and iron, and miscellaneous metallic "submuriates". Though the arcane chemical terminology occludes a direct connection with later analyses of industrial pollution, the link remains: sulfates are the salts of sulfuric acid, and muriates are derivatives of hydrochloric acid such as potassium chloride. In his analysis of air particulates in a foggy Chelsea of 1893, G.H. Bailey found the chemical composition at fully 4.3% sulfuric acid, 1.4% hydrochloric acid, 1.4% ammonia, 2.6% metallic iron, and a whopping 31.2% "other mineral matter," particularly silica (sand) and ferric oxide (oxidized iron) (201). Carbon and hydrocarbons made up the remainder. In chemical terms, the particulates demonstrably emitted by volcanoes through geological time shared their molecular structure with the new aerosols of industry, particularly elemental carbon, sulfuric acid, hydrochloric acid, and ammonium. Chemistry changed dialects over the course of the first industrial century, but nonetheless it became clear that the geogenic past held information to inform an anthropogenic environmental future. The second chapter of this study will take a

closer look at literary narratives that linked environmental disaster with human activity. Though these works are a species of artistic augury, it will become clear that literary portends are not merely the paranoia of a superstitious imagination at free reign, but form the basis of a scientific revolution that includes humans as primary agents of global-scale change.

V: Early Ecological Microcosms

On another epistemological frontier of the nineteenth-century, natural history was evolving from its eighteenth-century status as a science cataloging a coherent world towards *in situ* observations, or field studies. The cabinet of curiosities had embellished the décor of eighteenth-century naturalists and delighted collectors and the inquisitive with a notion of life as a divine *Concordia discors*. The underlying sciences of geology and chemistry were disposed to investigation outside the field: fossils are best understood when placed amid massive collections, and experimental chemistry relies on the controlled, ideal conditions found in laboratories. But the nineteenth-century's aesthetics of the picturesque encouraged naturalists to pursue their studies *al fresco*, amidst nature's vital interactions. For biology to grow into its own proper discipline, it needed to study its subject, life, where life was ongoing. Like laboratory experiments, the new biology also needed parameters to focus the level of investigation, and to define its terms and subjects. One way to generate a frame of reference is to delimit the subjects by placing them in a system, even if that system is somewhat arbitrary because of the breadth and depth of interdependence in nature.

> The writing of Alexander von Humboldt, Charles Darwin, and Stephen Forbes provides some perspective on how the science of life approached field observation and experimentation as it became more sophisticated during the nineteenth-century. These biologists established a discourse style that was based on the fruits of travel, though their works are more directed than travel narratives. They each appealed to the imagination of their readers; 'fancy' was identified as a

boogey-man of the brain, but a vital, synthesizing imagination was crucial for biologists to grasp the implications of organic inter-reliance from small to large scales. This new approach, which Goethe had identified as the "gentle empiricism" that does not manipulate or mutilate, but simply grows within the mind of the sensitive observer, preserved the webs of life as they had independently developed through evolutionary time. Though it would be misleading to claim that all biologists of the nineteenth-century followed Goethe's passive aesthetic (consider the vivisectionists), *ecological* empiricism demanded of its practitioners a holistic perspective in order to attain any intelligible advances. The impala cannot be understood as a biological entity without also considering savannah grasses and prides of lions. Systems created coherence by imposing frame of reference, and holism permitted biological life to keep its strings attached; indeed, the strings themselves were to become ecology's *raison d'être*.

These two prerequisites to an ecological vision coincided on the tropical islands colonized by European powers. Islands served as the first places to suffer palpable environmental degradation at the hands of colonists, who introduced alien species across the spectrum of biological kingdoms.[21] They were fortuitous early microcosm experiments. Though the microbes, fungi, and pests such as rats were accidental baggage, the European ships also brought goats, horses, beasts of burden, and the full complement of western staple crops. Islands were also used for intensive cultivation of native species: fruits, spices, and medicines were increasingly in

[21] Richard Grove's Green Imperialism (1995) elaborates on the importance of colonial exploration beginning in the sixteenth-century, particularly the French and English establishments on isolated islands throughout oceanic regions of the equator and southern hemisphere. It is an important study of colonial science in the context of Enlightenment thought, and his inquiry goes through the Romantic era.

demand in Europe. Small isolated islands such as Mauritius in the Indian Ocean and St Helena in the South Atlantic, which in a wild state sported an epidermis of thick forest, were denuded and converted to pasture and farmland. Conversions from this "savage" state of wilderness to a combed, controlled and productive system of agriculture were instrumental to colonial ideology and the Enlightenment desire to improve nature by taming it.

These directed changes constituted a symbolic shift from the wild island towards the cultivated garden. The two related microcosmic symbols found a home in the colonial conscience: the island itself served as a suggestive metonym for many systems (the entire world, self-regulating nature, monarchal society, national economy), and the garden embodied a controlled network of productive species owing its existence to educated and hard working colonists (Grove 14). Islands provided manageable parcels of nature with a complement of tropical species and a climatological receptiveness to botanical improvement, at least for a while. They carried an ideological promise of redemptive potential at the religious level, as a scattered series of possible new Edens, as well as ingenuity on scientific and medical levels, as loci of botanical cultivation for the derivation of new medicines. Colonial islands were nature's first provision of ecological laboratories.

Perhaps not surprisingly to humans of the twenty-first century, islands were most instructive about this new notion of ecology when their systems reacted drastically to the disequilibria introduced by colonial cultivation. The interrelation of organic and inorganic nature at specific scales was not to be formalized as ecological science until late in the nineteenth-century. But colonial scientists beginning in the

early eighteenth-century, many of whom were the most advanced and radical thinkers of their age, began to draw links between human agrarian activity and natural despoilment based on their experience with these isolated parcels. Deforestation, in particular, led naturalists towards an understanding of the relationship between forests and atmospheric composition (Grove 153). A series of "dessicationist" theories grew out of the observed drought conditions on islands that had been cleared of their moisture-holding trees. The extent to which island acres were forested, especially on slopes and in windward faces, also affected the soil quality, depth, and distribution downhill, where land was most often turned to intensive agriculture. From the seeds of island experience, colonial scientists gathered data to support the new notion that human activity could change an ecosystem for the worse as well as for the better. In fact, it introduced the irony that human energy directed specifically at improving nature from an untamed state towards a Biblical garden, pious as well as economical labor, was the sort of artificial control that replaced one scheme of wilderness with another, more frightening one: outlandish and sudden despoilment of foliage, water and soil-starved fields, and a virulent unfiltered sun.

The island of Mauritius, which turned from French to English rule in 1810, is an example of this early outgrowth of environmental conscience from the scope of a microcosm. In 1715 the French turned the island to sugar cane and indigo production, and scientists quickly noticed the deleterious effects of land clearing, and the water pollution resulting from effluvia of the indigo industry. On an island with limited freshwater resources, industrial pollution emerged as a menace to human health much earlier than it did on mainland Europe, and the French governors of

Mauritius established legislation to curb industrial excrescences by 1791 (Grove 256). Governor Decaen, who regulated Mauritius from 1803 until its loss to England during the Napoleonic wars, instituted a series of laws aimed at alleviating the environmental deterioration that was now evident. His legislation enforced the protection of river banks for 120 feet on each side and the preservation of forest on two-thirds of the mountain slopes (Grove 257).

Such ecological considerations addressed the problems of excessive runoff and topsoil loss, as well as protecting against the desiccation of denuded landscapes. Forests, it was observed, cultivated clouds, especially at the higher elevations. This new sylvan valuation succeeded earlier notions of forests as dark and insidious groves that grasped miasmic fogs in leafy layers and sustained an unhealthy boggy dampness at the soil level. Decaen's measures had only a limited time to alleviate Mauritius's ecological wounds, however: when the British seized control of the island in 1810 they wondered at the under-use of the mountain and riparian terrain, and set the land to another cycle of heavy cultivation (Grove 261). Within a short time the British began to notice the dissolution of their agrarian schemes, and William Chambers, a prominent industrialist, set the scientific world into serious and increasingly public debates about the dangers of desiccation with the following set of observations:

> Very shortly it was noticed that the streams were shrinking; that one spring after another had disappeared; that the green of the meadows was changed to a dusty brown; that the grain sown grew up thin and hungry; and that the earth, in short, ceased to be productive. Reflecting persons were not slow in discovering the cause of this great change. They noticed that the periodical rains, however abundant they might be, soon cleared away from the cultivated country, leaving it exposed to the rays of a fiery sun, which scorched and withered up everything for want of a perennial supply of moisture. The next step was with all possible speed to reclothe mountains with forest and jungle,

> upon which experience had proved the fertility of the lower lands depended. ("Failure of springs in the East" (1863) 1-3; quoted in Grove 261)

Such accounts were part of a growing and increasingly public consensus that human-driven environmental improvements were not so simple and unidirectional as early agrarian science had assumed. Though by the mid-nineteenth-century the problems of unchecked landscape alteration were beginning to be manifest, it remained the place of island colonies to reveal environmental trends that could only later be applied to the vast tracts of the mainland. In these island microcosms, the climate was changing palpably, and for explicable anthropogenic reasons. The reversal of atmospheric desiccation was indeed possible, but it required the admission that a certain amount of economically unproductive wilderness served to hold an ecological system in a more steady state.

Charles Darwin set himself to a rigorous education in island biogeography during the five years of the Beagle's voyage from 1832 to 1836. The adaptive radiation of finches across the Galapagos Islands is scientific history's premier lesson in how a series of islands can reveal, in microcosm, the larger forces at work that mediate between organic and inorganic nature, in this case allopatric speciation. But Darwin learned from another island that humans, over the course of a few hundred years, can have profound impacts on small circumscribed environments. During the final latitudinal ascent of the Beagle, in July 1836, the party landed at St Helena, an island of 164 square miles in the middle of the South Atlantic. St Helena is famed as Napoleon's place of forced exile from 1815 to his death in 1821, but it was used by a motley series of European sailors starting in the early-sixteenth-century, when goats and citrus trees were introduced.

It became a permanent British territory in 1834. When the Beagle arrived in July of 1836, Darwin had fully grown out of his recalcitrant academic youth to become an energetic and accomplished naturalist, actively considering competing scientific theories of geology, botany, and natural history during his rambles through Oceana. The flora and fauna of St Helena, however, reminded him somewhat too much of home. His diary from the voyage, which provided the bulk of his 1839 volume The Voyage of the Beagle, is revealing of a semi-conscious environmental ethic. First, the revelation of the island microcosm: "St Helena, situated so remote from any continent, in the midst of a great ocean, & possessing an unique Flora, -- this little world, within itself, -- excites our curiosity" (412).[22] Darwin's impression of the uncanny effect of English landscape in an exotic land has survived in fragments:

> In latitude 16° & at the trifling elevation of 1500 ft, it is surprising to behold a vegetation possessing a decidedly English character. But such is the case; the hills are crowned with irregular plantations of scotch firs; the sloping banks are thickly scattered over the thickets of gorse, covered with its bright yellow flowers; along the course of the rivulets weeping willows are common, & the hedges are formed of the blackberry, producing its well known fruit. When we consider the proportional numbers of indigenous plants being 52, to 424 imported species, of which latter so many come from England, we see the cause of this resemblance in character. These numerous species, which have been so recently introduced, can hardly have failed to have destroyed some of the native kinds. I believe there is not any account extant of the vegetation at the period when the island was covered with trees; such would have formed a most curious comparison with its present sterile condition and limited Flora. It is not improbable that even at the present day similar changes may be in progress. Many English plants appear to flourish here better than in their native country. (411)

[22] To our great misfortune, this suggestive passage comes directly after a 2 page gap in the diary's text, which the editor notes "relates the loss of two inserted pages [of]discussion on the changes in the fauna and flora of the island since the introduction of goats and hogs in 1502" (439, note 58).

Americans of the twenty-first century are used to the concept of invasive species: kudzu and bamboo from the East, ivy, the starling, and Dutch elm disease from Europe. Introduced species often become virulently successful in new environments because they are freed from the competition and predation of their natural environments. Invasive species have certain common characteristics, such as fast growth and reproduction, wide dispersal mechanisms, a broad range of environmental tolerance, and association with humans. The concept of invasiveness shows how ecology, including the evolutionary ecology that is largely Darwin's gift to biology, cannot discount the human factor when considering any environment. Though human impact may be as ancient as the species itself (which has existed a mere 200,000 years or 1/22,000th of the history of life on Earth), only the last few centuries have revealed the potential for a new endemic world order created by human traversal of the globe.

Even to a Victorian patriot, the little world of St Helena seemed ecologically damaged because the several species of animals and plants that came with settlers claimed a devastating proportion of the ecological niches. Darwin notes that different species of birds and insects are "very few in number; indeed I believe all the birds have been introduced within late years. Partridges and pheasants are tolerably abundant: the island is much too English, not to be subject to strict game-laws" (364). He makes a survey of the impact of European ungulates on the former forests of St Helena:

> The fact, that the goats and hogs destroyed all the young trees as they sprung up, and that in the course of time the old ones, which were safe from their attacks, perished from age, seems clearly made out. Goats were introduced in the year 1502; 86 years afterwards, in the time of Cavendish, it is known they

> were exceedingly numerous. More than a century afterwards, in 1731, when the evil was completed and found irretrievable, an order was issued that all stray animals should be destroyed." (363)

The culling of stray goats in 1731 constitutes an early act of what was later called restoration ecology, where humans imposed a check on the positive feedback loop of goat procreation.

Oceanic islands provided an experimental system by which colonial naturalists learned to discern the series of negative (stabilizing) feedback systems essential to an ecosystem, and how these feedbacks change in unpredictable and severe ways with the introduction of new species. Though these islands became cultural offspring the Imperial power, their regulation, through time, grew wise to the environmental imperatives of the contrasting tropical climate. The adventurous scientists who took posts at the edge of Empire were more likely avatars of experimental and radical measures such as reforestation. Conservation, by definition, is a conservative practice, but its instantiation in tropical colonies was a radical action that curbed the economic imperative of forwarding consumerism that informed legislation of the time.

Alexander Von Humboldt's Cosmos (1845), a unifying study of natural history in the nineteenth-century, was the consolidation of travel, research, theory, and lectures from his previous half-century of scientific activity. Borne conceptually on the imaginative notion of a coherent and unified earth system that is a prototype for Gaia theory, he supported his philosophical occasion with hordes of detail, the gleanings from increasingly-diversified sciences of astronomy, physics, geology, physical geography, climatology, botany, zoology, and anthropology. Humboldt's

death in 1859 provides an opening for a tempting chronological thesis that the old, Romantic, holistic, harmonious cosmos splintered under the hammer of Darwinian evolution, which introduced biological strife *as* the ontological condition of life.[23] But to do so would be to elide the more subtle interdependencies between Humboldtian ecology and Darwin's network of natural selection acting on variation within a complex organic and inorganic matrix. Though incessant competition, carnage, and chaos were read meta-textually onto Darwinian evolution, England's great Victorian bore an acknowledged debt to Germany's great Romantic, most succinctly summarized in the The Origin of Species (1859) closing trope of the tangled bank:

> It is interesting to contemplate a tangled bank, clothed with many plants of many kinds, with birds singing on the bushes, with various insects flitting about, and with worms crawling through the damp earth, and to reflect that these elaborately constructed forms, so different from each other, and dependent on each other in so complex a manner, have all been produced by laws acting around us. (450)

Darwin sought reasons to be sanguine about his notion of natural selection, and the aesthetic of the Law he rendered into prose invokes at least as much Humboldtian harmony as it does Malthusian mêlée. Though admittedly no avid student of literature, Darwin's narrative choice to place his empirical eye in the midst of an entangled intermixture, the closing image of his great work, demonstrates his debt to a newfound secular valuation of a complex, irreducible network of biological life.

Close on the heels of Darwin's discovery of natural selection, Stephen Forbes is the American naturalist who was first to put the microcosm to work as an explicit scientific practice. The influence of earlier nineteenth-century science is evident in

[23] See also Sachs's (2006) discussion of Darwin and Humboldt, 240-241.

the discursive narrative style of his paper, "The Lake as a Microcosm," presented in 1887 to America's Scientific Association. A systems understanding of the environment conveys organic sensibility, as though the organization of disparate parts itself constitutes a higher sense of awareness that can never be appreciated in a machine universe:

> Nowhere can one seem more clearly illustrated what may be called the *sensibility* of such an organic complex, -- expressed by the fact that whatever affects any species belonging to it, must speedily have its influence of some sort upon the whole assemblage. He will thus be made to see the impossibility of studying any form completely, out of relation to the other forms, -- the necessity for taking a comprehensive survey of the whole as a condition to a satisfactory understanding of any part. (77)

This "comprehensive survey" is particularly taxing on the scientist faced with the task of explaining, in prose, his hypotheses of inter-organization. The dry, cataloguing discourse of rational science is not equipped to convey such images of hierarchy and dependence: it effectively describes experimental design, controls, the outcome of trials, and conclusions. But the laucustrine microcosm, like Humboldt's cosmos and Darwin's narrative of natural selection, continually appeals to anthropomorphic language for intelligibility. As a result, these accounts read more as literature than as modern science. Forbes continues:

> First let us endeavor to form the mental picture. To make this more graphic and true to the facts, I will describe to you some typical lakes among those in which we worked, and will then do what I can (with much difficulty and perplexity no doubt, and I fear with no very brilliant success), to furnish you the materials for a picture of the life that swims, and creeps, and crawls and burrows and climbs through the water, in and on the bottom and among the feathery water plants with which large areas of these lakes are filled. (79-80)

He seeks an image, a metaphor for that "picture of the life that swims," and his image is framed by the boundaries of a little lake; his metaphor of microcosm is both literal,

in the sense of biosystems, and it relies on an open imagination for figuration. Chapter three of this study will turn this imaginative eye on the literary works that anticipate such hybrid epistemology as ecosystems science, and I will return in more detail to Forbes's work in the final chapter of the study. Forbes's "Lake as a Microcosm" serves as a pivoting point between literary and scientific uses of the microcosm trope.

This survey of nineteenth-century science has established the common ground from which literature began to elaborate the human condition in a post-Classical age. It is not valid or defensible to assign either a scientific or literary approach primacy; both were actively processing the implications of human mutibility in a contingent, dynamic world. By accepting the mutual influence of empiricism and imagination even within a single brain, as well as among consortia of intellects, we can see how the bewildering transition from being, in the created sense, to becoming, in the evolutionary one, informed new methods of understanding the world during the industrial era. Even lacking the genetic principle of mutation, a discovery of the twentieth-century, intellects discovered that there were wild, unpredictable impulses within the formerly static systems, and that this wildness, rather than exception or anomaly, was a principle by which life (d)evolved.

Kant had introduced the *a priori* principle into objective science of the eighteenth-century, flagging the human instinct to perceive teleology, an assumption of the Classical age. Kant brought the observer into the observation, rendering our senses and reason involved, rather than austere. The questions became personal; they involved aporia on the nature of ourselves, as well as how we approach valid

knowledge. With the brave new industrial world rapidly unfolding, a new emphasis fell on dynamic prediction. In literature, prediction often took the form of our deepest hopes versus our darkest fears, the many worlds that could come into being -- for the static, created world was now a relic of the past.

With these environmental conditions of the nineteenth-century surveyed, we may now turn to the literature of the century that explores ways to narrate unpredictable nature, and how patterns and models might be generated. Chapter two investigates four distinct narratives of environmental chaos spanning the long nineteenth century: Gilbert White, Mary Shelley, Richard Jefferies and H.G. Wells, emplot the radical new notion of a post-apocalypse environment in narrative schemes that rely on chaotic discontinuity, rather than the coherent gradualism that marked evolutionary theories of the time. The first three narratives were written at least partially in reaction to a massive volcanic eruption, and my readings investigate how imaginative literary works of the long nineteenth century process apocalyptic moments and their aftermath.

Chapter three moves into the various uses of microcosmic imagery in the work of several important poets, including William and Dorothy Wordsworth, John Clare, Percy Shelley, and Matthew Arnold. The microcosm has been figured through poetry as representing the psyche, the body, and the circumscribed plot of land. This chapter shows how the trope evolved from its metaphysical roots in Plato, who held that the human body was a microcosm of the Earth, into a true empirical strategy dedicated to understanding the anatomy of small natural systems like islands and lakes. I argue that the imagination and close observation of nineteenth century poets

helped the nascent sciences conceive of ways to simplify nature without dismembering its complex structures.

Chapter four, devoted wholly to the ecological thinking of Keats, traces his fragmentation of teleological narrative in the *Hyperion* poems in preference for the little worlds of the Odes. His transition from Miltonic blank verse in 1818 to the self-developed voice of his most personal metaphysical excursions in 1819 may show an intentional re-evaluation of what poetry of the environment could accomplish in his century. Though the Odes (especially *Nightingale*, *Psyche*, and *Autumn*) are already known as superlative poems of the Romantic period, I build upon recent ecocritical readings (particularly Bate [2000], and Bewell [1999]) that claim they are *avant-garde* in ecological conception. Proceeding from Bate's eco-existential reading of the Odes, my thesis pursues the Odes' imagistic and formal qualities, which amount to an early study of systems ecology.

Finally, chapter five reconciles the two tropes with an excursion into modern ecosystem science, paying particular attention to our contemporary strategies for investigating the climate change phenomenon. Though this chapter serves as a summation of the dissertation, it also complicates the dichotomy between narrative and model-microcosm, and brings the study into concerns of the present day. I introduce ideas of non-conformist ecologists of the twenty-first century, such as William Cronin and Tim Allen, who criticize the predominance of models and mechanisms (the offspring of a microcosmic view), and favor a recovery of narrative in ecological science. Global warming narratives, most of them disaster scenarios, are our updated version of the industrial narratives that germinated from nineteenth

century soil. Hardly 250 years into the industrial revolution, we face apocalypse narratives factually based in science, which deliver informed accounts of what might happen to the ultimate macrocosm, Earth.

Chapter Two: Chaotic Dynamics in Four Ecological Narratives

I: Introduction

This chapter will trace an alternative pattern of chaos that contrasted with the hegemony of coherent gradualism in narratives of the nineteenth-century. The prevailing gradualist thought about nature was based on a particular interpretation of geological evidence, and this coherent scheme of deep time unfolding with relative uniformity strongly influenced Darwinian evolutionary theory. The four narratives of environmental rupture I investigate show what an alternative state involving chaos could impose upon traditional narrative structures. With the innovative use of randomness, contingency, and indeterminacy in these stories about nature, the authors find a new frame for figuring the tempo of environmental change and human involvement in contingency. Their infusion of chaos into natural histories (even fictional ones) is linked to Foucault's theory of post-Classical thought in the nineteenth-century, which suggests that the "dehistoricized" human of the post-Enlightenment era was forced to realize that humanity had no special place in nature nor any Providential destiny. Filling this ontological vacuum is a valuation of the power and potential inventiveness inherent in a chaotic worldview; the discovery of a new infinity.

My sampling of works considers representative texts from moments in history that required explanation for what was happening in the evolving relationship between culture and nature; consequently, they fall roughly at generational footsteps across the long nineteenth-century: The 1780s (White), the 1820s (Shelley), the 1880s

(Jefferies), and the fin-de-siècle (Wells). James Chander's England in 1819 (1998) proposes a theoretical rubric for re-integrating historicism in Romantic studies by focusing on specific years that can be seen as 'representative' of a spirit of the age: 1798 and 1819 stand out as years of spectacular literary output and pivotal events in history, and yield representative anecdotes that clarify the historicist project in twenty-first century literary criticism.[24] This chapter benefits from Chandler's strategy by aligning specific environmental events with literary production: my selection is informed by actual dramatic events in the natural world, especially volcanoes. Though a coherent evolution in ideas about chaos over the course of the long nineteenth-century is elusive, trends of modernization in the chaos trope are demonstrable as indicators of literary minds influencing, and influenced by, scientific advances. For example, Gilbert White in Enlightenment-era 1789 assumes he will find a static, perennial nature in his parish and finds surprising evidence to the contrary when storms, landslides, and volcanoes roar; by 1895 H.G. Wells can manipulate the gradualist theory of evolution by natural selection to imagine deep, atelic disjunctions between the Victorian age and the deep future. Both writers produced narratives of chaotic change that challenged scientific and religious conventions of their time, but both works are still heavily imprinted by the cultural conditions of their emergence.

[24] Chandler explains his methodological strategy that balances between history and ethnography: "I attend closely to a number of mediational moments [in 1819], stressing that the return to history in recent years returns to a much older conjunction of two discursive frameworks: a discourse of chronology, which Levi-Strauss attempted to reveal as the 'historian's code,' and a discourse of culture, which presumes a sense of equivalence between historiographical and ethnographical operations. In the latter, this sense of equivalence is itself grounded in the practice of correlating the uneven development of societies in relation to a given 'state of the world'" (36).

This interest in identifying revolutionary ways that nineteenth-century writers imagined patterns in nature is linked to another historical trend: how industrial pollution was increasingly figured into narratives of environmental disaster. Especially in the earlier works (White and Shelley), industry plays only a minor role in affecting nature's behavior. By the second half of the century, Jefferies and Wells designate industry's pernicious effects as an essential component of nature's behavior, introducing a moral, environmentalist thread to their writing. Relevant to the theme of pollution and sudden change is the fact that three of these four works were written in the historical context of major volcanic eruptions. As discussed in chapter one, volcanoes were the first indicator that atmospheric chemistry can be changed by sulfuric and carbonic emissions, and these gasses and particulates were eventually linked to industry.[25]

Each writer has conceptual insights borne on observation and imagination that contribute innovative ideas about change in nature; these ideas foreshadow theories in modern chaos ecology, particularly population ecology, succession dynamics, meteorology, and climate change. Gilbert White studies population fluctuations and extinction in Selborne, and writes dramatically about Laki's eruption and its chaotic influence on the atmosphere in 1783. Mary Shelley, whose Frankenstein (1818) was directly precipitated by the Tambora eruption of 1816, counters the cooling and

[25] Max Nordeau's essay on *Degeneration* (1892) represents the end-of-century realization that industry in urban areas has epidemiological consequences because city folk breathe "an atmosphere charged with organic detritus…one can compare him without exaggeration to the inhabitant of a marshy district" (quoted in Otis 526). Nordeau's reversion to the older, miasmic theory of disease that had been disproved by Pasteur, Koch, and Lister in previous decades shows the conceptual difficulty of distinguishing unhealthy places from unhealthy microorganisms that hold their niche in those places (Otis 575). Both atmospheric pollution and disease transmission are ecological issues because they depend on the relationship between physical environment and measurable features such as air chemistry and microbial indigenousness.

clouding of a volcano year with miasmic accounts of atmospheric warming in The Last Man (1826). Her epidemiology of universal plague examines extinction as tragedy, but serves to reinforce a Malthusian worldview where unpredictable checks on population are a constant stressor on survival. Richard Jefferies wrote under the conditions of 1883's eruption on Mt. Krakatoa, which resulted in crop failures and local famine for several years afterwards. His knowledge of Darwin and his own gift for narrating evolutionary change result in a prescient account of biological succession based on initial conditions. London's virulent air and water pollution in the Victorian era is invoked when he imagines the chaotic afterlife of the industrial environment. H.G. Wells was brought up in working-class industrial London amid its poor environmental conditions, and his utopian vision of the tropical garden of London in the deep future quickly disintegrates into a realization of a dystopian machine world. His vision of the future holds a sophisticated interpretation of evolution that directly challenges progressive gradualism. Fortuitous events in population dynamics and climate change are essential components to his scientific projection of the future.[26]

Geology by the nineteenth-century had outlined two distinct patterns for how deep natural history might have unfolded. These contrasting theories of catastrophism (Cuvier's paradigm) and gradualism (Lyell's) were both supported by the fossil patterns to a limited extent, and lively debates about the nature of deep time

[26] Further reading to reinforce these cultural-environmental junctions includes: Stuart Peterfreund, "'Great Frosts and … Some Very Hot Summers': Strange Weather, the Last Letters, and the Last Days in Gilbert White's Natural History of Selborne" (2003); Christopher Goulding, "A Volcano's Voice at Eton: Percy Shelley, James Lind, and Global Climatology" (2003); Jeremy Hooker, "'Which Way is England?: Richard Jefferies's After London" in his Writers in a Landscape (1996); Katalin Csala-Gati, "The Socio-Biological and Human-Ecological notions in The Time Machine" (2003).

continued through the nineteenth-century when biological change came to the fore among scientific concerns. Darwin's evolution by natural selection builds upon Lyell's geological views, and the doctrine *natura non facit saltum* (nature does not proceed in leaps) is essential to Darwin's theory that omniscient natural selection slowly carves adaptive forms from the variations in populations, and requires a steady, deep evolutionary time to make those forms apparent. Peter Bowler (2003) discusses the influence of geology on evolutionary theory according to the dichotomy of continuity versus catastrophe:

> Lyell's steady state worldview was a by-product of his desire to uphold the 'principle of continuity,' according to which there were no breaks or sudden steps in the sequence of events, no causes outside the everyday range of experience. This aspect of his geology impressed Darwin, and Darwin's theory of evolution is a classic expression of the principle of continuity in biology. It uses only processes that can be observed at work in modern populations to explain changes in the past…Modern evolutionism has managed to combine the elements of continuity and cumulative change that were polarized in Lyell's time…the catastrophist form of discontinuity has reemerged in the theory that the history of life has been punctuated by mass extinctions caused by asteroid impacts. (9-10)

The narratives I interpret in this chapter used catastrophe to make sense of nature's patterns of change over time, and they did so by moving entirely beyond "the everyday range of experience" into empirical and emotional exhibitions of the extra-ordinary. These works of natural history, both experiential and fictional, explore the implications of catastrophe and establish a modern narrative aesthetic based on violent discontinuity. The literary appraisal of disasters in natural history is continuous with contemporary ideas of chaos ecology and punctuated equilibrium.

Most great novels of the nineteenth-century conformed to the convention of nature's constancy as a stage beneath human historical turmoil, from Scott to Austen,

Eliot to Gaskell. Nature may change cosmetically from anthropogenic stresses, as in Gaskell's North and South (1855), but these industrial imprints are set into the stable, fostering, motherly nature of gradualism. Where classic novels like Middlemarch (1874) and Bleak House (1852-3) prized coherent conclusions advancing moral arguments centered on human action, more modern narratives of environmental disaster drew momentum from the mystery surrounding sudden and extreme events in natural history. Furthermore, natural history in the industrial age became entangled with human activity; ecological damages apparent in the air, water, and soil towards the end of the nineteenth-century became focal points around which to organize modern drama.

By the end of the nineteenth-century, a well-recognized collective anxiety had settled on the British consciousness, and concerns about degeneration, squalid urbanism, substance abuse, and widespread psychosis became deeply informative to Victorian novelists. Stephen Arata (1996) has shown how the "decidedly eschatological impulse" of fin-de-siècle novels indicates that biological theories of devolution served as conductors for theorizing social decay, in effect laying a scientific foundation under "a form of common sense" (1, 2-3). Arata's focus on degeneration takes famed cases such as The Strange Case of Dr. Jekyll and Mr. Hyde (1886), The Picture of Dorian Gray (1890), and Dracula (1897) as epitomes of physiological and psychological degeneration in Victorian novels. I seek to extend this project by looking at ecological degradation as an essential *tristesse* of the nineteenth-century novelist, and also as a new beginning. Visions of decay, but also of renewal and renaissance through environmental chaos make these works much

more than dramatic elegies for their respective eras in the nineteenth-century. In chaotic narrative, catastrophe may engender unforeseen bounties.

These four innovative works that experiment with setting human agonists within a vortex of changing nature relate back to the "dehistoricized" narrative Foucault has identified as essential to post-Classical thinking (369). The energies of transformation in the biological world defied the predictive mechanics of Newtonian physics and Copernican cosmology, and held great imaginative potential for theorizing other kinds of patterns in nature. By putting flesh back on the fossils of Cuvier's geological catastrophism, these writers invoked new ideas of natural contingency in their narratives. The genre of the ecological thriller sometimes affords a paradoxical sense of control, when characters hold latent capabilities that come to shine under the new exigencies of environment just as the old, outworn culture is turned under. Chaos becomes a new outlet for romance, with fresh adversities confronted by modern heroes: disease-impervious wanderers, post-apocalypse pilgrims, time travelers. The eco-thriller is also receptive to tragedy and subversive comedy, as H.G. Wells so brilliantly realized, so fresh stores of human emotions and futuristic imagination could be tapped using this proto-ecological genre.

The larger thesis at play here is that literary schemes of sudden environmental change predate, and to some extent anticipate, the twentieth-century scientific paradigm of chaos as one of nature's essential patterns. Whenever a truly ecological concept appears in these four narratives, I claim the literary priority on that idea, whether or not that work was read and interpreted by later scientists. Unfortunately, the late nineteenth- and twentieth-centuries witnessed an estrangement between

humanist and scientific learning, so an argument based on direct causation between literary parentage and scientific heir is, for most ecological concepts, elusive. I don't consider an immediate influence as necessary, however, for an illuminating study of how the first industrial culture produced innovative theories of contemporary nature.

In his later writings Richard Jefferies (c. 1887) expressed a belief that scientific theory is formalized directly from intuitive findings of long-established cultures, using the kind of folk-knowledge that helped pre-scientific societies navigate and survive in a mysterious natural world:

> If you have been living in one house in the country for some time, and then go on a visit to another though hardly half a mile distant, you will find a change in the air, the feeling, and tone of the place. It is close by, but it is not the same. To discover these minute differences, which make one locality and home healthy and happy, and the next adjoining unhealthy, the Chinese have invented the science of Feng-shui, spying about with cabalistic mystery, casting the horoscope of an acre. There is something in all superstitions; they are often the foundation of science. Superstition having made the discovery, science composes a lecture on the reason why, and claims the credit. (2001: 92)

Jefferies's point, besides the gentle jab at Baconian scientific hubris, is that scientists do not observe the natural world with pure objectivity; scientists come to study systems in nature with the wisdom of their own culture as a standing hypothesis. The theories of miasma that were paradigmatic in the nineteenth-century were based on morbid relationships between people and certain environments, and resulted in superstitious behavior. Science's formal "lecture on the reason why" with the rise of epidemiology is continuous with the folklore knowledge that sets taboos on unhealthy places, and establishes aesthetic traditions that favor healthy landscapes and dwellings.

Where Jefferies highly appraises folk knowledge of nature, Gilbert White shares the "superstitious awe" of Selborne's denizens when a volcano stains the sky,[27] Mary Shelley's heroes rely on superstition and augury to guide them through the harrowing, chaotic patterns of a plague, and H.G. Wells's time traveler is educated by the social behavior of the Eloi, who shun the Morlock wells and desperately fear nightfall (when Morlocks advance), before he realizes the right theory about their predator-prey relationship. These authors are devoted to demonstrating, though the medium of literature, how cultural wisdom that is stigmatized as superstition is actually the ground upon which scientific fortresses are built.

The first work, Gilbert White's Natural History of Selborne (1789), is the only nonfiction work among the four; it is best defined as a chronicle proceeding through decades of close study. White's understanding of the events around him progresses from an aesthetic of Classical cycles towards a more bewildered and open-ended vision of wild, unpredictable nature. He invokes Milton's chaos as a literary device that gives imagistic energy to his descriptions of the meteorological chaos caused by Laki's eruption. The three later novels I analyze in this chapter use sudden environmental change as a new mechanism driving human history; each imagines a futurity in which the nature of nineteenth-century Britain has succumbed to some

[27] Richard Jefferies wrote an introduction for the 1887 edition of Gilbert White's *Selborne*. Though he is full of admiration for the perspective on a small landscape that White attains, he is critical of White's ignorance of the people of his parish. Their folk wisdom, Jefferies implies, was lost in White's scientific narrative: "If the great observer had put down what he saw of the people of his day just as he had put down his notes of animals and birds, there would have been a book composed of extraordinary interest…he saw and heard all their curious ways, and must have been familiar with their superstitions…It must ever be regretted that he did not leave a natural history of the people of his day" (quoted in Looker 1965: 180-181). White's passage about the superstitious fear demonstrated by country folk in the summer of 1783 is notable because he both distances himself from this "primitive" reaction to the volcanic weather and he partakes of the same emotions of awe and wonder at the atmosphere's colors.

ecological punctuation event. Mary Shelley's The Last Man (1826) unravels a tragic tale of apocalyptic epidemiology; Richard Jefferies's After London (1885) envisions a revolutionary fallow period and a return to feudal society following a mass extinction in England; H.G. Wells's The Time Machine (1895) narrates a deep evolutionary future deterministically-evolved from the social circumstances of industrial society. Each of these narratives gestates the infant paradigm of ecological dynamism in its distinctive way, and the environment of industry increasingly influences projections of the human legacy after the nineteenth-century (all three novels take place in the future).

My use of the trope of chaos as a method of narrative analysis requires a brief preliminary discussion. In literature beginning with the Renaissance and perhaps most notably in Milton's work, chaos appears as figured in its original, related denotations: It is a formless void, an imbroglio of elements, a conglomeration of things without shape or order. There is an awesome power unleashed in images of chaos in *Paradise Lost*, as chaos is the realm of Satan, but it is also God's workshop from which He creates the divinely ordered natural world. Chaos is the Garden's ontological opposite; however, the two realms are polarized by a difference in coherence, not in an opposition of material versus immaterial. Chaos is the elemental world deprived of any principle of organization; its analogue in biological origins is the primordial soup of amino acids or RNA from which, it is theorized, life spontaneously organized (perhaps with the energetic assistance of lightning). These images of ultimate material disorder, which hold essential imaginative power in their potential for a future scheme of order, are the chaos that writers of the nineteenth-

century would have held in their lexicon. Though chaos denotes disorder, it is inconceivable without the complement of some system in which the chaos of elements will find coherence. In Creationist tradition, the Deity is the organizing force; in evolutionary theory, there inheres a principle of nature that spontaneously (without requiring an outside intellect) articulates adaptive forms from simple laws; Darwinists would call that law natural selection, but postmodern evolutionists have further appraised the random agents of mutation, genetic drift, and catastrophe in the evolutionary play.

From this chao-theistic origin in myth and literature emerged a second denotation of scientific chaos that stands in parallax with the first: it holds a slightly different perspective on the same object of study (nature), and suggests an error in the original perception. Mathematics of the mid-twentieth-century demonstrated the new chaos as an empirical pattern denoting the spontaneous order that can appear in complex systems. Order does not demand a teleological endpoint; this fortuitous order merely implies that the elements of a system generate emergent relationships through time. The evolution of a chaotic system appears random at many levels of analysis, but with the proper scope of investigation chaotic systems demonstrate an articulate organization, and emergent interrelation of parts. Chaos in this sense was added to the Oxford English Dictionary in 1997, defined as "behaviour of a system which is governed by deterministic laws but is so unpredictable as to appear random, owing to its extreme sensitivity to changes in parameters or its dependence on a large number of independent variables" (*OED* online, 1997 Additions Series). Chaos theory circumvents the obvious fallacy of a static nature and deconstructs the more

subtle fallacy of a teleological, gradualist natural history by introducing random potential to every moment.

The four chaotic narratives in this chapter are precocious from an ecological standpoint because they highly appraise random events in natural history and weave them into the fabric of futurity. I do not stress interdisciplinarity by claiming that these works demonstrate formal mathematical chaos; such a claim would play into objections that literary criticism oversteps its bounds by adopting scientific tropes as critical methodologies. However, the very pattern of sudden ecological punctuation is a timely contribution of a literary imagination. These works are precursors to contemporary chaos theory because they establish how chaos might look, not in equations or in recursive computer modeling, but in fictional narratives where nature's fabric has unraveled. They display how chaos directs the new ecological vision that seized the nineteenth-century cultural imagination. Each text imaginatively foreshadows the scientific theory that randomness articulates order in nature.

II: The Natural History of Selborne

Between 1768 and 1787, Gilbert White brought to the Enlightenment's resources the first in-depth, *in situ* study of an ecosystem. The text has never been out of print since it was first published in 1789. White's chronicle of The Illustrated Natural History of Selborne, which discursively reports on several aspects of Selborne's environment -- its geology, botany, and zoology in particular – is notable for its movement through time, with the three dimensions of space fixed in White's home parish.[28] His original use of *phenology*, the study of naturally-recurring cycles such as the seasons, provisionally advanced knowledge according to Enlightenment expectations of stability. A devotion to ornithology, in particular, predisposed him to detailing species migration according to predictable annual patterns.

Almost in spite of its design, however, The Natural History of Selborne deconstructs the Enlightenment sensibility of coherent, patterned nature. By the end of White's chronicle, the author views extraordinary environmental events as prescriptive of Selborne's natural state. Meteorological contingency becomes a principle of ecological behavior that White is determined to address, though the only epistemological tools at his disposal are close observation, basic measurement and epistolary narrative. The latter opened the way for a new century of chaotic

[28] Like a Jane Austen novel, the wider world of colonial politics sheds only indirect light on White's observations: his migrating birds have unknown harbors to the north and south; the grand oaks felled for £20 each are hauled off to military uses, he visits London and speculates on animal populations in America, but the circumference of his vision only occasionally gestures to other places than Selborne. Like the other works discussed in this chapter, the passage of *time* allows the observation of natural change rather than *place*. This distinguishes White's epistemological strategy from, for example, that of Alexander Von Humboldt, who traveled extensively in his researches on the natural world, and first theorized the importance of elevation to the distribution of plant types in the topography of the Andes range.

environmental stories, as generations of nineteenth-century Britons adopted his text as the model for a new kind of relationship with nature based not only on eternity and balance, but more importantly on sublime awe and indeterminacy.

Critics have nearly always distilled White's text down to precisely the inverse of chaos by celebrating its stable Enlightenment essence. David Allen's important study of the evolution of biological science, The Naturalist in Britain (1976), invokes such Classical paradigms. Selborne is "an irresistible classic: Somehow, it enshrines a portion of our necessary collective mythology…For it is, surely, the testament of Static Man: at peace with the world and with himself, content with deepening his knowledge of his one small corner of the earth, a being suspended in the perfect mental balance. Selborne is the secret, private parish inside each one of us" (50-51). Though the first two-thirds of White's chronicle are passably "at peace with the world" and imply the utopia of a microcosm, Allen's Edenic summation of Selborne's cultural import as a "collective mythology" that knows Paradise only as sunny spots of greenery is an incomplete reading. Though the Static Man may be responsible for outlining Selborne's initial coordinates like creations in the Garden, before the end of 25 years White has grown into a much less self-assured reader of the complex dynamics around him. Indeed, the opposite principles of unpredictability and discord come to command the narrative contours of Selborne, and bring it into the modern epistemological age of bewildering change. If Selborne were really a chronicle recording eternal peace it would be functionally obsolete; a twenty-first century visitor to the parish would find very little to recognize from White's account. Selborne is a classic text for modern times not because it depicts a

set of poignant by-gone myths about the balance of mother nature, but because White successfully divests the static paradigm in favor of a more frightening natural condition, that of discord and contingency. White's gift of empathy for the nature around him, a "much more modern gift" than mere observation, allows him to supersede his contemporaries with the rich texture of his chronicle and push it towards Romanticism (50).[29]

Donald Worster's (1994) evaluation of Selborne also figures the work within Enlightenment thought, though he shows how White's work was precocious of some ecological concepts. Worster emphasizes the importance of biological heterogeneity in the legacy of White's work, claiming that Selborne's diversity allowed White, "a man of considerable sophistication and learning, to devote his life to so small a terrain. In any case, in contrast to the general mania among eighteenth-century British scientists for collecting and cataloguing exotic species from the farthest corners of the world, White's attention was remarkably focused on this microcosm, the natural order of his little parish" (6). Selborne possessed the diversity required to demonstrate intricate symbioses between species, the anchor of an ecological vision based on nature's balance or economy (indeed, Worster's history is entitled Nature's Economy). But the microcosm of Selborne, White would discover, was vulnerable to violent change and rapid degradation partially by virtue of its diminutive scope.

[29] Mary Ellen Ballanca's recent study of naturalist journals, Daybooks of Discovery (2007), briefly discusses the critical reception of *Selborne* as an Enlightenment, static text, see especially p. 46, 75-77. Bellanca finds more subjective speculation-as-epistemology in White's early journals, which she usefully captures as "a palimpsest of concurrent and intersecting narratives" that show "his fascination and delight in an ever-living yet ever-changing, ever-elusive, ever-miscellaneous nature" (77). Though I agree with her evaluation of White's narrative multiplicity, my reading of Selborne centers more on the epistemological mysteriousness borne of observing unruly nature than on White's "delight" in dynamism.

These theories of chaotic endangerment have not been developed in the critical literature on Selborne.

By 1770, two years into his study, White details the elaboration of more precise methods of observation, and gives himself the title of "monographer," he who writes on a single, scientific subject:

> Men that undertake only one district are much more likely to advance natural knowledge than those that grasp at more than they can possibly be acquainted with: every kingdom, every province, should have its own monographer (125).[30]

White's single subject is not a taxonomic group, it is a location; his circumference is not defined by species, but by ecosystem. Though Selborne is not an "ecosystem" in the modern biological sense of a semi-closed unit of interdependent organisms and their abiotic media, Selborne is a parish, the socio-political analogue to ecosystem. A parish represents a territorial unit governed by a representative of the church, and geography operates on the bordering phenomena of mountains, rivers, and oceans. White's parish-ecosystem, then, revisits the limiting principles of ancient feudal territories: The Anglo-Saxon estate established borders by defensibility, a highly geographical consideration that holds connections with the ecological relations of an area. Selborne is not a coastal parish, nor is it featured like the midlands. White celebrates the microcosm of Selborne for the biodiversity it holds as a southern parcel

[30] The OED shows White's use of "monographer" in 1770 as the first in the language. The next citation, from 1826, is from an introduction to Entomology that identifies Apollodorus as the "first monographer of insects." Later in his own narrative, White advises that "A good monography of worms would afford much entertainment and information at the same time, and would open a large and new field in natural history" (197). This monograph was not to appear until Charles Darwin's The Formation of Vegetable Mould through the Action of Worms (1881), a work that does not acknowledge White.

of land not far from the sea, and its feudal history assures the circumscribed autonomy necessary for a monographic study.[31]

Over the course of four letters he comes to realize the strong potential of this serendipitous method of monography-by-location. It began with simple recording designed to enable a more detailed report. But even from this commonplace, White's instincts push his science towards innovation:

> For many months I carried a list in my pocket of the birds that were to be remarked, and, as I rode or walked about my business, I noted each day the continuance or omission of each bird's song; so that I am as sure of the certainty of my facts as a man can be of any transaction whatsoever…(117)

The key concept here is White's notice of "omission" in migratory patterns. Not merely the presence of an individual from an identifiable species, but also the absence becomes formalized towards facts in the natural history of Selborne. Here is a crucial turn in methods of ecological knowledge: science was accustomed to in-depth study of apparent, observable, material entities, but it had no way of getting to the gaps and absences that are equally important to understanding patterns of species distribution through time, especially in disturbed environments. White's pocketed list accumulates the + of presence alongside the 0 of absence, and observation gains a new dimension of explanatory power by making use of both a phenomenon (the red-breast was singing today) as well as its inverse. White was eager to formalize his

[31] The opening passage locates Selborne geographically, with a balanced tone that appreciates both self-containment and diversity: "The parish of Selborne lies in the extreme eastern corner of the county of Hampshire…is about fifty miles southwest of London, in latitude 51…Being very large and extensive, it abuts on twelve parishes…The soils of this district are almost as various and diversified as the views and aspects" (7). The ornithologist White is proud of Selbone's literal containment of the great bird menagerie: "Selborne parish alone can and has exhibited at times more than half the birds that are ever seen in all Sweden…Let me also add that it has shown near half the species that were ever known in Great Britain" (96). These passages secure the parish of Selborne as an ecological microcosm, and anticipate the modern philosophy of 'bioregionalism' advocated by environmentalists such as Kirkpatrick Sale (1985).

methods of observation and recording in a way that begins to resemble early population ecology.[32]

Before White, the commonsense assumption was that where a species is not found, that species is not to be studied. His decision to focus on the organic interactions and environmental events of his home parish provides a crucial trial of the stability through time that Natural History had assumed to be inherent to created nature. By focusing on a single place through time, and appreciating the elucidating power of a negative phenomenon, White was able to narrate the scientific observation of ecological variation, and even irreversible change in its fundamental patterns. This discovery is far afield from White's original phenological rationale to formalize the reliable and unvarying episodes that guided Selborne through the cycle of a cosmic year. Extraordinary events of environmental disturbance (cold, heat, drought, landslide, extinction) become more and more frequently White's occasion for writing on some phenomenon, especially for the letters of the 1780s. Because of its innovative methodology, White's Selborne implicitly disavows Classical cycles set in eternity, and looks towards modern contingency with some trepidation.

The widespread appeal of White's chronicle rests partially on his caring and concerned voice for all the non-human denizens of Selborne; he shows more affection for oaks, turtles and worms than for the "hordes of gypsies which infest the south and

[32] His note on the distribution of animals in Selborne leads to pressing contemporary questions about nature in America, and further speculation: "how [animals] came [to America], and whence? is too puzzling for me to answer; and yet so obvious as often to have struck me with wonder. If one looks into the writers on that subject little satisfaction is to be found. Ingenious men will readily advance plausible arguments to support whatever theory they shall chuse to maintain; but then the misfortune is, every one's hypothesis is as good as another's, since they are all founded on conjecture" (65). White is asking how the biology of populations could study distribution patterns, and how ecological hypotheses themselves are to be tested empirically. Later I will discuss his avant-garde observations of wasp populations. The predator-prey relationship is one of several in the ecological sciences to make use of scientific chaos.

west of England" (179). The results of human activity are too-often destructive of the peaceable web of species in Selborne: where the oak is felled, the intrepid mother bird is struck dead (11); where hunters are unreasonable in their kills, the partridges and red deer become rare or extinct, leaving a "gap" in *Fauna Selborniensis* (22); lowly worms are essential to soil health (196). White writes,

> Earthworms, though in appearance a small and despicable link in the chain of Nature, yet, if lost, would make a lamentable chasm…Worms probably provide new soil for hills and slopes where the rain washes the earth away; and they affect slopes, probably to avoid being flooded. Gardeners and farmers express their detestation of worms…But these men would find that the earth without worms would become cold, hard-bound, and void of fermentation; and consequently sterile. (196)

White's religious-Enlightenment paradigm of the great chain of being is here stressed by these undeniable gaps and chasms in the interdependent biotic network. His point falls hard on the ignorance of humans, when even those who make a living from the earth, the farmers and gardeners, assume the subordination of other species rather than their natural synergy. As White observes, nature's economy is a precondition to stability; when that economy is violated, surprising imbalances become manifest and have noticeable effects on the web of life. The over-hunted red deer is now a specter of seventeenth-century Selborne, and other populations inevitably become stressed under the hunters' sights. Since humans are part of, rather than elevated over the economy of nature, White's advice is to place intrinsic value in diversity, a fundamental prerequisite to conservation.

White's history shifts from an occasional tone of lamentation for a species lost towards less self-reflexive expressions of awe and fear at the unpredictable

meteorological events of the 1780s.[33] With a gathering appreciation for the power of sporadic weather over the course of 25 years, the narrative gains momentum by considering the effects of climate anomalies on established ecological relationships. White explicitly brings meteorology, the study of the unpredictable or "meteoric," into Selborne's history:

> Since the weather of a district is undoubtedly part of its natural history, I shall make no further apology for the four following letters, which will contain many particulars concerning some of the great frosts and a few respecting some very hot summers, that have distinguished themselves from the rest during the course of my observations. (253)

This letter, number 61 out of 66 total, opens an extended exposition of sublime phenomena noted objectively as temperature and barometrical readings, but also attendant to the subjective psychological affect of the unusual, and even the unprecedented, in these surprising turns of natural history. White is never able to return to his initially calm narrative voice that observes cyclical, consistent patterns from the commonplace of Deistic design, or Enlightenment intelligibility.

His language comes to rely on exceptional terms quite foreign to a natural theology based on the balanced economy of nature: paradox, severity, loathsome, amazing, tremendous, extraordinary, portentous, superstitious, strange, prodigious, violent, deluging, convulsed, and fierce all appear as descriptors in the final series of letters (253-268). The four letters that detail sudden and unseasonable extremes of warmth and cold prepare the reader for the last two entries, which detail the

[33] A primer for the narrative tone at the end of *Selborne* comes when a landslide, caused by a sudden massive thaw, tears a "huge fragment" hundreds of yards down a steep slope. Houses, woods, and farm fields are "strangely torn and disordered" by the mysterious event; all witnesses agree "that no tremor of the ground, indicating an earthquake, was ever felt" (222-223). In this as in other apocalyptic passages, White offers little speculation as to the causes; he seems to enjoy lingering in the perversity of the incident, allowing sensation to work its own effect out of the objective account.

atmospheric effects of 1783's Laki volcano eruption in Iceland and the sublime thunderstorms that accompanied this many-leveled catastrophe. White uses these extreme observations rhetorically, as well as epistemologically: the ethos established by his talent for close and patient description measures his brave new narrative of wild weather and brings to those passages a face-value believability that would have been lost in the work of more histrionic writers. White feels the need to "make no further apology" for the unorthodox content of his final letters; he feels confident as a respectable member of establishment science, as well as an independent-thinking scholar who knows the subject of his monography better than anyone else. Though Enlightenment natural history purports equal-access to the facts of nature, rendering the history's author irrelevant (the fraternity of equality based on an ideal of objective observation), White has come to possess Selborne as his own epistemological microcosm. Its own dynamic of nature makes intelligible the movements of a larger natural world, and he knows that his audience is eager to learn the lessons of the model, however surprised they are by its sudden recalcitrance.

White himself is surprised. Sudden, unseasonable changes in temperature determine the biological character of entire years, they are not merely passing inconveniences of physical discomfort. On the cold front, White "would infer that it is the repeated melting and freezing of the snow that is so fatal to vegetation, rather than the severity of the cold…thaws often originate under ground from warm vapours which arise…cold seems to descend from above…the author had occasion to go to London through a sort of Laplandian-scene, very wild and grotesque indeed" (253, 255, 258). The exceptional winter season shows White that extreme solsticial cold is

less damaging to the biotic community than is equinoctial vicissitude. Vacillation around a freezing temperature, especially during the growing season, is fatal to crops and ornamental plants, though it may be less apparently uncomfortable to humans.

Conversely, the summer extremes also bring variable effects: "The summers of 1781 and 1783 were unusually hot and dry…The great pests of the garden are wasps, which destroy all the finer fruits just as they are coming into perfection. In 1781 we had none, in 1783 there were myriads" (263). In the twentieth-century ecology portion of Donald Worster's history (entitled "Disturbing Nature"), Worster revisits Gilbert White by discussing this passage on the wasps. He calls the observations in this letter

> an example of nature's irregularities that had continued right down to the present. The point was that species did not all exhibit the same demographic patterns. Some remained numerically constant over long periods of time, others oscillated greatly from generation to generation but always around a stable long-term norm, while still others fluctuated radically each year, with no apparent norm, even when weather conditions were steady, *suggesting there was something chaotic in their genetic makeup or response to the environment*…the variability found among species made the science of ecology far more complicated than had long been supposed. [my italics] (1994: 410)

White has no desire to elide or simplify these chaotic patterns that become apparent when closely observed and recorded over years' time. Though he did not have the conceptual or quantitative tools to elucidate the mysteries of population fluctuation, his work effectively acknowledges a problem that the science of ecology would come towards modeling more than 200 years later.[34]

[34] The first mathematical model came with the famed Lotka-Volterra equations of the 1920s, which concentrated on the predator-prey dynamic as an isolated, strictly interspecies system without relation to environmental variation. In twenty-first century population biology, as described by theoretical ecologist Peter Chesson, "there is growing theoretical interest in understanding how pattern in the physical environment interacts with biology to yield the patterns that organisms show…Many

Culminating the wasp-laden summer of 1783, the Laki volcano in Iceland erupted, rendering the season

> an amazing and portentous one, and full of horrible phenomena; for, besides the alarming meteors and tremendous thunder-storms that affrighted and distressed the different counties of this kingdom, the peculiar haze, or smokey fog, that prevailed for many weeks in this island, and in every part of Europe, and even beyond its limits, was a most extraordinary appearance, unlike anything known within the memory of man…the country people began to look with superstitious awe, at the red, louring aspect of the sun; and indeed there was reason for the most enlightened person to be apprehensive… (265)

Though White has generally been able to maintain his enlightened distance from the superstitious masses in the interest of forwarding good observational, objective science, here he appeals to the forthcoming Romantic discourse that appreciates the awesomeness of natural forces as he admits to their irreducible mystery. Though frosts and heat waves are damaging of a baseline species routine, and may render a growing season less productive, they are small anomalies in comparison to this extraordinary event that caused widespread famine, stifling air pollution across Europe, and a particularly severe winter into 1784.[35]

Benjamin Franklin, on the other side of the Atlantic, is another Enlightenment figure who found that this volcanic eruption and its effects beggared reason.

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researchers appreciate that it is time to for the next step in which the role of physical environmental variation is a focus in theoretical models. There is also a growing realization that the details of how population and community patterns are affected by physical environmental pattern are every bit as fascinating as the details of endogenously generated pattern." One of the studies outlined in Chesson's (2003) summary involves "the rich interplay between nonlinear population dynamics and temporal environmental variability in a predator-prey model. [The researchers] show that the resulting population dynamics can look like chaos, as defined for noisy systems, and emphasize the care necessary for interpreting the nature of the fluctuations seen in short time series of population densities" (Abstract). When population ecology takes account of a variable environment over years' time, the system often shows non-linear and emergent properties consistent with chaotic dynamics.

[35] Dr. John Grattan of Aberystwyth University, Wales, has studied local parish records from 1783-1784 across England, and concludes that the Laki eruption killed 23,000 British men and women, which would make it "the greatest natural disaster in modern British history." An estimated 120 Million tons of sulfur dioxide was emitted, which is three times the total industrial output of Europe in 2006 (Walker 2007).

Franklin, not knowing whether a volcano was involved, called the phenomenon a "universal fog," and forthrightly rendered the mystery a useful predictive mechanism. If dry summer fogs were to become a new reality, "men might from such fogs conjecture the probability of succeeding hard winter, and of the damage to be expected by the breaking up of frozen rivers in the spring; and take such measures as are possible and practicable, to secure themselves and effects from the mischiefs that attended the last" (377). Franklin wishes to secure a useful indicator out of a confusing phenomenon. But for White, mischief of the most imaginative variety, rather than rational predictiveness, takes over his prose. He seems particularly fascinated by the solar warp and decay affected by the dense smoke; appealing to sublime imagery, the sun in 1783 "looked as blank as a clouded moon…but was particularly lurid and blood-coloured at rising and setting" (265).

White turns to the resource of literature to make a lasting image of this apocalyptic summer. He writes, "Milton's noble simile of the sun, in his first book of *Paradise Lost*, frequently occurred to my mind…it alludes to a superstitious kind of dread, with which the minds of men are always impressed by such strange and unusual phenomena" (265). The passage he quotes abuts a description of Satan as the "Arch-Angel ruin'd…th'excess of Glory obscur'd" (PL.I.593-594); having fallen, Satan's full angelic sun is occluded by his moral corruption, and his legions are filled "with fear of change" (598). Though Satan's band of fallen angels organizes in ranks, and they emit "A shout that tore Hell's Concave, and beyond / Frighted the Reign of Chaos and old Night" (ll. 542-543), the revolution itself is a principle of disorder set against divine cosmic harmony. White's allusion to Milton is suggestive: it figures

this ensanguined sun following Laki's eruption as a principle of corruption and error. The Laki phenomenon is neither to be ignored, nor can it be fully explained away; it partakes of the chaotic, rebellious dark side of the cosmos. And it is, without question, portentous of some set of environmental disturbances yet to come: at the very least, it unleashes earthquakes in Italy, sulfurous summer thunderstorms in Selborne and dusty, cold winters throughout the northern hemisphere. As Satan has only begun to cause trouble in the balanced, hierarchical world of God's creation, White confers a nagging sense of augury surrounding these "horrible phenomena." Between Milton's classical use of the Chaos trope and the contemporary, dynamical denotation, Gilbert White negotiates his observations in a bewildering scheme of random/predictability.

Selborne's final letter recounts a particularly violent thunderstorm in 1784, usually a rare event in Selborne because the parish is girdled by diverting hills. New technology brings the narrative atmosphere towards the nineteenth-century by anticipating moments of drama that writers like Mary Shelley would develop into poignant intersections of science and literature. White writes, "no storm was in sight, nor within hearing, yet the air was strongly electric; for the bells of an electric machine at that place rang repeatedly, and fierce sparks were discharged" (268). The electric principle, which formed the basis of new theories on the nature of life, was alive and detectable in the unsettled air over Selborne. But its purpose was dispersed and indeterminate; there was no discernable pattern to this meteorological behavior, and White is left only with his role as observer, admittedly finding in these strange events "reason for the most Enlightened person to be apprehensive" (265).

Somewhat abruptly, Gilbert White concludes his chronicle to his known and trusted public with a self-effacing, and revealing, adieu: "As the length of my correspondence has sufficiently put your patience to the test, I shall here take a respectful leave of you and natural history together" (268). Natural history of the Classical period has succumbed to modern contingency; this historian leaves the stage accompanied by the uncertainty for which scientists would need to develop a quantitative language to identify.

This reading of environmental contingency in White's Natural History of Selborne has, I believe, complicated the perennial reception of the text as the narrative epitome of Enlightenment stability and ecological balance. The work is innovative for several complementary reasons: its use of monography allows a microcosmic vision that anticipates the development of the ecosystem concept (credited to Roy Clapham and Arthur Tansley, ecologists of the 1930s); White observes and begins to theorize the extinction phenomenon due to human activity, which he images as gaps in the great chain of being; his predisposition to observe economy in nature by no means blinds him to the importance of extreme, unpredictable weather and its downstream effects through many seasons and across species. These elements of chaotic modernity in Selborne culminate in the chronicle's fragmentation, where the author divests his audience and his science at once. There is no indication in the text that White is particularly disconsolate as a result of his modern observations, but there is a sense that the phenomena are beyond the state of the science. Less than a century later, John Ruskin would lament the visitations of the industrial "plague-wind" in his famous jeremiad "The Storm-Cloud

of the Nineteenth Century" (1884), putting to rest all doubt that anthropogenic activity could sink a malaise into the atmosphere.[36] Like White, Ruskin used his longstanding diary entries on particulars of the weather as a basis for identifying meteorological anomaly amid a background stable state. Ruskin in 1884, unlike White in 1783, had the ecological effects of industrial emissions to aid his understanding of why and whence these events sporadically seize the elements.

[36] Ruskin's language begs to be quoted for its pure energy and industrial gothic imagination: The plague-wind "looks partly as if it were made of poisonous smoke; very possibly it may be: there are at least two hundred furnace chimneys in a square of two miles on every side of me. But mere smoke would not blow to and fro in that wild way. It looks more to me as if it were made of dead men's souls – such of them as are not gone yet where they have to go, and may be flitting higher and thither, doubting, themselves, of the fittest place for them" (637).

III: The Last Man

Mary Shelley's novel The Last Man (1826) appears to be a fiction far removed from the natural history chronicle of White's Selborne. Divided by genre and composed under the auspices of a different cultural climate, the two works nevertheless find common ground in their mutual concern for elucidating nature's patterns of dissolution, and both balk in the face of nature's chaotic plots. Shelley's work appeared as one of many "last man" narratives during the economic depression of the 1820s, long after the French Revolution fervor of the 1790s had chilled. A subsequent nationalistic conservatism reactionary to the political agitations of 1816-1819 kept radical writers under relative cover. Influenced by her knowledge of Malthus, The Last Man depicts the environmental checks on population that the famous economist had used as an argument against Enlightenment utopianism. It is one of the first of a series of nineteenth-century Thames Valley catastrophes; stories that form their own sub-genre by destabilizing the British identity during its colonial apogee. Like the later nineteenth-century catastrophe novels, which include After London and The Time Machine, Shelley's literary device for knocking down British narcissism is invoking the powers of a wild, witch-like mother nature. The contingencies and anomalies of European weather in 1816 caused by the eruption of Indonesian volcano Tambora provided conditions for a ghost story contest for which Shelley wrote Frankenstein. Shelley's flint-stone for sparking a human catastrophe on the scale of The Last Man is again wild weather and its weapon of disease. Her narrative plays out these ecological effects on mind, body, and species.

Shelley's vision is a tragedy of humanity's final, peripatetic years of suffering at the hands of a universal plague. A reader diagramming the hero, Lionel Verney, on his peripatetic journey could articulate an unbroken line that wanders circularly through Great Britain and, later, through the European continent as the survivors grow more desperate. The prolix account of his physical movements evinces a narrative mainstay of continuity because the novel progresses from the classic autobiographical beginning, "I am the native of a sea-surrounded nook…" to the promised resolution, "behold the tiny bark, freighted with Verney – the LAST MAN" (9, 470).

But the apparent coherence and predetermination of narrative course in Shelley's novel is misleading. The frame of The Last Man, contained in the preface, introduces a second author of the narrative, an unnamed vacationer who discovers, in 1818, the "Sibylline leaves" that are rendered into Verney's prophecy in novel form.[37] The Last Man is a narrative of fused fragments confused by time: anterior events are eventually seen to be posterior. The 1818 discovery of the Leaves near Naples *postdates* the end of Verney's tale, in 2100. This initial narrator, whom the reader never again encounters after the preface, defines his editorial role of constructive dissemination:

> I present the public with my latest discoveries in the slight Sibylline pages. Scattered and unconnected as they were, I have been obliged to add links, and

[37] Shelley's Frankenstein is a doubly-framed novel, a device that the author uses to great effect for manipulating point of view, narrative reliability, and temporal continuity. Though Shelley's use of framing in The Last Man is much more cursory, her ongoing devotion to this technique shows that there was some intentionality behind the preface, and undeniably its information complicates our understanding of the novel. One could claim that the preface's sole purpose is to seal off logical objections that the narrative of a last man would have no readers further in time, but her placement of the preface *anterior to* the agonies depicted in the narrative gestures to a more essential, if enigmatic, role for these initial five pages (out of nearly 500 total). It engages readings of prophecy delivered by the Sibylline leaves.

> model the work into a consistent form…Sometimes I have thought that, obscure and chaotic as they are, they owe their present form to me, their decipherer…My only excuse for thus transforming them, is that they were unintelligible in their pristine condition (6-7).

These "obscure and chaotic" fragments of a narrative are assembled in a certain order, one that is doggedly in pursuit of coherence and causality, part of our collective cognitive predisposition. In their discovered form they were admittedly "unintelligible," and this undeveloped outer-frame narrator claims responsibility for whatever makes causal sense in the unfolding of events, including his temerity to compose "links" between fractured episodes. Immediately, the apparent narrative continuity of Shelley's long novel is compromised by the conditions from which the text emerged. The tale of Verney, the Last Man, possesses none of its initial coherence when the traveler in 1818 discovers the story's fragments in a remote cave. This man (or woman) *after* the last man organizes a coherent story from the material chaos of a shredded prophecy from the future; the authorship of The Last Man is smeared between the wills of two composing minds dispersed in non-linear time. As Sophie Thomas (2000) notes, "where fragments of prophecy are discovered before the time of the prophecy's putative fulfillment, we have a document of what *will have been*" (35). Shelley's complicated scheme of succession defies temporal causation. Thomas continues, "I suggest that the novel is in fact driven by, or generated from, the dynamic established by its relation to the preface, while remaining unable either to fulfill or complete it, or even in a sense to arrive at it" (36).

Since the disparate worlds of 1818 and 2100 are denied even their temporal relationship and 2100 is represented in antique fragments that warn of proleptic

disaster in 1818, readers are left with a chaos of causation.[38] For a novel so poor in futuristic detail (the only technological advance in the late twenty-first century is a winged transport balloon), the narrative scheme itself is notably post-modern.[39] The outer narrator claims to bring sense to the chaotic fragments by imposing narrative order. Readers are given a narrative that has been doubly-worked to display harmony, causation, and coherence out of a background of random disorder. Any appearance of order, to a sensitive reader of The Last Man, is based on an illusive cognitive drive that interprets order from randomness rather than a reflection of the order of things in an objective sense.

Shelley's discernment between art and artifact is revealing. It allows authorship to remain indeterminate, and worries the fabric of classic linear narrative form so as to experiment with a diachronic and dialectic relation of origins. The fossil record was Enlightenment natural history's Rosetta Stone for translating the life-forms of the deep past into a set of historically-fixed markers of evolutionary progression. But the fossil record was famously imperfect, rife with gaps between pieces of evidence, and Charles Darwin in Origin was forced to explain away this layered text that was "a history of the world imperfectly kept, and written in a

[38] "Narrative chaos" is an angle on chaotic aesthetics that literary criticism has embraced. Volumes including Hayles (1991), Parker (2007), Conte (2002), Palumbo (2001), and Livingston (1997) look at narrative dynamics (especially in twentieth-century literature, and particularly in Joyce) through a post-structural lens of non-linearity and contingency. Science fiction and the visual aesthetics of chaos, including fractalization, are more recent avenues for this kind of work. Shelley's novel is surprisingly modern because of its unusual scheme of embedding multiple texts and authors in non-linear time, but these eccentricities have not been described using the chaos trope.

[39] Carolyn Merchant has imagined what form a chaotic narrative of natural history might take: "What would a chaotic, nonlinear, nongendered history with a different plot look like? … A post-modern history might posit characteristics other than those identified with modernism, such as a multiplicity of real actors; acausal, nonsequentioal events; nonessentialized symbols and meanings; many authorial voices, rather than one; dialectical action and process, rather than the imposed logos of form; situated and contextualized, rather than universal, knowledge. It would be a story (or multiplicity of stories) that perhaps can only be acted and lived, not written at all" (2003: 157-158).

changing dialect" because its aesthetic of fragmentation was so baldly opposed to the consummate Victorian's coherent, constant principle of natural selection (312). Only evolutionists of the twentieth-century (most notably Stephen Jay Gould and Niles Eldredge) have accepted that the existing fossil record is true to the pattern of natural history: sporadic, inconstant, contingent, and yet eventually affecting higher-order biological complexity. Without a doubt, grand coherent narratives can be wrought from historical shards, but these narratives inevitably owe some of their effect to what Yeats called "the artifice of eternity." Like the diffuse fossils that supported so many conceptual advances in the life sciences, the Sibylline Leaves are the true twenty-first century artifact, and their quilting into coherent narrative form allows their consumption by the nineteenth-century reading public. Ironically, Shelley's novel has received much more positive attention from her inheritors than it did from her contemporaries: The Last Man only came to widespread critical appraisal after a new edition was printed in American in 1965 (Parrinder 1995: 66). It came back on the literary scene once its time, environmentally and in literary theory, had finally arrived.

The plot itself revises the age-old story of the plague from Biblical traditions, but it grows beyond known cyclical patterns of population checks into a new precedent that marks humans for outright extinction imposed by their environment. The plague as a living entity acts sporadically amid an otherwise one-way progression to the end. Widespread confusion on many (categorical) levels surrounds speculation about the plague: it diffuses in winter, but appears capable of altering the environment to its advantage through a phenomenon akin to global warming (ecological); it is first

noted in war-torn Constantinople, but only arrives in England from an American ship (originary); earth-bound disease is accompanied by extraterrestrial anomalies like the tri-partite solar eclipse, which compels a tidal wave over Dover (catastrophist); only one inoculation is ever known to occur, that of Verney himself by the "negro half-clad" squatting in his London abode (epidemiological); the final two deaths in the narrative are caused by drowning, not by the universal pestilence (eschatological). From the above, we note that the plague is indeterminate of origin, it flourishes in coordination with an alien Nature that increasingly accommodates its infectiousness, cosmic events portend ill, but bear no known relation to the sublunary pestilence, human imperviousness is shown to be possible, but unrepeatable, and the promised finale of universal plague-death is denied by an alternative and more conventional fate.

Each of these indeterminate dynamics deserves analysis when it comes to understanding Shelley's invocation of narrative chaos, but I will confine the present study to the ecological anomaly of climate change and its relationship to the advance of the plague. Where Frankenstein made so much of the sublime terror evoked by the vast arctic plains, ending with the blind image of the creature "lost in darkness and distance," The Last Man capitalizes on the paradoxical horror of a too-pleasant nature mocking psychological despair. Earth again becomes a garden of "grateful vicissitude," to use Milton's phrase, but its inhabitants are, by the end, only the beasts of the field. The early arrival of the warm season indicates that the survivors' annual plague-trial has arrived. Mother Nature as a figure reveals her vindictive, witch-like properties in the face of the humanity's reasoned opposition:

> Nature, our mother, and our friend, had turned on us a brow of menace. She shewed us plainly, that, though she permitted us to assign her laws and subdue her apparent powers, yet, if she put forth but a finger, we must quake. She could take our globe, fringed with mountains, girded by the atmosphere, containing the condition of our being, and all that man's mind could invent or his force achieve; she could take the ball in her hand, and cast it into space, where life would be drunk up, and man and all his efforts for ever annihilated. (230)

This willful, destructive witch of Nature is a characterization that is frequently linked to chaos ecology and it was originally embodied as the fallen Eve in the Western tradition.[40]

For Shelley, a witch-like Nature is more of a psychological affect than it is an accurate description of how the natural world appears in her narrative of the advancing plague. Any appearance of order that Enlightenment characters like Raymond and Adrian (Percy Shelley) had espoused in their grand soliloquies is exposed as cognitive fantasy, mere delusion. Nature is chaotic and indeterminate in her behavior towards humans whether, meteorologically speaking, she rages or she purrs. The latter pattern of inverse causality is perhaps more alarming by virtue of its ironic potential:

> The sun came out, and mocking the usual laws of nature, seemed even at this early season to burn with solsticial force. It was no consolation, that with the first winds of March the lanes were filled with violets, the fruit trees covered with blossoms, that the corn sprung up, and the leaves came out, forced by the unseasonable heat. We feared the balmy air – we feared the cloudless sky, the flower-covered earth, and delightful woods; for we looked on the fabric of the universe no longer as our dwelling, but our tomb. (270)

[40] Feminist ecocritics have identified three ways that modern Western culture has characterized nature: As virgin Eve, fallen Eve, and mother Eve. Merchant suggests that "Chaos is the reemergence of nature as power over humans, nature as active, dark, wild, turbulent, and uncontrollable (fallen Eve). Ecologists characterize 'mother nature' as a 'strange attractor,' while turbulence is seen to be encoded with gendered images of masculine channels and feminine flows. Moreover, in the chaotic narrative, humans lose the hubris of fallen Adam that the garden can be re-created on earth. The world is not created by a patriarchal God ex nihilo, but emerges out of chaos. Thus the very possibility of the recovery of a stable original garden – the plot of the recovery meta-narrative – is itself challenged" (2003: 157).

The tone of each of these passages of contained horror is informed by a Malthusian worldview, which of course helped Charles Darwin envision how survival itself was a virtue that affected evolutionary progress. Malthus's essay on the *Principles of Population* (1798) proposed that the plights of human experience (war, famine, disease) could not be wholly extirpated by Enlightenment human institutions such as democratic government, intensive technological farming, and enhanced medical technology. Shelley's father William Godwin, an Enlightenment political idealist, wrote a voluminous refutation of Malthus's *Principles of Population*, the essay that sent the nineteenth-century intellectual world into a moral spin. However, as critics have noted, Mary Shelley's novel consistently builds, and then systematically destroys, schemes of Enlightenment-rational and Romantic-imaginative hope developed by her characters.[41] The Last Man is a Malthusian work without recourse to the more salubrious consequence of evolution of any kind. Shelley takes the notion one step further by envisioning a world in which even Edenic, productive, nurturing Nature has no succor for the cursed human race. Much worse than providing a challenge to survival, Lionel Verney comes to know the pleasant natural world as a set of false signs that belie an inexorable fate of death-by-disease. Perhaps her point is that order and causation are illusive hopes, manifestations of an overwrought cognitive capacity rather than a true mirror of larger intelligible forces at work in the cosmos. Verney returns again and again to microcosm images of order and containment lost to chaotic indeterminacy at the narrative level. His last thoughts

[41] Morton Paley's introduction to the Oxford edition (1998) enumerates the roller-coaster cycles of hope and despair through the course of the plague's advance. The "delusion of the earthly paradise" theme simultaneously indicts the idealist aims of art, policy, science, and religion, and undermines Enlightenment, Romantic, and Christian narratives of redemption (xv).

play at the now-familiar binary: alone among great works of art in Rome, Verney describes his soul in "wheeling circuits round and round this spot, [when] suddenly it fell ten thousand fathom deep, into the abyss of the present – into self-knowledge – into tenfold sadness" (463).

By virtue of its thematic relevance to modern public health concerns, the figure of chaotic narrative, and the framing scheme of narrative-out-of-fragments, The Last Man has risen from the ashes of its initial public reception in 1826. As part of the post-modern legacy, our twenty-first century world of environmental indeterminacy has come to appreciate the apocalyptic vision of which The Last Man is an archetypal exemplar. Patrick Parrinder points out how Shelley's "secular eschatology" became a popular notion in later nineteenth-century fiction, laying a foundation for the other two works I'll consider in this chapter, Richard Jefferies's After London and H.G. Wells's The Time Machine (58). These novels are part of the cohort of "Thames Valley Catastrophe" narratives that grew out of gothic, urban, industrial themes familiar to the Victorian imagination.

Shelley's work is a dirge for her portion of the Romantic period. But even with this funereal, backward-looking exigency, Shelley seems determined to create something new in her vision of human fate, and out of a deep personal sadness, to bring forth a text that arrives at a new way of knowing the world. Her fictional proxy Lionel Verney is touched by an excerpt from *Macbeth*, which he hears at a London theatre during the plague years: "Alas, poor country, almost afraid to know itself. It cannot be called our mother but our grave…where violent sorrow seems a modern ecstasy" (IV, iii, 164-170). For the Romantics, Shakespeare had already written most

things worth writing better than anyone else could. But Shelley's violent sorrow is modern because her way of knowing the world is through acknowledging that it can't be known absolutely, but only gestured towards in fragments of vision. By releasing those fragments, one gains the hope that they, like the Sibylline Leaves, will fuse into intelligibility in some future world.

IV: After London, or, Wild England

Richard Jefferies's novel that imagines a post-apocalyptic Great Britain, After London (1885), can be read as a continuation of Shelley's drama of human decline. Though the texts have many differences, perhaps the most important being Jefferies's sensitivity to the pernicious effects of industrial pollution on his late-nineteenth century environment, their manifest similarities keep this thread of argument based on chaotic narrative intact. Jefferies's novel describes the nature and culture of a world approximately a century after the great majority of humans have perished, and he develops an innovative narrative about the chance-driven succession of species radiating to fill opened niches. The cause for humanity's near-extinction was, as in Shelley, a great worldwide plague. The narrator describes the prudent superstition held among the remaining humans to shun the physical relics of the old world:

> They say when they are stricken with ague or fever that they must have unwittingly slept on the site of an ancient habitation. Nor can the ground be cultivated near the ancient towns, because it causes fever … No sooner does the plow or the spade turn up an ancient site than those who work there are attacked with illness. (46)

Though the plague haunts this scene, it is a specter of the past easily meliorated by distance, temporal and spatial. Humanity itself has survived in pockets to form revolutionized, primitive societies, and nature, by Jefferies's conceit, can be studied for its intriguing evolutions in the primordial post-modern.

Jeremy Hooker's (1996) extensive writing on Jefferies includes the observation that the author repeatedly reacts to a "crisis of modernity" in his nature-infused works (38). By invoking revolutionary natural forces in After London, Jefferies is both responding to social anxieties about anthropogenic nature in his time,

and courting this neo-wild Nature as an actor in her own right, in the foreground of his attention, with human actors pushed to secondary roles (43). But Hooker's reading is wholly occupied with these secondary human relations in After London, and the fascinating agonist of a liberated natural world never receives ample consideration. My reading details the scientific insights of Jefferies's theories of the new nature after industrial times. Jefferies lived in the age of Darwin, and benefited from the insights of evolution by natural selection without fully subscribing to a Darwinian worldview. He sought after a more synthesized scheme that factored in natural selection, species and population dynamics, and environment as contributing factors in evolutionary ecology. In a notebook he wrote: "Natural selection a true cause, modifying, but not sufficient cause to explain all phenomena. Climate a true cause but not sufficient" (quoted in Looker 166). He was able to sketch out these evolutionary synergies in After London, which figures catastrophe, extinction, founder effects, succession, and environmental pollution as ecological concepts.

The first section, entitled "The Relapse into Barbarism," is the most precociously ecological portion of what is otherwise a classically heroic, pastoral romance. Its relevance to later ecological thought is borne on the contingencies the narrator recognizes in his version of natural history, contingencies made clear by the scientific methods of close observation and hypothesizing that the narrator employs to make sense of the past. At the novel's narrative level, history is a selection of the relics of individual conversations; there is no master volume that tells the whole of the apocalypse story, as The Last Man presented itself (under false pretenses, as we have seen). After London's narrator tells the history after the Fall as necessarily one

of comparative relativity, involving "various traditions" without appealing to the classical ideal of "ultimate truth." Truth, as an epistemological monolith, has been worn down to fragments by the extenuating effects of the natural catastrophe; the fragments of various oral testimonies can approach, but will never arrive, at a single Truth.

On another level of contingency, narrative history is estranged from Truth because it is borne on a series of inscrutable ecological events. The evolutionary succession that follows this man-made universal flood (another secularized apocalypse) is random and chaotic rather than teleological, as I will discuss later. By saying "the truth was lost," the narrator implies that Truth itself is extinct, buried like a fossil in the shambles of past memory and the cryptic physical evidence in the new world. In this vision, as in a court of law, the truth resides with those who can articulate the most believable narrative. Narratives gain credit with coherence and supporting evidence; Jefferies's narrator, particularly in the first part of the tale, has a masterful eye for detail and he brings the reader around to his version of things not by claiming absolute correctness, but by developing his ethos as a fully considerate, open-minded interpreter of the book of post-modern nature, not unlike a fictional Gilbert White.

"The old men say that their fathers told them," begins Jefferies's narrator, "that soon after the fields were left to themselves a change began to be visible. It became green everywhere in the first spring, after London ended…" (11). The verdant wilderness that is Natural History's new subject unfurls using the testimony of survivors. Every history requires an individual subject to select, organize, and

make sense of a congress of stories and details so that it appears as a coherent and purposive narrative, not only of what happened, but of why.[42] After London's narrator is anonymous, but Jefferies does not pretend that he is omniscient, or objective, or even altogether self-assured. As the "say" and "told them" cues of the opening passage signal the oral nature of all extant history in this new natural world, they are also clues to the reader that this tale is founded on a subjective, contingent narrative dynamic complicates theories on the environmental upheaval in the novel's recent history. The narrator continues, "none of the accounts agree, nor can they be altogether reconciled with present facts or with reasonable supposition…the truth was lost…Therefore, what I am now about to describe is not to be regarded as the ultimate truth, but as the nearest to which I could attain after comparing the various traditions" (24).

With the plague as a working theory on the fate of industrial human populations, the narrator is left to speculate on the ontogeny of the landscape. A massive inland lake defines the geography of the new England, and the narrator insists that "the lake itself tells us how it was formed," involving "changes of the sea level and the sand that was brought up [the Thames] must have grown great banks, which obstructed the stream" (42-43). He entertains two major theories on the mechanism of creating this laucustrine environment: his theory of choice is gradualist, borrowing its aesthetic from the Neptunism of Werner and Lyell. Through an accelerated gradualist process, the choked river Thames "began to overflow up into the deserted streets, and especially to fill the underground passages and drains, of

[42] Hayden White's Metahistory (1973) is a useful primer for this kind of historical criticism, and Shelley's The Last Man, as discussed above, is a fictional history with imposed coherence.

which the number and extent was beyond all the power of words to describe…lastly, the waters underneath burst in, this huge metropolis was soon overthrown" (43). After a period of only thirty years, the narrator theorizes that the Lake reached equilibrium with sea levels, and the extreme reaches of the Lake to the East (at the Thames) and the West (at the Severn) came to exhibit daily tidal exchanges with the ocean. In his version, the disequilibrium imposed by a saltation event achieves natural balance along a new principle of organization, and the Lake in After London becomes the focal point for both scientific explication and the playground for its hero, fortunate Felix Aquila.

By gifting modern England with its own self-contained sea, Jefferies effectively re-centers what's left of civilization around the shores of a new Mediterranean; England becomes a contained little world of vying human bands and strange natural forces, much more heterogeneous on cultural and biological levels than his own Victorian England. Narratively speaking, After London is a microcosm experiment that interrogates the social and ecological dynamics of a world-made-new by environmental upheaval.[43] It uses a defined small area that is its own natural system, and describes the flows of energy and resources through time.

One of the few ways the reader knows to identify the unnamed narrator as an opinionated living person (rather than simply an omniscient voice) is that he

[43] In his remarkably detailed historical study of coastal changes in England for the past two millennia, Outrageous Waves (2005), Basil Cracknell traces London's encounters with high oceans from the time of the Romans (89-102). Sea levels increase with warm periods (the Medieval, from 1000-1400, in particular) and in times of intensive storms. In 1281-2, several arches of London Bridge collapsed and became the legend of the nursery rhyme. Daily tidal fluxes have grown severe as embankments became more imposing in efforts to control a commerce-laden Thames. Ecological historians such as Moss (2001) have imagined disaster scenarios in twenty-first century London, which Cracknell corroborates as "right to warn of the terrible danger facing London in the years ahead if the decision is not taken to build a more effective flood barrier before it is too late" (102).

introduces the theories of his rival, Silvester, who is a cosmic catastrophist at heart. Our narrator impugns Silvester's integrity as a philosopher of natural history by gesturing to his chao-theistic convictions: "Those whose business is theology have pointed out that the wickedness of those times surpasses understanding, and that a change and sweeping away of the human evil that had accumulated was necessary, and was effected by supernatural means" (25). Silvester's scheme of a divinely retributive catastrophe involved "some attractive power exercised by the passage of an enormous dark body through space" which affected the earth's axial lean and "altered the flow of the magnetic currents, which, in an imperceptible manner, influence the minds of men" (25). In Silvester's reality, the psychology of catastrophe is material, involving attractions and magnetism on the cognitive level. This quasi-scientific way of explaining the more traditional Old-Testament "sweeping away of the human evil that had accumulated" is part of geological catastrophism's legacy to the scientific debates around the turn of the nineteenth-century. Though Cuvier had no interest in corroborating Biblical accounts with his fossil-based theories of catastrophe, evidence of upheavals in deep time tempted natural theologians intentionally to read these events as material evidence of the Bible's stories rather than as apocryphal scientific texts.

When drained of its religious moral overtones, Sylvester's catastrophist line of explanation shares aesthetic ground with the Alvarez hypothesis on the Cretaceous extinctions that killed the dinosaurs, and most other large organisms living on Earth 65 million years ago. Chaos ecology makes much of the influence of such random events. The "enormous dark body" that impacted near the present-day Yucatan

peninsula is a catastrophist's explanation of widespread extinction, and cause of all downstream effects. Another way of approaching the same paleontological puzzle is through a narrative of "coherent catastrophism," where many unrelated factors collude to manifest the ultimate determinative event. For the Cretaceous conundrum, coherent catastrophists appeal to a long series of disadvantages in the dinosaur phenotype, which over a period of thousands of generations weakened the taxonomic super order *Dinosauria*; in this narrative, the meteor impact is merely the *coup de grâce* ending a long decline.[44] While the single Truth of what really happened has become, epistemologically speaking, a quaint concept, current theories of paleo-geology welcome a landscape of relative truths and shared causations around which scientists cluster to form general consensuses.

After London's voice appreciates modern historical relativity, then, without undermining its own authority as a balanced record of the evidence of past events. The novel implicitly theorizes historical narrative at the same time as it establishes the history of a world-made-new, showing Jefferies's dual commitment to authorial relativity and environmental contingency. Any number of personal stories can be told once a certain stage is set; Shakespeare was a master of populating his stages, like the eternal forest of Arden, with individuals as motley as Rosalind, Jacques, Touchstone, and Celia. But when the stage itself is relative and mutable, as is the landscape in Jefferies's post-apocalypse England, Nature herself is a dynamic character and stories

[44] See, for example, Palmer's (2003) discussion of coherent catastrophism (205). Palmer quotes physicists Wallace and Thornhill: "It is time to re-examine those 'laws' of long-held beliefs that have diverted scientific curiosity away from uncomfortable questions about the safety of our spaceship Earth. We can no longer afford to deny the possibility that global myths and images of the planetary gods may refer to a frighteningly close-up view of the planet within the memory of the human race" (206).

about her develop into a new species of *bildungsroman*. As Gilbert White tacitly made a living character out of his beloved home parish, and found its story to be one of change and contingency more than the grand immutable cycle of an Enlightenment aesthetic, Jefferies's environment after London flourishes by virtue of a complex character development. Nature's body, written as the fortuitous succession of species growing and adapting to fill niches in the new world, is the subject of development that organizes the narrative of After London.

Part 1's title, *The Relapse into Barbarism*, is devolutionary, subverting the narrative of the increasing articulation of natural splendor that the account actually delivers. Particularly in the context of the deep polluted evils steeped in the site of the old city, the "barbarism" that nature exhibits when fallow is actually ameliorating, evidence of the self-restorative capacities of nature that generations beginning with Jefferies's ardently traced as evidence for hope in the industrial era. Though the narrator is too rational to fully anthropomorphize nature as a mother, or to speak of an entity that is more than the sum of individual animal groups and flora set in fallow, nature-as-character in the *Relapse into Barbarism* follows from the narrator's voice as natural historian. There are no other characters in the first part of the novel, only nature's recovery as envisioned through the evolution and succession of species. Herein lies the novel's relevance to modern ecological thought: using the model of a self-contained England, Jefferies narrates the history of what could happen when disturbed land is largely left to itself, and human command over nature succumbs to intrinsic natural forces that modern civilization had only temporarily kept at bay.[45]

[45] Jefferies encounters similar linguistic challenges to what Darwin faced in attempting to narrate evolution by natural selection. Darwin writes in The Origin of Species: "again it is difficult to avoid

As the narrator closely observes, nature's succession follows a random, chaotic pattern of recovery from the apocalyptic moment of flooding, now many years past. It takes only one generation for most of the industrial human legacy, which is called the culture of the Ancients, to fall asunder in the undergrowth. In the first few pages, Jefferies treats the accumulation of time both cyclically and linearly: first the four seasons of a single year wreak havoc on the formerly-controlled agrarian countryside, meadows are "not mown" and the wheat fields have "no one to reap," opening that bounty to "clouds of sparrows, rooks, and pigeons…feasting at their pleasure" (11). Complex new interconnections arise by only the second year, when rapidly colonizing species occlude human paths, and naturally re-seeded fields grow a ghost crop of staples, which again are devoured and turned under by the onset of winter. Though the aesthetic discord of briars and brambles instills an image of unchecked and unproductive nature, that which "helped to destroy or take the place of the former sweet herbage," these stages of initial succession permit the natural, ultimate aesthetic of grandeur that is the inheritance of mature wilderness (12). From a distressing vision of a harlot nature "starting from all sides at once" to extirpate the

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personifying the word Nature; but I mean by Nature, only the aggregate action and product of many natural laws, and by laws the sequence of events as ascertained by us. With a little familiarity such superficial objections will be forgotten" (88). The recalcitrance of active-voice language becomes clear in Darwin's argument: "It may metaphorically be said that natural selection is daily and hourly scrutinising, throughout the world, the slightest variations; rejecting those that are bad, preserving and adding up all that are good; silently and insensibly working, *whenever and wherever opportunity offers*, at the improvement of each organic being in relation to its organic and inorganic conditions of life. We see nothing of these slow changes in progress, until the hand of time has marked the lapse of ages, and then so imperfect is our view into long-past geological ages, that we see only that the forms of life are now different from what they formerly were" (90-91). By collapsing the time required to observe change into a few human generations (the distinction between evolution of species and evolution of a landscape), Jefferies casts a clear beam on his vision of nature's spontaneous movements from disorder towards a new order.

human legacy, time successively renders the thorny, entangled wilderness as the new force that permits eventual coherence:

> …protected by the briars and thorns from grazing animals, the suckers of elm trees rose and flourished. Sapling ashes, oaks, sycamores, and horse-chestnuts, lifted their heads. Of old time the cattle would have eaten off the seed leaves with the grass so soon as they were out of the ground, but now most of the acorns that were dropped by birds, and the keys that were wafted by the wind, twirling as they floated, took root and grew into trees…the young trees had converted most parts of the country into an immense forest. (12)

Keys to trees, goes this new scheme of aesthetic inheritance from the lower players among flora, the vines and brambles, up to the grand species that serve as metonyms for mature English nature, the elms and oaks. The initial chaos of competitive colonization is reigned in, after all, by Nature's heavyweights; indeed the progress from human civilization in the form of agrarian parcels to natural civilization in the form of mature forests is enabled by an intermediary imbroglio. Nature inexorably self-organizes towards a more steady-state climax, using many randomly competing forces to develop towards a system of established, long-lived species.

Jefferies has anticipated a debate that was to rage at the center of the ecological sciences for much of the twentieth-century: whether biological succession implies a telos towards the static climax community, or whether fallow nature is comprised of a more random and directionless mosaic of species competing through perpetuity. Fredric Clements, the American grassland ecologist, would theorize succession-based climax in disturbed plant communities in his study Plant Succession (originally published in 1916), and he figured successional ecosystems as their own super-organisms, driven by internal coherence towards a higher principle of organization, the static-state climax. He writes, "The unit of vegetation, the climax

formation, is an organic entity. As an organism, the formation arises, grows, matures, and dies…The climax formation is the adult organism, the fully developed community" (quoted in Merchant [2007], 182). The climax ecosystem, figured as a higher-order organism with synergetic components and structural robustness, is the kind of aesthetic-based theory that would later make the Gaia concept controversial in many circles, especially among strict empiricists.

The succession debate is one instantiation of the larger ontological rivalry between schemes of time: the arrow versus the cycle. The predominance of each model was debated intensely with the rise of modern geology in the early nineteenth-century, when gradualists like Hutton and Lyell came up against the catastrophist ideas of Cuvier and Buffon. This debate was updated with evolutionary theory, when biological change through time was laid over geological schemes. Darwin, the gradualist, imagined a slow, constant improvement of form through deep time, and later theorists like Gould and Eldredge emphasized the role of sudden punctuations wrought by environmental catastrophe as essential to evolutionary history.[46]

A major contribution that ecology provides to these contrasting aesthetics is the simultaneous conception of both schemes as inherent to nature set in time: ecosystems undergo directional change after disturbances, then settle into a more stable cyclical condition until the next disturbance (a storm, a volcano, a farmer carving out a new field) lurches the system into the new disequilibrium. Anticipating

[46] Gould's book-length study of temporal aesthetics, Time's Arrow, Time's Cycle (1987), shows how important a conceptual balance between paradigms is in the post-modern understanding of nature. The cyclical balance of a perfect cosmos maintained by God in Newton's system butted heads with a nineteenth-century metaphor of a machine world subject to entropy. Gould writes, "I dedicate this book to a different view of this discrepancy: Time's cycle cannot, in principle, encompass a complex history that bears irreducible signs of time's arrow. Hutton's rigidity [on time's cycle as the necessary condition for understanding deep time] is both a boon and a trap. It gave us deep time, but we lost history in the process. Any adequate account of the earth requires both" (97).

later ecological philosophy, Jefferies's detailed description of natural succession introduces humanity as a principle of disturbance; the legacy of the industrial Ancients dissolves as nature shifts towards its next stasis of complex organization. Though the established forest could be viewed as the predetermined telos to which nature aspires when left to itself, there is a subtle and necessary distinction between the tenuous balance of any mature natural system and the teleological determinism of a single climax community of certain species composition that will inevitably be reached, time permitting.

In the first few pages of After London, we are presented with the mechanisms of time's arrow which, within a century, settle back into time's cycle as the forests establish deep roots in the disused farm fields, and the lake that organizes the geography of this new world balances with the oceans through daily tides at the eastern and western extremes. Succession is a principle by which disturbed nature evolves through time, but the initial conditions play an essential role in crafting the appearance of nature's next ecological station, often involving chaotic dynamics along the way. *The Relapse into Barbarism* takes place within a century, and human culture's dissolution permits the rise of a new primitive natural order centered on the serendipitous Lake.

Because plant growth dominates the former land routes, the Lake is essential to the commerce of the world after London, and it comes to embody several of the paradoxes of the post-industrial world. It is predominantly clear, fresh, and pellucid, but the regions around old cities (London in particular) are viciously polluted and miasmic; it facilitates communication and commerce, but also permits violent raids

and feudal rivalries; it is the center of the known world, but is also at the heart of geographical mysteries because of a highly fractal shoreline; it is both a new frontier and an ancestral burial ground. The Lake takes on both the goddess and witch characterizations of nature; along Jefferies's ideals, the goddess is nature's creation, and the witch is the specter of industrial humans past.

The site of ancient London represents the ecological results of the collapse of complex industrial society. Poisons seep up from the submerged city and adorn the landscape in a hellish menagerie of fire, killer fog, and slimy soot that shellacs the skin of any explorer who pursues the treasures of the lost Ancient civilization. Without needing directly to indict the practices of the past, the toxic scene that Felix eventually confronts serves as an admonition of machine-driven society and the dystopias that mark both its present form and the legacy it leaves to the post-apocalyptic world. The narrator never draws a direct causal link between industry and the ecological catastrophe of the previous century; though industrial culpability would seem to be a given, it is possible that the Ancient practice of coal-driven manufacture was not in itself the catalyst of the rising oceans and consequent flooding. Even so, the industrial gift to posterity provides the only manifestation of pollution that its inheritors conceive, and something deeply evil lurks in old London as a result of the long urban-marinating decades. The chaos that plays out over the site of London is a narrative that imagines how, given a set of initial conditions, the industrial environment will devolve when its architects die.

This brings to the surface an interesting question that ecologists have only begun to theorize, and writers to put into narrative form: what happens to our

industrial-military infrastructure if no one is around to maintain it through perpetuity? Even if industrial practices are not directly responsible for some Armageddon to be, how will those initial conditions of neglect incubate emergent ecological problems in the world that is heir to our legacy? The final chapter of this dissertation will take a look at a narrative that attempts, scientifically, to measure the footprint of the industrial world through deep future time (particularly problematic are two inventions unknown to Jefferies: nuclear fission and plastic). H.G. Wells engages in an analogous task in The Time Machine by looking at the deep evolutionary legacy of industrial social stratification; his narrative will be the last subject of this chapter. For Jefferies, though, only a century of succession is enough to redefine the edges of existence; the site of old London holds waters that are not to be traversed and are only to be entered at extreme peril to explorers.[47] The narrative develops a complex relationship between strange bedfellows: degraded industry and primitive nature. Jefferies's interbred vision permits industrial-ecological futurity to have a life, even if that life imagines that "all that [Felix] saw as something so strange as to be unaccountable…The deserted and utterly extinct city of London was under his feet" (200). Cities and the industrial legacy have succumbed to environmental disaster, but their deep-seeded ecological effects live on as the new, primitive world's purgatory,

[47] Jefferies is careful not to accuse the industrial Ancients of greed, hubris, or irresponsibility; on the contrary, his prose cultivates a sense of wonder about the magnificent workings of the bygone civilization, even in the midst of his descriptions of its horrific urban specter. The historian-narrator testifies, "there were said to be places where the earth was on fire and belched forth sulfurous fumes, supposed to be from the combustion of the enormous stores of strange and unknown chemicals collected by the wonderful people of those times" (200). The Ancients are characterized as alchemists with "wonderful" inventions throughout the text, when they so obviously could have been vilified as the authors of this environmental malignity. Jefferies preserves the innocence of vision that the latter generations inherit by virtue of their ignorance of the Ancients' culture, a gesture to legitimate reverence for the power of industrial technology that could be occluded by its manifest liabilities, the smog, the stink, and the pigeon-holed labor.

the site of infinite toxic corruption that is also the gateway to impossible wealth. These eventualities are the result of a chaotic narrative experiment using the active reagents of nineteenth-century industrial London.

By secularizing religious rites and positioning a quest-narrative on the stage of a post-industrial environment, Jefferies effectively recasts Romantic natural supernaturalism in a modern, deep-ecological mould. The hero confronts and overcomes the nasty inheritance of his extinguished elders, and founds his quasi-religious new world on the aesthetic principles of sustainability, community, and harmony with nature. Felix captures the jewels of the Ancients from the jowls of London, muses on his dual fortune and personal fortitude, and rises to apotheosis among his new brethren of the Shepherds, who are the gentle folk among the mainly savage races of his world. His success comes from an ability to pay close attention to nature's patterns: the tides and winds that direct his canoe around the Lake, the exodus of birds that warn of London's proximity, the sense of accord given by landscape heterogeneity, the instinct of being home when at last he finds a dwelling place in Shepherd land. In every way, this last virtue participates in the aesthetic of the picturesque, as contrasted with the vile sublime of dead London. While hiking through higher lands on a solitary hunting trip, Felix discovers his Valhalla, a self-contained lake,

> half a mile across, and the opposite shore was open woodland, grassy and meadow-like, and dotted with fine old oaks. By degrees these closed together, and the forest succeeded; beyond it again, at a distance of two miles, were green hills. A little clearing only was wanted to make the place fit for a castle and enclosure…A more beautiful spot he had never seen, nor one more suited for every purpose in life…There he remained a long time, designing it all in his mind. (220-221)

Felix's ability to cultivate nature into productive harmony makes him a god among shepherd men, and he commands their human resources to aid in his gentle conversion of their land towards a sustainable community. Jefferies's final images of the world after London are overtly idealistic, with a back-to-nature narrative ending in the romantic comedy of Felix bringing his future bride, Aurora, to her new home.

But the comedic ending is never actually attained in the narrative. Jefferies leaves the story fragmented, the ideals merely theoretical. After London's final image describes Felix hiking west through thick woods to reach his original home, where Aurora, we assume, waits for him to claim her. Norman Page shows how Felix's journey westward to claim his bride (Aurora, the sunrise), is the story of a man "likely to be disappointed"; the woods have consistently been equated with "darkness and menace" as opposed to the freedom and easy movement of the Lake's open waters (361). Though Felix's good fortune has been uncompromised within the narrator's story, his personal fate remains outside of the tale itself, and Jefferies plants subtle portents that complicate the easy coherence of a back-to-nature success story. In the end, indeterminacy rules the narrative's fragmentation; bibliographers Miller and Matthews have quoted Jefferies conviction that "A true Life History has no wind up and nothing finished or complete" (439). Though the romantic pastoralism of After London may gesture towards ecological ideals, an indeterminate finish is congruent with the story's cryptical origins; insoluble mystery forms the bookends.

It is revealing of an 1880s *zeitgeist* that John Ruskin delivered his "Storm-Cloud of the Nineteenth-Century" lecture to the London Institution in 1884, one year before After London arrived in bookshops. Ruskin gives an eyewitness, insistently

objective account of the environmental effects of industry just as coal burning greatly intensified in British urban centers. The essay reveals the psychological and physical stresses wrought by chaotic weather that Ruskin calls the "plague wind" of his modern age. Perhaps nostalgic for a time before industry, Jefferies instead imagines the scenario of nature's reclaiming of her ground and atmosphere after industry, the post-modern primitive, and the sinister fate of urban centers in this new world order. Also contributing to the atmospheric chaos of that era was 1883's eruption of Mount Krakatoa, an event responsible for below-average cold though 1888, resultant crop-failures due to heavy rains, and major optical effects, most notably spectacular sunsets in continental Europe and England until February 1884.[48] Though Krakatoa itself may have been beyond Jefferies conscious knowledge and that of his European counterparts,[49] as Laki's eruption was for Gilbert White almost exactly a century earlier, the ecological manifestations its eruption and of industrial emissions were very much within Jefferies's direct experience.

[48] David W. Olson (2004) a physicist and astronomer, published his theory on Krakatoa's atmospheric effects that draws an intriguing link to Edward Munch's famous 1883 painting "The Scream," which, Olson remarks, "has become the symbol of anxiety in our modern age." The figure's petrified horror is made intelligible by the vivid red sunset behind him, and Munch's journals reinforce the link between the spectacular, threatening sunsets and his artistic inspiration.

[49] With the help of hindsight, H.G. Wells was able to make an account of the Krakatoa eruption of 1883 and use it to substantiate Jefferies's intrinsic vision of ecological succession and the climax community. Wells *et al*'s The Science of Life (1929) devotes a long chapter to the emerging science of ecology, which at that point is largely organized around the interactions within 'life-communities': "There is a progression of inhabitants, one set of animals and plants succeeding another in sequence, until finally a stable state is reached. In a state of nature, the animal and plant life of this stable phase is the same as the original life of the area. The life-community has reproduced itself. This community reproduction was seen on a grand scale after the great eruption of the volcano Krakatoa, in the East Indies, in 1883…" (973). The perspective of an inevitable climax community was advanced by Fredric Clements, and heavily debated in the first decades of the twentieth-century. It has been replaced by more nuanced theories of community interrelation through time, but the importance of the initial catastrophe is still essential to succession theory in community ecology.

The mature Jefferies would pen a remarkably precocious and brilliant observation on the role of randomness and patterns in nature; from it, he would recover a sense of beauty inherent in the Victorian fear of indeterminacy. In the late essay, "Absence of Design in Nature" (c. 1887), Jefferies envisions scientific chaos:

> When at last I had disabused my mind of the enormous imposture of a design, an object, and an end, a purpose or a system, I began to see dimly how much more grandeur, beauty, and hope there is in a divine chaos – not chaos in the sense of disorder or confusion but simply the absence of order – than there is in a universe made by pattern. This draught-board universe my mind had laid out: this machine-made world and piece of mechanism; what a petty, despicable, microcosmos I had substituted for the reality. Logically, that which has a design or a purpose has a limit. The very idea of a design or a purpose has since grown repulsive to me, on account of its littleness. I do not venture, for a moment, even to attempt to supply a reason to take the place of the exploded plan. I simply deliberately deny, or, rather, I have now advanced to that stage that to my own mind even the admission of the subject to discussion is impossible. I look at the sunshine and feel that there is no contracted order: there is divine chaos, and, in it, limitless hope and possibilities. (quoted in Hooker, 163)

By recovering chaos from myth-status and placing its powers within material nature, Jefferies has also rediscovered infinity. Science still has work to do in formalizing ideas of chaos into empirically-actionable schemes; it is limited, like the story of God's creation, to a design and a system, the "petty, despicable microcosmos" that Jefferies seeks to explode into another new world. The tension between tropes, each a distinct scheme of thought, comes to the foreground in this passage as the very tension between "contracted order" in the physical microcosm and "divine chaos" in the unraveling of future time. The author has closed his mind to closed worlds, and so he welcomes infinite possibility.

V: The Time Machine

Where Jefferies's After London uses shallow time, matters of decades and centuries only, *deep* time is The Time Machine's (1895) mechanism of narrative fragmentation. H.G. Wells would later claim that ecological succession, as seen in After London, is essentially "the same competition" as evolutionary succession, only cast in different scales of time.[50] The fourth, temporal dimension, when manipulated, imposes radical alterations on the other three dimensions of space. Rather than a sudden natural disaster, Wells imagines gradual climactic and evolutionary trends suddenly envisioned using the hero's mechanical invention of a time machine. Wells's debt to nineteenth-century science's "bursting the limits of time" (Cuvier's exuberant phrase) is evident in his projection of the future world. His Morlocks, especially, are analogues to the bizarre creatures that Enlightenment geology had uncovered as ancient fossils. So bracing by virtue of their uncanny similarity, and so repugnant in their essential difference from the human essence, the Morlocks and Eloi are the evolutionary monsters of the future, but they are also us. Comparative physiology allows a conceptual continuity between humans and the creatures of

[50] I quote Wells et al's 1929 encyclopedic narrative, The Science of Life: "There is another way in which the little mirrors the big. The same competition which results in the comparatively speedy development of ecological succession results also in the portentous slow development of evolutionary succession. A landslip or man's destructive hand uncovers a patch of the bare earth, or impounds a body of barren fluid; it is colonized by a succession of communities, and in a few decades is tenanted with rich life again. The whole world, both land and sea, was once free of life; and aeons later all the land was still one great bare patch of earth and rock. First the seas, and then the lands were colonized. In both there has been a succession of faunas and floras, each one on the whole exploiting the environment a little more effectively than the one before. Evolution is a slow succession of a series of ever new and ever improved communities towards a still unrealized climax…It remains to be seen whether man, with his deliberate aim at a higher efficiency, his replacement of the hitherto dominant tree by his own cultivations and devices, will make a mess of things and fail, or will succeed and hold on from climax to climax. If he fails the forest will return" (989).

802,701 AD, but troubling this continuity are the alienating rifts in cognition (the infantile Eloi) and physique (the spider-monkey Morlocks).

Wells's leaping narrative is chaotic in the modern denotation because the small impacts of initial socio-industrial conditions in the present-day have tremendous, determinative downstream effects in evolutionary time. My example from chapter one of chaos theory applied to the history of industrialism links directly to Wells's socio-biological fiction. From the initial conditions that divided people between the capitalist working- and ruling-classes, and from the machines that made this division profitable, Wells extracts a chaotic narrative in which the emergent social properties of occupation, spatial division, diet, and disposition become the prevailing topoi that impose biological changes in the future. In this industrial condition that unfolds over nearly a million years towards the Morlock state, those conditions that Wells saw as most characteristic of his time have grown from seedling social shifts into full-blown physiological imperatives wrought by evolutionary selection. No eighteenth-century narrative could have achieved Wells's bizarre vision of dystopia; The Time Machine takes biological evolution and the conditions of industrial modernity as launch pads, and he propels these ideas through the exacerbating eons.

The Time Traveler's series of insights on the nature of the future world shows his theoretical progression from millenarian idealist towards the chilling evolutionary pragmatism that best explains his observations of the Eloi-Morlock dynamic. Where at first he viewed the world as a warm garden, and its people delighting in their labor-free existence (with the minor liability of intellectual death), he comes to understand

how the Eloi are “mere fatted cattle” serving the appetites of the intelligent mechanic Morlocks, who live in a dark, noisy underworld (62). This is no Enlightenment millennium; it is a sinister vision of (d)evolution set on industrial rails through deep time. The stark evolutionary disjuncture between the Traveler’s Victorian England and the Morlock world (for the Morlocks are master) instructs us about manifest differences wrought by time, but these contrasts are unnerving because they are exceptions set into relief by the enduring similarities that remain.

Once Geology forced time to expand in extra-Biblical quantities, the future was a concept that could sprawl beyond humanity itself. The human became only one of myriad narratives that represent the world, and time itself was seen to discourage the eternity of any form, placing the human story on the verge of extinction at every ledge of future time. Unlike Shelley and Jefferies, whose narratives unfold only a few generations beyond the nineteenth-century, Wells’s use of deep time shows the mechanisms at work, indeterminately but inexorably, to alienate us from our own legacy. The sense of isolation we feel on behalf of the Time Traveler when his machine is lost to the Morlocks reveals the power of the deep time trope; our brains are simply not equipped to imagine the passing of 32,000 generations, each of them hungry in their own time. For any coherence, the narrative needs to leap into the future, providing spots of time that (paradoxically) provide evidence of gradual changes wrought in the meantime. Wells imagistically reduces time traversal to the flickering of a lamp; a blended grey elides the succession of night and day.

Once the concept is within our ken, we find ourselves frightened of a reality that we will never experience, but that stains the features of our own civilized order. For Wells, the literally-spatial discrepancy between social classes in an industrial order that entombs the workers in dark factories and blesses the ruling classes with leisure can be rendered into a higher-order evolutionary trend. Industrial civilization drives an evolutionary wedge between the classes. Allopatric speciation, which occurs when two populations of a single species are spatially separated until they are distinct, is the most evident mechanism of this estrangement. Interestingly, the state of the environment in the deep future follows suit with Enlightenment ideals of improvement, but Wells takes an ironic turn: the utopia of the surface world in 802,701, a prolific, exotic garden that needs no tending as Eden did, is the deceiving veil over an insidious engine-driven reality. The machine remains central, but it is now the machine under the garden, and the whole ecological world has become techno-sphere.

Rather than projecting a future environment overtly destroyed by the products and by-products of industry, Wells is more nuanced in having his time traveler vacillate between scientific hypotheses of utopia and dystopia in the artificial ecology of the Morlock world. At a basic level, the Traveler's initial vision of an ecological utopia is based on aesthetics; his realization of dystopian nature comes with the insight that this world is an energy-exchanging system in which one group systematically preys on the other. The static-state aesthetic utopia, then, falls apart with his subsequent and stronger theory of systems ecology, which allows him to trace the flow of energy and nutrients throughout the system.

The Traveler's scientific speculations wade through some conceptual bogs, and his hypotheses grow more pessimistic along with his deepening acquaintance with this uncanny world. From an Enlightenment telos that imagines the Eloi state "settled down into perfect harmony with the conditions under which it lived…the last great peace" he concludes, following Occam's principle, "I thought that in this single explanation I had mastered the problem of the world…Very simple was my explanation, and plausible enough – as most wrong theories are!" (33). There is no resting place for evolution, he learns, and correlatively there is no static state of the environment; both processes are involved in ceaseless turmoil, whether vacillating around an average condition or shifting wholly towards a distinct set of ecological relationships. The broad scope of vision, in this case a temporal scope, is essential to conceiving the dynamics of evolutionary ecology that occur on super-human scales.

The climate is hotter in 802,701 than it had been in 1895; though he avoids a singular explanation, the newly-arrived Traveler promotes a cosmic catastrophist view of the warming, which prizes contingency:

> I think I have said how much hotter than our own was the weather of this Golden Age. I cannot account for it. It may be that the sun was hotter, or the earth nearer the sun. It is usual to assume that the sun will go on cooling steadily in the future. But people, unfamiliar with such speculations as those of the younger Darwin, forget that the planets must ultimately fall back one by one into the parent body. As these catastrophes occur, the sun will blaze with renewed energy; and it may be that some inner planet had suffered this fate. Whatever the reason, the fact remains that the sun was very much hotter than we know it. (45)

Perhaps combustion of the planet Mercury, or Venus, can explain the intensified heat of the sun. As in the earlier narratives, the Traveler advances no industry-based theory on warming, but of course this speculation comes before he is aware of any

industry at all in the pastoral new world. Other imperatives ensue (the Morlocks are interested in his flesh), and he never has the leisure to return to theories of industry-based climate change, only to note its effects: the Eloi enjoy a half-clad existence almost wholly outdoors; the inconveniences of seasonal variation are unknown (but the absence of vicissitude contributes to the Eloi's cognitive oblivion); the place that was greater London now blooms as a strange tropical paradise:

> You who have never seen the like can scarcely imagine what delicate and wonderful flowers countless years of culture had created…My general impression of the world I saw over their heads was of a tangled waste of beautiful bushes and flowers, a long neglected and yet weedless garden. (25-26)

This depiction of a terrifying yet pleasant nature harkens back to Shelley's apocalyptic world. The language is intensely descriptive because of its inherent contradictions, which heightens the sense of satire: the beautiful waste, the weedless neglect. Cultural selection imposes artificially-bred beauty, and the climate acquiesces. The flowers become the symbol of this future world because they are the only piece of evidence that the Traveler brings back to his day. Their fruit is consumed by the vegetarian Eloi, and herein is another tacit contradiction: the flowers are the blooms of machines. Though their principle of growth may be organic, using water, air, and sunlight to make carbon-based matter, their existence is owing to the technology that created them. Like a biotech crop that uses borrowed genes to make it better adapted to environmental extremes, these flowers exist because they have been genetically manipulated by their human-esque creators. The Eloi, the Traveler ruefully comes to acknowledge, live on a glorified feed lot controlled by Morlock technology. Their tender flesh and underdeveloped minds make them perfect for

domestication, and one post-human species systematically breeds and devours the other at the apex of Wells's sardonic vision. This is not a lobby for vegetarianism, it is a vision of a world grown so technological that every level of what used to be Nature is now regulated as part of a thermodynamic system, a mechanization of systems ecology. Thermodynamic systems don't have morals; neither do humanity's heirs to the industrial legacy.

Accompanying this lugubrious (if comical) insight into the post-human predator-prey dynamic is a further blow to Enlightenment teleology: the Traveler discovers the decay of all former knowledge as a consequence of intellect's obsolescence. Moral systems are borne on human intellectual capacity; one way that humans through the ages have divided themselves from other animals (perhaps speciously) is by a perception of our unique capacity to 'do the right thing,' sometimes in spite of self-interest. Altruism is the subject of intense debate in evolutionary biology. Though the Traveler had endured a moral blow by observing the Elois's indifference to Weena's near drowning, a deeper despond results from the discovery of the decayed Palace of Green Porcelain, a place resembling Victorian England's Crystal Palace. The Traveler, leafing through the disintegrating books that form what's left of a massive library, says

> Had I been a literary man I might, perhaps, have moralized upon the futility of all ambition. But as it was, the thing that struck me with keenest force was the enormous waste of labour to which this somber wilderness of rotting paper testified. At the time I will confess that I thought chiefly of the *Philosophical Transactions* and my own seventeen papers upon physical optics. (67-68)

A literary man, he suggests, would brood over the philosophical and egotistical "futility of ambition," where the scientific mind turns to the thermodynamic, entropic

concerns surrounding a "waste of labour." But the sense of regret is the same: the Traveler finds the Earth a garden, but recognizes in the decay of civilization that its remnants are a new form of 'wilderness,' and the intellectual labors that constitute the human devotion to self-betterment are themselves subject to the contingencies of deep time. *Philosophical Transactions*, the journal of the Royal Society, was the most recognizable disseminator of scientific authority through the nineteenth-century; the Traveler's contributions turn to dust when the social institutions that cradled his work are themselves pulled under.

There is a deep chill intrinsic in the wasting that the Traveler consistently sees as a necessary precursor to the next system of organization; these lapses and subsequent articulations of a new ontology (in this case, the leap from Victorian positivism to Morlock predationism) demonstrate a chaotic underlying pattern to the evolutionary articulation of biological forms. Though Charles Darwin remained faithful to Lyellian geology and argued that natural selection continually increased the perfection of fit between organism and environment, the Traveler's experience suggests something different. The trajectory of evolutionary ecology is unreliable and is demonstrably not progressive. He implicitly argues that chance conditions and variations are more important to evolutionary narrative than any near-teleological theory of increasing perfection and complexity. "Papers upon physical optics" are as useful in the world of 802,701 AD as they had been in the analogous date anterior, 800,000 BC, when *Homo erectus* began to use stone tools and fire to cook their prey. Morlocks fear and loathe flame, the Traveler is fortunate to discover, so they eat Eloi raw.

The Traveler's final great leap forward past the Morlock age into the deepest future cinches Wells's vision of eternal environmental dynamism towards no particular endpoint. Superficial stasis elides the changes always occurring at a microscopic level; these small fluctuations in genetics or environment are mostly erased, but a few mutants impose enduring downstream effects. Several million years into the future in the algorithm of evolutionary selection, the Traveler finds his alienation from the surrounding life complete:

> I cannot convey the sense of abominable desolation that hung over the world. The red eastern sky, the northward blackness, the salt Dead Sea, the stony beach crawling with these foul, slow-stirring monsters, the uniform poisonous-looking green of the lichenous plants, the thin air that hurt one's lungs; all contributed to the appalling effect. I moved on a hundred years, and there was the same red sun… (83)

The earth has lost its axial spin, leaving its outlandish inhabitants in perpetual, chilled twilight where the city of London used to be. The valley, which had burst with sinister vitalism while the Morlocks were cultivating it, has succumbed to a long senescence and now imposes an aesthetic of the poisonous sublime where its picturesque garden had once grown for the Eloi. From a perspective of uncanny similarity with the Earthlings of 802,701, the Traveler has arrived at the estranged state of an astronaut on an alien planet; from a paragon among Eloi, he has devolved into prey for enormous crustaceans. Even though the man remains the same, his position in the environment of this extreme future time is relative to *its* condition, not his; he is misplaced in evolutionary time. This final vision of utter desolation, which presumes human descendants are extinct, cinches Wells's thesis that the narratives of the deep future are fragmented, only partially coherent, and completely subject to the exigencies constantly imposed on life.

The Romantic quest of an inspired and desperate man pushing the limits of knowledge by extensive wanderings undergoes, in this novel, a crucial revision for the audiences of late-Victorian, industrial England. The Traveler wanders in time and barely survives to bring his tale back to the comfortable lounge where his audience is assembled to judge the bizarre narrative. This staged opposition of armchair philosophy with sinewy enterprise piques the concerns of a positivist era when scientific epistemology sought to engulf the colonial, evolutionary and ecological mysteries of the day. So outrageous a tale is the Traveler's that he ends his narrative with a philosophical disclaimer that brings his uproarious claims down into the controlled sphere of a gentleman's supper:

> I cannot expect you to believe it. Take it as a lie – or a prophecy. Say I dreamed it in the workshop. Consider I have been speculating upon the destinies of our race until I have hatched this fiction. Treat my assertion of its truth as a mere stroke of art to enhance its interest. And taking it as a story, what do you think of it? (87)

Involved as he is in a meta-discourse with the sciences of his tutelage, Wells has used literary narrative to advance a creative argument about the nature of scientific prediction, the patterns of evolution, and the legacy of Victorian industrialism.

One other insight from the experience of The Time Machine is that a prophecy is the same as a lie; most lies don't come true, but some inevitably do; from the wide terrain of possibility spring a few fortuitous seeds. Once the future has happened, we can trace its origins in the past and pretend that time connotes destiny. But this is a lie that substitutes necessary causality and design (the telos) for the mere necessity that something succeed among the many forces vying for success. Teleological surety is hacked down to its elements by this satire of evolutionary

mischance and the further farcical vision of a moribund Earth impossibly removed in future time. The gentlemen assembled take the account as just a story, only excepting the withered, alien blooms the Traveler has recovered from 802,701. This little piece of evidence teases narrative chicanery from demonstrated scientific fact, effectively suspending judgment indefinitely. The Traveler brazenly disappears into another time, once again, and leaves his personal fate as indeterminate as the veracity of his first journey. The novel ends, "as everyone knows now, he has never returned" (90). The unraveled narrative now only gestures to infinite possibility, something close to the post-modern chaotic cosmos imagined by Jefferies ten years earlier. That sort of knowledge ultimately lies outside the Victorian drawing room.

An ecological reading of these four texts reveals new outlets for theorizing the role of chaos in the narratives on nature. The epistemological movement from balance and eternal cycles towards open-ended visions of change, ruled by indeterminacy, signals a nineteenth-century shift in vision after the Classical age. With advances in geology, epidemiology, and evolutionary theory, these authors were able to imagine bizarre new ecological realities as the various legacies of an industrial world order; each text renders a more incisive narrative than the reactionary, pastoral conventions of longstanding environmental conservationists. While each of these works could accurately be called environmental because a dynamic stage of nature is pivotal in the action portrayed, fruitful readings result from the texts' interrogation as works of imaginative early ecology. Chaos permits even the most conventional formulations, such as Jefferies's neo-feudal order, to raise still-vital questions in the sciences of the environment, such as the nature of ecological succession. The

narrative fragmentation that inheres in each of these four works reminds us of repeating conceptual failures in linearity and periodicity when it comes to predicting the dynamics of a late industrial environment.

As theorists of the twenty-first century are learning, an accurate narrative vision of the future that involves the reality of climate change requires our acceptance of chaos as a player in future scenarios. Where Gilbert White inquired into the downstream effects of volcanoes and hot summers, climate scientists now look to mathematical tipping points that may irreversibly accelerate glacial melting. Where Mary Shelley conceived a tragic drama out of scientific epidemiology, the CDC in America issues disaster scenarios that narrate the potentials of bioterrorism, and monitors the waves of disease inherent to high-density population. Where Wells elaborated on the moral perils of industrial animal husbandry, innovative farmers have begun to shift away from concentrated animal feeding operations (CAFOs) back to an emphasis, philosophical and material, on using biodynamics as an agricultural mantra. Our ability to ameliorate climate change, mass extinction, disease transmission and agricultural pollution depends on constructing models and accurate narratives of the future, understanding how our activities can affect many environments, and modifying industrial consumption patterns.

These four texts are not in themselves scientific works. By invoking the insights and anxieties of nineteenth-century British culture they anticipate the ways that science would develop, theoretically, in the modern industrial state of nature. They may well have accomplished this anticipation unconsciously, but such is the nature of epistemological advance: art accompanies and expands scientific ideas

using a free play of imagination, clearing more theoretical space for science to formalize.

Chapter Three: Lyrical Microcosms of the Nineteenth-Century

I: Introduction

One way to recover a sense of pattern in a chaotic world is draw boundaries around coherent subsystems in nature and study them in isolation from the larger cosmos. This chapter develops a thesis that the ancient concept of the microcosm evolved during the nineteenth-century away from metaphysical ideals and towards physical applications that are in parallel with microcosm experiments in ecology. Literature, I suggest, was an important intellectual mediator between the philosophical and scientific denotations of microcosm, because writing of the nineteenth-century considers and revises several uses of microcosmic aesthetics in the context of studying nature. The microcosm, as a kind of epitome, suggests that if parts of the world are knowable and are found to be synergetic, we can extrapolate those principles of organization onto the macrocosm, and this practice makes the wide world less bewildering. Exquisite little systems appear in British literature of the last four centuries, ever since Renaissance metaphysics and Enlightenment science first became intrigued by the minute worlds just beneath our perceptions.[51]

Two factors make the nineteenth-century a frontier for a new kind of microcosm concept that is aligned with ecology. First, Romanticism developed a philosophy that the imaginative brain was its own little world that could rework the material cosmos

[51] Microscopy resulted in extensive philosophical debate about ideas of inter-scalar correspondence in the cosmos, and the role of the "minute particular" as the factual information that microscopy produces. Tita Chico (2006) has pointed out the paradox of epistemology that began with the writings of microscopist Robert Hooke, who argued that the microscope allowed a widening of perception because "examining the minute world actually amplifies our senses and, by extension, our reason and understanding" (144).

into a distinctive harmonious form. As a redress of the prevailing empirical science of the time, the High Romantics pursued the thesis that man could inform the senses from the mind, thus creating a utopian psychological microcosm that revels in subjective knowledge. Though this may seem inimical to any scientific method based on the microcosm, Romantic philosophy carries a surprising affinity to future ecological methods. Both inquiries treat microcosms as theoretical (rather than literal) systems that can be isolated from the rest of nature. In the twentieth-century, defining the ecosystem (a microcosm existing in nature) required an admission of the conceptual, imaginative work that foregrounds identifying self-sufficient isolates in what is actually a continuous landscape and an interconnected globe. Both inquiries value the aesthetic pleasure and epistemological insight that results from circumscribing heterogeneous, synergetic systems and controlling their fate. Poets control the fates of microcosms by imaginative manipulation (as when Coleridge transforms his Lime-Tree Bower from a wasteland to a garden); scientists control microcosms by manipulating variables through many permutations of experiment. These practices are not equivalent, of course, but they grow out of the same conviction that a small system can be imagined, possessed, and managed in a way that forwards our knowledge of the natural world.

Second, literary figures of the nineteenth-century were obliged to establish some of the first reactions to industrial materialism's despoilment of the environment. The microcosm was increasingly figured in poetry of utopian escapism, where small shelters in nature served as food for the imagination battered by the rudeness of urban life and commercial rhetoric. By century's end, the disturbance of these aestheticized plots was the source of outrage as the first waves of organized environmentalism gathered energy

in England. The microcosm's liminal status between objective object and subjective construct was a source of fascination in the nineteenth-century. As epitomes of larger systems in nature, the endangerment of microcosmic landscapes became the source of concern and outrage. Science has turned to microcosm experiments to evaluate both utopian and dystopian scenarios, for example, how agriculture is embellished by increasing atmospheric carbon, or how a given toxin will affect the nutrient cycling in a wetland. Microcosms provide essential models for the future course of anthropogenic nature.

The microcosm originated as a philosophical trope in Ancient Greece that traced parallels of structure and relationship across physical scales. As an aesthetic device for organizing spatial relationships, cosmos was seen as the opposite of chaos, a figure of order and harmony, and the sum of total of human experience (OED, second edition 1989). Our word "cosmetic" derives from the desire to beautify and harmonize disordered elements of our faces. To Hippocratic medicine, the microcosm was a figure for the human body, which displayed in miniature the elements and energies of an ordered cosmos. Illness, then, could be understood as an imbalance in this corporeal system, and philosophers before Socrates used the microcosm conceit to understand stability and variation both within the body and in relation to larger spheres, including human environments, the earth as a whole, and the entire cosmos. Analogies based on familiar objects carried the conceit forward: Eyes are lanterns, the stomach an oven, veins are rivers.[52] The four elements of earth, air, fire, and water corresponded with the four humors, and these analogical elements required a proper balance for the enjoyment

[52] Vivian Hutton's chapter on Hippocratic medicine describes in greater detail the analogical elements of the medical microcosm (2005: 23-25).

of health both in human bodies and their earthly environments. The monarchal microcosm so well known to Renaissance writers is a political version of this medical conceit: the King's body represents his dominion and the health of both spheres depends on the wise and self-disciplined purview of their leader.[53]

During the nineteenth-century the microcosm trope evolved towards a new epistemological status. The Romantic poets came to describe their brains, with extensive capacities for memory, imaginative recombination, and artistic production, as microcosms with power over the natural environments they sought to capture in verse. In order to preserve the memory of a place in nature, poets studied landscapes with such devotion that their brains were figured as half-creating the nature they knew so well, as when Wordsworth famously describes the mind as a "mansion for all forms," or when Keats in his *Ode to Psyche* decorates his verse with "the wreath'd trellis of a working brain." Cognitive science applied to literature has recently shed light on the relationship between contemporary understandings of the brain and poetic production (see Richardson), but no literary critics have yet identified the Romantic conceit of the mind as microcosm. This psychological microcosm, it could be argued, provides a new view of the Romantic sublime that relies not simply on the awesome massiveness of the macroscopic in nature, nor on the exquisite minuteness of the microscopic. Instead this new sublime excites visions of scalar parallels between various structures in nature, and the brain of the perceiver serves as catalyst for the metaphysical chemistry of poetic epiphany.

[53] Shakespeare's *Richard II* is one of the many literary works of that period that finds the monarchal microcosm a useful trope for exploring how failures of authority can degrade the state alongside the body politic. Shakespeare develops his castle gardeners into experts on political parasitism (see the famous scene, III.iv), and Richard often laments the wasting of his physical body though he seems to be blind to the analogous degradation of his reign.

Most relevant to my concerns in this study is the advent of the ecological microcosm during the nineteenth-century. The first scientific work that used the microcosm as an experimental strategy was Stephen Forbes's *The Lake as a Microcosm*, published in 1887. This empirical breakthrough quickly became both a conceptual and instructional aid to the adolescent sciences of nature, and microcosm studies bloomed into the twentieth-century as the best way to reduce a complex natural system into an intelligible scheme without completely dissecting it into estranged parts. The present chapter is devoted to showing how nineteenth-century literature imagined the ecological microcosm before science adopted the microcosmic lens as an experimental strategy.

In chapter one I described how islands became incidental microcosm experiments when colonists introduced disordering elements into their stable systems. By looking at the microcosm through a literature of environmental engagement such as the nineteenth-century offers, we come to appreciate how advances in concept are often borne on free imaginative acts before they can be formalized and fully understood as effective models for generating new information, as first seen with Stephen Forbes in 1887. Because I am searching for the ecological microcosm's emergence before it was ever described as such, my examples from literature are harvested regionally (from nineteenth-century British poetry) rather than locally (concentrating on a specific writer or single school of thought). While this may admit a sense of arbitrary textual selection, it provides the best way to demonstrate how widespread, if only semi-conscious, the use of the microcosm trope became to the literature of the nineteenth-century. (I will focus specifically on Keats in chapter four.)

All of the texts discussed here use the microcosm as a point of orientation between the writer and the natural world. Romantic-era writers most often figured the microcosm cognitively and philosophically, as a new hyper-subjective lens through which to envision nature. Victorian-era writers, especially women, became skeptical of the egotistical, brain-fetish mode of the High Romantics, and their microcosms directly address the industrial endangerment of ancient landscapes and the ways of living within them. Many of the works I discuss have distinguished volumes of criticism devoted to their complexities; my aim is not to engage all of these loci of discussion, but rather to pour a wealth of diverse works through this very specific filter.

Because nineteenth-century poetry so often reacts to the subordination of nature under industrial modernity, we can rely on its portrayal of nascent ecological mindsets, and we should not be surprised when these perspectives take many developmental forms. Therefore I have organized the chapter under the headings of medical, psychological, and ecological microcosms of the nineteenth-century; these headings help clarify how the trope evolved from Hippocratic medical aesthetics, found an outlet in the Romantic psychological sublime, and invented an ecological utility over the course of the century. These three iterations of microcosmology all have links to the ways that the natural sciences employ this trope, unlike, for example, the social microcosm that comments on human interrelations.[54] While my argument makes no

[54] Since the social microcosm deals only tangentially with scientific knowledge, I have excluded it from particular consideration in this chapter; it is too rich a topic to enter into in this specialized interdisciplinary study. Certainly novels are uniquely well-suited to explore the dynamics of social hierarchies in microcosm, especially considering the stratified economic conditions of the British nineteenth-century. One interesting angle recently developed by scholars of evolution in literature considers how novels in the age of Darwin use social relations to distill concepts like natural selection, sexual selection, and ecosystem dynamics. Peter Graham's Jane Austen and Charles Darwin (2008), and Joseph Carroll's "Human Nature and Literary Meaning" (2005) both look at Austen's novels as social microcosms that reveal biological principles. Gillian Beer's classic study Darwin's Plots

causal claims that would artificially promote an essential mediatory role for literature between philosophy and science, my thesis maintains that the evident fascination with minute natural systems in literary epistemology of the nineteenth-century represents the British culture's maturation towards the holistic empirical thinking that would be necessary for ecological science to fledge by the turn of the twentieth-century. Microcosmic thought generally evolves from more abstract and metaphorical inter-scalar pairings towards more literal, material, and diagnostic ends over the course of the century. For it to be useful in ecological science, the microcosm had to evolve away from its origin as a thought experiment in philosophy towards a controlled empirical scheme set within a material system. Between these two distinct but related ideas lurks an interesting study of interdisciplinary epistemology. The scientist Stephen Forbes, admitting that he had not the poet's talent for ekphrasis, still adopted a poet's perspective to introduce the aesthetic of the laucustrine microcosm to a scientific audience. This chapter proposes several literary origins for his act of consilience.

(originally published in 1983) essentially founded this perspective on literature, and her readings of Eliot and Hardy are indispensable to the evolutionarily-engaged reader.

II: The Medical Microcosm

Drawing equivalence between two overtly different entities, such as the human body and the whole world (the medical microcosm), is the act of making a metaphor. It proposes a figurative truth made out of a literal falsehood. Such poetic reasoning stems from a desire to make sense of a chaotic cosmos in which humans hold a mysterious and variable place. Though the human body is not literally a miniature of the earth, it nevertheless participates in analogous chemical exchanges with the same elements, and each individual life is a discreet proof of the universal biological procession through conception, ontogeny, birth, growth, climax, senescence, and death. Science before the Enlightenment used the aesthetic of economic balance to guide its understanding of cosmic organization, and was able to provide limited evidence that the microcosm trope had some purchase on the physical body. The four elements of earth, air, fire, and water corresponded to the four bodily humors, creating a material rationale for literature that employed the pathetic fallacy, in which nature seems to mimic human emotion.

The medical microcosm is the trope's earliest exposition. In ancient philosophy, Plato, tutor to the more medically-inclined Aristotle, asserted in *Timaeus* that the body's blood acted analogically to the waters of the earth, carrying nutrients and dispelling wastes in cyclical harmony:

> the elements besetting us outside are always dissolving and distributing our substance, sending each kind of body on its way to join its fellows; while on the other hand the substances of the blood, which they are broken up small within us and find themselves comprehended by the individual living creature, framed like a heaven to include them, are constrained to reproduce the movement of the universe. (80e, 81a, b; quoted in Barkan, 18)

Plato's language is deterministic; the body is "framed" and "constrained" to recapitulate the universe, and these requirements serve rhetorically as a telos. A congruency

between body and universe serves to clarify the individual's place within the widening concentric circles of an ordered cosmos.[55]

William Harvey would formalize this medical notion in Renaissance England with his proof in The Circulation of the Blood (1628). The revolutionary study opens with a dedication to King Charles in which Harvey explicitly employs the classic figurative analogy between the king's body politic and his monarchal domain:

> Most serene King! The animal's heart is the basis of its life, its chief member, the sun of its microcosm; on the heart all its activity depends, from the heart all its liveliness and strength arise. Equally is the king the basis of his kingdoms, the sun of his microcosm, the heart of the state; from him all power arises and all grace stems…Placed, best of Kings, as you are at the summit of human affairs, you will at least be able to contemplate simultaneously both the central organ of man's body and the likeness of your own royal power. (3)

This dedication is a medical spin on the traditional Elizabethan sycophancy of a subject towards his sovereign; Harvey makes it clear that the trope of the microcosm in contemporary discourse is sufficiently powerful to secure parallel relationships between heart and body, king and domain, earth and sun; each with its mutually reinforcing scalar equivalence. The microcosm of political philosophy, which had proved useful in assigning a purpose and mutual responsibility between ruler and subjects, is by Harvey's work on blood circulation translated to a medical paradigm useful in elucidating the mysterious revolutions of the physical body that all humans possess. Without the longstanding rhetorical aesthetic of the monarchal microcosm, Harvey

[55] Sharon Ruston (2005) has recently argued that the description of Earth in book I of Shelley's *Prometheus Unbound* makes use of the ancient medical microcosm trope linked to Renaissance notions of the monarchal body politic, particularly evident in the lines, "I am the Earth, / Thy Mother; she within whose stony veins, / To the last fibre of the loftiest tree / Whose thin leaves trembled in the frozen air, / Joy ran, as blood within a living frame" (I, 152-156). Ruston suggests that, rather than forcing a political statement, Shelley's lines explore the distinction in contemporary scientific debates between the natures of vegetable and animal life (121).

would not have such an easy and self-promoting entrée into his relevant physiology of blood circulation.

Walter Pater's aesthetic observations in The Renaissance (1873) benefit from the trope of the medical microcosm, which he adopts in order to conceive of the forces (as opposed to stases or cycles) of senescence that render human physical beauty a handful of dust. Pater identifies the poignant aesthetic of aging as a series of parallels between body and biome, and his melancholy rhapsody becomes a celebration of natural dynamism, the kind that in the Renaissance under girded the *carpe diem* imperative. Pater's formulation of *carpe diem* is modern, however: his rosebuds are rust and corn, and the *forces* of this biological world partake in contemporary evolutionary discourse. He writes,

> What is the whole physical life in that moment but a combination of natural elements to which science gives their names? But those elements, phosphorus and lime and delicate fibres, are present not in the human body alone: we detect them in places most remote from it. Our physical life is a perpetual motion of them -- the passage of the blood, the waste and repairing of the lenses of the eye, the modification of the tissues of the brain under every ray of light and sound -- processes which science reduces to simpler and more elementary forces. Like the elements of which we are composed, the action of these forces extends beyond us: it rusts iron and ripens corn. Far out on every side of us those elements are broadcast, driven in many currents; and birth and gesture and death and the springing of violets from the grave are but a few out of ten thousand resultant combinations. That clear, perpetual outline of face and limb is but an image of ours, under which we group them -- a design in a web, the actual threads of which pass out beyond it. This at least of flamelike [*sic*] our life has, that it is but the concurrence, renewed from moment to moment, of forces parting sooner or later on their ways. (234-235)

The human body is merely a cistern within which our organizing brains can arrange the elements that belong to the universe. To ignore the commonality between elements in nature and those that comprise the physical body is to misunderstand the common material condition of both corpus and cosmos, both set into motion by the mysterious

forces, electricities, and flames that animate biological life. For Pater, the medical microcosm is much more than a set of physical indicators that, by correspondence, aid in the treatment of illness. His suggestive image allows a conception of the human condition as indivisible from nature's condition; though there may seem to be boundaries between human and nature, those boundaries are all too dissoluble, and the elements we seem to possess are in fact the possessions of the macrocosmos; we only borrow them for our day. The body is not God-given, it is a transient gift of nature. Pater's philosophical moment, borne on the medical microcosm, brings our understanding of life towards an environmental ethical conviction: There is no 'other' in the universe, no boundary between human and nature, and circumferences are always conceptual, provisional, and permeable.

In evolutionary theory, Ernest Haeckel's theory that "ontogeny recapitulates phylogeny" held powerful implications for the temporal and material relationships between individual and species, and emphasized the power of the analogical reasoning that grounds microcosmic philosophy.[56] He theorized that the prenatal development of an individual, from the fertilized gamete through infant birth at nine months, rapidly revisits each stage of evolutionary development attained by the human species as a whole. Herbert Spenser extended this notion to include cultural evolution, as Spenser envisioned the educational trajectory of children as a stage-wise recapitulation of the historical advances in knowledge (1861: 5). Haeckel's doctrine that ontogeny

[56] In 1866 Haeckel coined the term 'ecology,' the study of the *oikos* (Greek for home or dwelling-place), a word that emphasizes the importance of circumscribed and inter-contained systems in our studies of the natural world. The word has evolved, etymologically, into ecosystem, ecotopia, ecoregion, ecocide, ecophene, ecoconscious, etc; the prefix eco- is now a mainstream handle for 'green' versions of everything we buy, even though these products are often, on the uptake, less favorably eco-nomical.

recapitulates phylogeny has been debunked on the literal level, but it is still taught in college biology courses as a revealing metaphorical thought experiment that places the temporal depths of phylogenic evolutionary change within the conceivable timescale of individual growth. The ontogeny/phylogeny relationship was the subject of major investigation in nineteenth-century science, stirring extensive debate on the ultimate origins of life.

The related concept of the protoplasm, a theoretical unit of primitive life that laid the foundation for many subsequent theories of developmental and evolutionary biology, was of intense interest to Erasmus Darwin, Richard Chambers, Charles Darwin, and Thomas Huxley.[57] The protoplasm went hand-in-hand with a belief in unifying, ubiquitous forces in nature, particularly evolution. It served as a concept for how all life could be contained in a single, archetypal unit, a microcosm that by its own developmental energy created the biological macrocosm, of which it, in turn, became the epitome. This "atom of life" made its way into the imaginations of nineteenth-century writers, as well: among others, George Eliot and Richard Jefferies adopted the aesthetic of biological minutiae to contain the symbolism of their literary imagery, and present the richness of the micro-scale world at the eye level of their readers.

[57] Erasmus Darwin's *Zoonomia* (1803) enthusiastically speculates on the prototypical filament as a rationale for biological origins in life, a notion made especially appealing under the light of early evolutionary theory. Darwin writes, "…would it be too bold to imagine, that in the great length of time, since the earth began to exist, perhaps millions of ages before the commencement of the history of mankind, would it be too bold to imagine, that all warm-blooded animals have arisen from one living filament, which THE GREAT FIRST CAUSE endued with animality, with the power of acquiring new parts, attended with new propensities, directed by irritations, sensations, volitions, and associations…delivering down those improvements by generation to its posterity, world without end!" (I, 509). Tertius Lydgate is Eliot's persona of the early nineteenth-century scientist for whom "too bold to imagine" was an anathema represented by small-minded, old-fashioned, often determinedly Theistic individuals.

By the middle of the nineteenth-century, sciences of evolution and biological origins were at the center of empirical intrigue. George Eliot's tragic physician in Middlemarch, Tertius Lydgate, is a man with a mission to elucidate the mysteries of the theoretical protoplasm. Lydgate's downfall results from his disastrous social decisions rather than his science, which Eliot characterizes as his greatest passion and virtue. He

> longed to demonstrate the more intimate relations of living structure, and help to define men's though more accurately after the true order…What was the primitive tissue?...He counted on quiet intervals to be watchfully seized, for taking up the threads of investigation – on many hints to be won from diligent application, not only of the scalpel, but of the microscope, which research had begun to use again with new enthusiasm of reliance. Such was Lydgate's plan of the future: to do good small work for Middlemarch, and great work for the world. (139)

Lawrence Rothfield (1992) has argued that Eliot's focus on early cell biology in Middlemarch serves as a critique of biological science's ability to generate unifying, conciliatory information across biological scales. However effectively cells and organisms were studied individually as their own clear biological units of scale, Rothfield argues that "retaining some faith in an ultimate unity, or at least some hierarchical relationship, among the sciences" was elusive in Eliot's time (99). But in important ways, intact relations of scale are essential to this novel's several threads of argumentation. Though there are episodes of despair and frustration in which the unintelligible prevails, the illustrative case or exemplary narrative is still Eliot's heuristic. Small experiments in Middlemarch translate into great advances in national science; the movements under the microscope perhaps hold the key to all higher-order life forms; individual couples reveal the varied challenges of the larger quest to attain happiness. Middlemarch is a microcosm of English social dynamics, and readers have long appreciated how Eliot is able (like her predecessor Jane Austen) to illustrate the

structures and interrelations of English society through a discrete epitomic case study such as the village of Middlemarch affords.

Lydgate's timely scientific passion to find the universal protoplasm gestures to the scientific future, and Eliot balances his relevant inquiry with the obsolete ambition of Casaubon to find the key to all mythologies. Mythology, in this new age of the biosciences, grew into a fresh body of knowledge based on primordial affinities, energies, biotic webs and nerves rather than the legends of the ancient Gods.[58] Though the sciences of the 1860s did not yet possess the power of inter-scalar translation, from cell to organism, or from individual to nation, the potential of the illustrative microcosm was tantalizing enough for Eliot to write her most intelligent character, Lydgate, into the small circle of a cell, while promising him greatness and renown as the scientific ascetic's prize.

In one of his later essays, "Hours of Spring" (c. 1887), Richard Jefferies indicates the intrinsic value of genetic essence that is captured by the protoplasm concept. Twenty years beyond Darwin's evolution, the environmentally-minded Jefferies describes ontogeny using microbiology, which updates his John Clare-like eco-valuation for a contemporary audience. He writes, "…the eggs of the starling are laid in the knot-hole of the pollard elm – common eggs, but within each a speck that is not to be found in a cut diamond of two hundred carats – the dot of protoplasm, the atom of life" (2001: 123). This moral moment, which prizes life of any kind over mineral wealth, comes among a series of observations about the mutualisms between various bird species and their biotic environments. The essay is one step short of a lyric

[58] Poets such as Keats would find common ground between these diverse traditions of telling deep history; his "Hyperion" (1819) is an evolutionary poem that I'll discuss in depth in chapter four.

on the ecosystem (not yet a defined concept), an entangled web in which the starling relies on the elm to cradle its atoms of life, and each successive bird species holds similar conventions with reciprocal trees. Jefferies's high valuation of the protoplasm as a biogenetic key to myriad adult forms previews the high value that twenty-first century medicine places on stem cells, those potential-filled undifferentiated units that we can coax into many useful specialty cells to treat disease. The stem cell is more precious than gems because all of its ontogenetic portals are still wide open, and so quite literally it contains all adult cell forms in one microscopic puck suspended in developmental abeyance.

The congruence between microcosm and macrocosm is an aesthetic aid to conceiving the hierarchical ranks of the biological world, and it has many literal applications in medicine. Each microcosmos may be coherent within itself, but none could exist without inter-scalar linkages. A key modern revelation follows: any little world is vulnerable to pollution by association. An individual organism may be polluted by a mutation in genes, an ecosystem by community imbalance, a biosphere by large-scale regional shifts, such as massive deforestation and glacial melting. The congruent scalar aesthetic is so fully integrated into scientific thought that taking this step back, realizing that the imaginative trope of the microcosm roots this commonplace of biology, makes it worthy of further inquiry. In addition to the medical microcosm, two other iterations of the microcosm are relevant to nineteenth-century literature and the biological sciences that inherited holistic schemes of thought: microcosms of the psyche, and of the *oikos*.

III: The Psychological Microcosm

The psychological microcosm, a figure that seeks to engulf nature's macrocosm into the folds of brain and imagination, is a central unifying principle of poetry in the early nineteenth-century. Though literary critics have never used the microcosm trope to theorize this inter-scalar, reciprocal relationship between lobe and globe, a sampling of the most interesting, complex, and important passages of early Romanticism reveals the ubiquity and power in the microcosmic construct of mind-as-world, a kind of intense philosophical subjectivity.[59] In order to show the scope and prevalence of microcosmic ideas of the brain in nineteenth-century poetry, my readings are brief and somewhat provisional; this strategy of surveying the territory of an idea is consistent with my treatment of both tropes. While I do not pretend that my readings are exhaustive, I trust that the appearance of this trope in some of the most celebrated passages of High Romanticism supports the claim that psychological microcosm aesthetics served an important intermediary role in the evolution of the idea. The brain-as-worldmaker notion of Romantic philosophy established how the alchemical action of poetic production might reverse the traditional "senses inform mind" into "mind directs senses." Coleridge was familiar with the microcosm in philosophy, which was enriched by his reading of the German Romantics Shelling and Novalis. Nicholas Halmi's essay "Mind as Microcosm" (2001) demonstrates how Coleridge's commitment to the

[59] Alan Richardson's British Romanticism and the Science of the Mind (2001) investigates the development of neurological sciences in the early nineteenth-century, and the ways in which Romantic psychologies developed around these new scientific insights. The enormous pace of discoveries between 1790 and 1830, including definitive evidence that the brain was the seat of thought, that portions of the brain took on specific tasks, and that psychosomatic affect could have a non-dualistic basis, aided in the development of a literature that was cognitively modern (1-2, 6). Psychology became of central interest among the sublime mysteries of existence; my treatment of the psychological microcosm in literature reinforces the Romantic notion that brains exchange impressions with environment, and that brain and biome have a mimetic relationship.

microcosmic man (as seen in the eleventh of his Philosophical Lectures, delivered on March 8, 1819) was based in his desire for "the recuperation of nature in a meaningful relation to humanity" (49).

By the second half of the nineteenth-century, a humorous and somewhat cynical view of the Romantic psychological microcosm was expressed on the pages of female Victorian poets May Kendall and George Eliot. The psychological sublime, which had supported Romantic visions of inter-scalar connection and the synthesizing power of imagination, became by the end-of-century a comical conceit that exposed the egoism of a masculine intellect imposing his visions on the natural world. These claims and trends will be spelled out in this section on the psychological microcosm.

The Romantics sympathized with Milton's Satan, who reasoned in a fit of self-empowerment that "The mind is its own place, and in itself / Can make a Heav'n of Hell, a Hell of Heav'n" (PL, I, 254-255). Blake's moonlit river bank in *The Marriage of Heaven and Hell* is a landscape regained, by force of imagination, from the angelic nightmare of a subterranean mill; his harper sings, "The man who never alters his opinion is like standing water, & breeds reptiles of the mind" (plate 19). Blake's Urizen, a figurative subset of reason divided from the infinite cosmos, finds himself shackled to his solipsistic psyche; the poet's Orc cycle is a whirlpool of psychological figures (Los, Urizen, and Orc) that is recapitulated in Freud's ego, superego, and id. Blake recognized that some of the most pernicious aspects of British society were borne on rails of institutional religion, and institutional science held a complement of hazards; Los, the imagination, balances these frames of mind and, unlike Justice, Los is not blind. Blake's continual reliance on states of mind as themselves constitutive of an

individual's reality reinforces subjectivity in perception. Realizing the tyranny of institutional "reality" as the kind of social interpellation that endangers every individual, Blake identified mind as the main agent of both imprisonment and emancipation.

Wordsworth's epiphanic moments, his spots of time, appear when emotion is recollected in tranquility, when blizzards of experience are distilled by the brain into symbolic representative episodes. Wordsworth's realizations are the offspring of "a mighty Mind, / Of one that feeds upon infinity" (13, ll. 69-70); this central formulation follows from the earliest parts of the *Prelude*,

> The mind of man is framed even like the breath
> And harmony of music. There is a dark
> Invisible workmanship that reconciles
> Discordant elements, and makes them move
> In one society… (I. 352-356)

In her celebrated study of literary Darwinism, Gillian Beer observes the use of "lyrical materialism" by the elder Romantics, which leads to secular-spiritual way of knowing nature: "Wordsworth's emphasis upon the congruity of the inner and the outer worlds allows harmony and development without the need to insist upon a preordained design" (45). In *Tintern Abbey*, the poet recognizes in nature a spiritual energy that is "anchor of my purest thoughts" (110), and wishes for Dorothy to grow, intellectually, to resemble himself: "thy mind / Shall be a mansion for all lovely forms, / Thy memory be as a dwelling-place / For all sweet sounds and harmonies" (140-143). Later in this chapter I will demonstrate how Dorothy's mind and memory did indeed form itself around her nature-infused experiences with William and others, and how she was more scientific and exact in her observations of nature than her brother.

The philosophical foundation of the *Intimations of Immortality* ode is contained in the preamble: Wordsworth as a boy was overwhelmed by the solipsistic "abyss of idealism" that his imagination continually created, and he sought escape by grasping at "a wall or a tree," something material in nature that was definitively *outside* of his mind. This memory leads to the poem's philosophic occasion: "Archimedes said that he could move the world if he had a point whereon to rest his machine. Who has not felt the same aspirations as regards the world of his own mind?" Poetry is the vehicle that moves the whole cosmos of the psyche. Unlike religion, which appeals to spirit and soul, and science, which appeals to reason, poetry for the Romantics was a wellspring for moving the mind all at once, never dispensing with or reducing the whole into a ration of spirit, imagination, intuition, emotion, memory, and reason. Over the course of his epic poem, which was to rival the world-wandering heroic epics of past ages, Wordsworth sought his alternate title in a microcosmos: "The growth of a poet's mind." Wordsworth's brain is invested in molding the external world to imagined schemes of harmony with the help of the harmonizing rhythms of blank verse.

His work with Coleridge demonstrates how individual minds could coordinate in philosophy with the psychological microcosm, and yet starkly diverge in practice. Wordsworth's genius usually led him to flights of fancy on mountain peaks in memory; Coleridge's mind circled around more macabre foci, like the desperate psychological worlds of the Mariner and Christabel. The two poets parted ways over these dispositional discrepancies. But Coleridge's notion of the poetic symbol identifies a common focal point. The symbol is that which "is characterized by a translucence of the special in the individual, or of the general in the special, or of the universal in the

general; above all by the translucence of the eternal through and in the temporal. It always partakes of the reality which it renders intelligible; and while it enunciates the whole, abides itself as a living part in that unity of which it is the representative" (*The Statesman's Manual*). Coleridge's idea supported the realization, in poetry, of little worlds that reflected the true nature of things in the larger patterns of the universe. This denotation of *symbol* is itself a Romantic epistemology, and it is microcosmic.

High Romanticism is equipped with powerful lenses of the imagination; these lenses navigate the scales of nature through their rhapsodic panning into particulars, and out to universals. Traversing scales in nature, in effect, prepares the poetic mind for its moment of enthusiastic insight. There is cognitive chemistry involved in transforming the mundane quotidian into the illustrative symbolic. In *Kubla Khan*, Coleridge's laudanum-driven brain envisions the ideal, circumscribed space of paradise:

> So twice five miles of fertile ground
> With walls and towers were girdled round:
> And there were gardens bright with sinuous rills,
> Where blossomed many an incense-bearing tree;
> And here were forests ancient as the hills,
> Enfolding sunny spots of greenery. (6-11)

We will see how the ecological microcosm relies on diversity of landscape and life-form within a small circle; here, Coleridge's "psychological curiosity" attains an ecological vision of a paradisiacal place by using the dreaming imagination and the pharmacological muse as vehicles. Famously, Coleridge lost his memory of the rest of the poem, he claimed, because he was interrupted in his frenzied composition by a knock at the door. This Xanadu existed only in his mind, and only during the intensive aftermath of the dream when his neurons held the short-term memory of the vision that

vanished, as Coleridge describes in the poem's preamble, like "images on the surface of a stream into which a stone had been cast."

Coleridge's poem *This Lime-Tree Bower my Prison* is set on firmer ground. The poem wrestles with the mundane until it finds its moment of insight, but the poet has no need to climb a mountain peak (or take laudanum) for his eventual perspective. Simply by dwelling in the same small, complex, natural place and *thinking* through his mood, Coleridge transforms blindness and separation into a vision of interconnection. Imagining his friends' progress on their walk, the poet is moved to empathy and transposes their experience into his own circumscribed location:

> A delight
> Comes sudden on my heart, and I am glad
> As I myself were there! Nor in this bower,
> This little lime-tree bower, have I not marked
> Much that has soothed me. Pale beneath the blaze
> Hung the transparent foliage; and I watched
> Some broad and sunny leaf, and loved to see
> The shadow of the leaf and stem above
> Dappling its sunshine! (43-51)

Coleridge finds, in the sun patterns on a single leaf, a recursive view of an entire grove of sunbathed trees; he harnesses his imagination into a labor of deep empathy with Charles Lamb's experience:

> So my Friend
> Struck with deep joy may stand, as I have stood,
> Silent with swimming sense; yea, gazing round
> On the wide landscape, gaze till all doth seem
> Less gross than bodily; (37-41)

Though his body is passive, his active brain transforms the scene into a vision of nature's ubiquity, even downscale:

> Henceforth I shall know
> That Nature ne'er deserts the wise and pure;

No plot so narrow, be but Nature there,
No waste so vacant, but may well employ
Each faculty of sense, and keep the heart
Awake to Love and Beauty! (59-64)

This famous passage has moral as well as ecological resonances; the "wise and pure" are those who dwell in patient contemplation of nature, and are rewarded for their imaginative sophistication; the initially-perceived vacant wastes are transformed into minute gardens and wildernesses. Since Coleridge is forced, by physical injury, to stay put beneath the lime tree, his imagination delves deeply into the scene, and he emerges with the microcosmic epiphany that is unavailable to those hikers contemplating a broader range. Again, circumscription is crucial to a vision of the microcosm, and the imagination successfully performs the enzymatic activity that makes a minor paradise out of a vacant waste.

Percy Shelley's poetry develops the trope of mind-as-universe by fully subsuming one into the other. These cycles of shifting congruence between inner and outer worlds are approached by Shelley's almost immaterial phraseology: "unentangled intermixture" and "unremitting interchange" are the products of a poetic language straining to capture his imagination's information, which is derived from a lifetime of studying forms in nature. Mont Blanc is the apex of Shelley's abstract philosophical formulations:

Dizzy Ravine! and when I gaze on thee
I seem as in a trance sublime and strange
To muse on my own separate fantasy,
My own, my human mind, which passively
Now renders and receives fast influencings,
Holding an unremitting interchange
With the clear universe of things around;
One legion of wild thoughts, whose wandering wings
Now float above thy darkness, and now rest

> Where that or thou art no unbidden guest,
> In the still cave of the witch Poesy,
> Seeking among the shadows that pass by,
> Ghosts of all things that are… (ll. 34-46)

Shelley's verse seeks to contain the vastness of material nature in some coherent parcel of cognitive space; he carves a cave in which poetry dwells so as to delimit the thoughts themselves from their source of inspiration ("the clear universe of things around"); this circumscription, however, is necessarily incomplete and the interchange of mind and mountain is a continual process enabled by their mutually active energies.

These major poets of the Romantic period demonstrate how the world of the mind is a laboratory that can be used to recombine the elements of nature and formulate a distinct epistemology based on imagination. Mental microcosms have a philosophical basis in desiring to understand the natural world as a system of materials and energies that is congruent and complementary with a human brain that evolved from the self-same processes. An ambition to know nature deeply by delving into the stores of the imagination, by forcing the brain to recombine sense elements into the secondary, higher-order capability of inspired perception (and thereby to derive the sublime from the hum-drum), is the epistemological belief that guided these natural supernaturalists beyond the knowledge-avenues of traditional religious faith (which spurns both the senses and reason) and strict empiricism (which disavows imagination). The psychological microcosm personalizes the world-at-large, permitting, as Keats would imagine of Galileo, new planets to swim into our ken. With these acts of close, open-minded observation, habitats grow in the brain, and the shadows of nature lighten to the bright imagination.

Later writers of the nineteenth-century, particularly those in dialogue with the minds directing Victorian science, would become suspicious of the paradises offered up by the Romantic imaginations of poets and utopian techno-scientists. In particular, women poets would make comical figures out of the earlier generations' deeply serious epistemology of imagination and the egotism of the hyper-subjective, world-commanding psychological microcosm. Cautionary Victorians distrusted the popular belief that paradise, if imaginable, could be created as a material reality using recent advancements in the sciences and technology. George Eliot's *A Minor Prophet* (1874) satirizes the ideas of a "vegetarian seer" named Elias Baptist Butterworth, who philosophizes "Somewhat too wearisomely" on the uneasy evolution of Christianity into a new technical age (ll. 1, 16). Butterworth's physiognomy makes him physically fit to absorb the world of "Transatlantic air and modern thought" (23); his hair is brushed back "to show his great capacity -- / A full grain's length at the angle of the brow / Proving him witty…/ his doctrine needs / The testimony of his frontal lobe" (28-30, 32-33). A cognitive analogue to spiritualism's notion of the collective soul, Butterworth subscribes to the highly industrial image of a "Thought-atmosphere," made of

> a steam of brains
> In correlated force of raps, as proved
> By motion, heat, and science generally;
> The spectrum, for example, which has shown
> The self-same metals in the sun as here;
> *So* the Thought-atmosphere is everywhere. (ll. 38-43) [italics in the original]

Eliot's fun with her sardonic indictment of the Victorian kings of ideas is measured by a serious concern for the environmental endpoints of their actions. The self-admiring, world-conceiving intellect of this rapid, machine-driven age is far from harmless, and

the psychological microcosm comes to show how privileged English industrial ideals come to be stamped upon the body of "our infant Earth":

> When it will be too full of human kind
> To have the room for wilder animals.
> Saith he, Sahara will be populous
> With families of gentlemen retired
> From commerce in more Central Africa,
> Who order coolness as we order coal,
> And have a lobe anterior strong enough
> To think away the sand storms. Science thus
> Will leave no spot on this terraqueous globe
> Unfit to be inhabited by man,
> The chief of animals: all meaner brutes
> Will have been smoked and elbowed out of life. (ll. 66-78)

The chilling accuracy of this semi-comical passage, as we look back on the long century since its composition, makes Eliot's poem a serious and inspired environmental claim that values 'wildness' over the intellectual cult of idealistic beauty-worship. The speaker, who dubs herself "Colin Clout," identifies how "every change upon this earth / Is bought with sacrifice" (ll. 145-146); a technological purchase, we have learned, that comes at the cost of biological heterogeneity as well as intellectual richness (remember the idiocy of Wells's Eloi from my analysis in chapter two). Clout takes a position against the eugenic ideal that raged in the wake of evolution by natural selection:

> A clinging flavour penetrates my life –
> My onion is imperfectness: I cleave
> To nature's blunders, evanescent types
> Which sages banish from Utopia. (ll. 173-176)

Surely the human mind is yet an inadequate vessel for containing all perfection *and* all imperfection it views in the natural world; when we design the future around a Utopia of industrial synergy, physical comfort, and conventional beauty, we substitute a bland

and predictable telos for the wild vitality of nature's ongoing experiments with life. Recall Richard Jefferies's prophetic quote from late in his career:

> When at last I had disabused my mind of the enormous imposture of a design, an object, and an end, a purpose or a system, I began to see dimly how much more grandeur, beauty, and hope there is in a divine chaos – not chaos in the sense of disorder or confusion but simply the absence of order – than there is in a universe made by pattern…this machine-made world and piece of mechanism; what a petty, despicable, microcosmos I had substituted for the reality…I look at the sunshine and feel that there is no contracted order: there is divine chaos, and, in it, limitless hope and possibilities. (2001: 163)

Written at the same time, Eliot's poem and Jefferies's essay are pointed critiques of a Romantic vision that had been streamlined for more businesslike times. By the 1870s, the imposition of synergetic order over nature, both conceptually and technologically, had become a noticeable threat to the wild vitality that the Romantics had celebrated half a century earlier. Eliot's "steam of brains" and Jefferies's "machine-made world and…petty, despicable microcosmos" reveal a moral problem with an imagined perfection of the mind becoming manifest in nature. We will see in chapter five that some ecologists of the twenty-first century have analogous concerns with the degree to which scientists conceptualize nature as a mechanism we can model using microcosms, and therefore disrespect the element of chaotic creativity as a continual and crucial factor in natural systems.

May Kendall, a late Victorian poet, was as cheeky as George Eliot when it came to the great advances in technology borne on scientific advance. Her *Lay of the Trilobite* (1887) sounds a pastoral trope of desirable simplicity in life, a blissful state of ignorance that has been shattered by the monstrous cerebral cortex of *Homo sapiens* (the sapient ones). Thinking is tortuous trouble, and in this ballad the evolved brain demands stimulation to fill its vacancy:

A Mountain's giddy height I sought
Because I could not find
Sufficient vague and mighty thought
To fill my mighty mind;
And as I wandered ill at east,
There chanced upon my sight
A native of Silurian seas,
An ancient Trilobite. (ll. 1-8)

This image of the Romantic wanderer directly addresses the Wordsworthian mind feeding upon infinity, and, like Cleopatra, this mind makes the man hungry where he is most satisfied. Here, the *potential* for a psychological microcosm is itself a weary notion, and all the complexities of philosophy, poetry, religion, science and politics become forms of delusional self-enslavement, rather than avenues through which the natural world can be better captured in the world of neurons. The poem becomes a lyric of Paleolithic theriophily (animal love):

I wish our brains were not so good,
I wish our skulls were thicker,
I wish that Evolution could
Have stopped a little quicker;
For oh, it was a happy plight,
Of liberty and ease,
To be a simple Trilobite
In the Silurian seas! (ll. 64-72)

The comical adolescence of this ballad verse, (its easy and obvious rhymes, its exclamations of simple emotion) exhibits more than just the intermediary role between children and men that women's writing was slotted to play in Victorian culture. Kendall's caution cuts at the heart of her ambitious age, which produced so many mammoth, world-swallowing studies of nature and culture. Her poem adopts a Quaker ethic, aligning simplicity with freedom, and divests itself of the heavy garments of haughty intellect in preference for the bare skin of cognitive frugality. The Trilobite

hero feels no compulsion to defend his ignorant ways, or his meager means, they simply *are*. There is no need to force them into becoming something greater. He concludes,

> I didn't grumble, didn't steal,
> I never took to rhyme:
> Salt water was my frugal meal,
> And carbonate of lime. (ll. 53-56)

As Victorians looked ahead to Modernity, many of them also looked back to the Romantic ideal of the world-reflecting mind. A small percentage of humanity, particularly the British upper-class, had attained relative liberty from hunger, disease, and physical oppression; these liberties cultivated further philosophical and scientific advance in the networks of educated minds. A larger percentage of the British people lost the freedom and health of their formerly agrarian lifestyle as a compulsory sacrifice to mammon, the industrial, material beast, which closes windows on the natural world. Kendall's poem also speaks for the masses who have enjoyed no increase in their standards of living as a result of the modern industrial state, and whose comparative freedom had been based on simplicity and non-materialism.

The psychological microcosm carried a whiff of idealism into a practical age, thus wedding the metaphysical concept of holistic containment with myriad mechanisms that might realize such coherence in physical terms. What the brain contained, nature reflected, and technology and mechanics might eventually manufacture. The brain-as-world trope can be linked to the biogeochemist Vladimir Vernadsky's concept of the *noosphere* (dating from the 1920s), which he defined as a new inheritance of cosmic organization, after the geosphere and biosphere phases. Biological life altered the face of the sterile boiling lump that had originally been planet

Earth; Vernadsky drew the corollary of the human brain coming into command over the biological world. His mechanism, based on nuclear physics, theorizes how humans could transmute elements to create whatever matter they desired, from the basest of inputs. As a speculative hypothesis, the noosphere is an epitome of metaphysics, but like the most self-absorbed versions of the psychological microcosm, it has a rational limb that strikes at the physical world.

An alternative concept of the microcosm was to rise to centrality during the nineteenth-century. This *ecological* microcosm brought the little worlds of the mind out of the cranial cavity and onto the terrain of investigable biological phenomena. More than a trope, less than a truth, the ecological microcosm straddles epistemological territories, thus opening space for fresh equations of human involvement with nature. The final section of this chapter investigates ways in which literature accommodated, and translated, earlier microcosms in order to address the ecological concerns of nineteenth-century.

IV: The Ecological Microcosm

With the increasing industrial stresses on natural environments, nineteenth-century writers were in a position to actuate the power of the ecological microcosm as a material construct built upon an imaginative conceit. These literary encounters actively recombined some parcel of physical nature with the writer's imagination of her place within the cosmic network; I distinguish these readings from the earlier instances of the psychological microcosm by virtue of their locus within nature, rather than in the mind of the seeker of nature. There is no hard-and-fast distinction that imperviously separates the world-of-mind trope from the world-of-nature or *oikos*; if there were, we would be some way towards addressing the insoluble debate still surrounding subjectivity in science. The mind always partakes of the reality which it renders intelligible, and the works I select here and promote as epistemological ancestors to modern ecological science are, indeed, works of art. Art since at least the eighteenth-century has negotiated with scientific theories about the way nature behaves. In chapter two we observed the chaotic narrative dynamics of rapid environmental change as evoking a signal pattern in ecology. The present chapter is involved not merely in showing the symbolic sense of control afforded by a simple and small system that models the global macrocosm, but also the vulnerability to utter dissolution that models can exhibit, portending global upheaval.

In 1935 the American ecologist Arthur Tansley sought a formal definition for the new scientific concept of the ecosystem, which is one scientific way to conceptualize an ecological microcosm. Ecosystems, though not literally isolated from surrounding areas, are largely isolated and intra-dependent in their materials, species,

and energy exchange patterns. Tansley was bothered by the muddiness of boundaries in ecology, and yet he recognized that circumscription in nature was often as much a matter of theory and imagination as it was an extant reality that could be studied. To this end, he writes:

> [Ecosystems] are of the most various kinds and sizes. They form one category of the multitudinous physical systems of the universe, which range from the universe as a whole down to the atom. The whole method of science…is to isolate systems mentally for the purposes of study, so that the series of *isolates* we make become the actual objects of our study, whether the isolate be a solar system, a planet, a climatic region, a plant or animal community, an individual organism, an organic molecule or an atom. Actually the systems we isolate mentally are not only included as parts of larger ones, but they also overlap, interlock and interact with one another. The isolation is partly artificial, but it is the only possible way in which we can proceed. (299-300)

The boundaries of ecosystem ecology, then, are systems "we isolate mentally." They are half-imagined for the sake of coherent study, and they half-exist as distinct sub-structures of organization in nature. To imagine their existence is a necessary precursor for theorizing how they might work: how inclusive to be in the model, how to measure the impalpable entities, and to account for contingent events set in time. The ecologist dwells in a liminal terrain between theory and material entity, and the dimensions of this meta/physical space are largely subject to her own definition (though the terms and rationale of ecosystem boundaries will inevitably be vetted by the scientific community). Ecology's hope for simplifying enormously complex natural systems falls to isolating a small portion of nature from all the rest for the purpose of studying it in a kind of intellectual vacuum. Tansley admitted "the isolation is partly artificial, but it is the only possible way in which we can proceed."

The word "artificial" might be substituted with intellectual or imaginative or even empirical, since Tansley is demonstrating how any subject of study that exists in

nature will require its observer to define the boundaries of inquiry and make a series of subjective decisions about what is within the lens and what must be excluded for intelligibility's sake. These decisions of empirical circumscription become more difficult in the middle, ecological, scales of inquiry: solar systems and atoms are conceptually more isolated than climactic regions or animal and plant communities because they are closer to infinite largeness and minuteness. Because of the muddy middle scale, the scale of every day human life, ecological science has had to theorize its terms and methods of circumscription in order to make empiricism at these scales actionable. The microcosm concept performed the much-needed labor of clarification for ecologists in the twentieth-century. In this section I will sample early literary uses of the ecological microcosm, circling around the notion that imagination is essential to theorizing a distinct, austere system in nature that can be studied empirically as though it were an isolate.

A commonplace of Romantic aesthetic theory lies in the observation of the picturesque as a selective subset of nature's scenes; this vogue could be understood as an industrial mass population's desire to recuperate the Edenic bower. In 1794, William Gilpin's essay on "Picturesque Beauty" formalized the notion of the picturesque composition as "uniting in one whole a variety of parts; and these parts can only be obtained from rough objects…the picturesque eye is to *survey nature*; not to *anatomize matter*…It examines *parts*, but never *particles*" (508) [italics in the original]. Contrasting the reductionism of the empirical sciences, yet still seeking a frame for his formal vision of the picturesque, Gilpin requires the partition of Nature for aesthetic effect, noting his opinion that "her ideas are too vast for picturesque use, without the

restraint of rules…[the painter must] remove little objects, which in nature push themselves too much in sight, and serve only to introduce too many parts into your *composition*" (510). Simplicity, variety, and synergy became the requirements for viewing a landscape properly and for choosing a subset of nature that was to become an idealized representation of the sampled whole.[60]

Almost a century later, William Morris would criticize this detached vision of nature as a lamentable inheritance of the "Century of Commerce." In *The Beauty of Life* (1880), Morris politicizes Gilpin's austere doctrine with a simple question: "How can you care about the image of a landscape when you show by your deeds that you don't care for the landscape itself?" (chapter 3 page 10). It had become clear near the end of the nineteenth-century that the picturesque aesthetic was an effective way to summarize nature, but that art did not always play the role of preserver and, along with the general commerce of industrialism, many works of art had come to exploit natural scenes for capital gain.[61] Other methods of aesthetically partitioning a system of nature,

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[60] Edmund Burke (1756) was soon to raise the ante on Romantic aesthetics by theorizing the sublime as a counterpoint to the picturesque and the beautiful; his idea of sublimity was based on its defiance of circumscription, including the characteristics of terror, obscurity, power, privation, vastness, infinity, difficulty. To contrast, he somewhat tersely captured the essence of beauty by associating it with exquisite smallness: "in most languages, the objects of love are spoken of under diminutive epithets" (503).

[61] Tim Morton's recent study Ecology without Nature (2007) critiques the reveries of literary ecocritics, whom he believes demonstrate "a refusal to engage with the present moment" by their "vision of the text as a pristine wilderness of pure meaning" (122). He is working from a critique of 'wilderness' established by Bill Cronin. Morton's present moment addresses the late industrial, post-wilderness condition that has been brought about by science and technology in the years intervening since the Romantic period, which he identifies as a "negative awareness" quite estranged from ecofeminist and Gaian images of holism (84). He states: "*Ecology* derived from the Enlightenment view of the *economy of nature*. This economy is an organization to the mutual cost and benefit of its participants. But ecology had begun to appear rather fuzzy and even spiritual, a superorganism composed of all organisms. Despite its connotations of the theoretical, at least to reactionary ears, the idea of environment as a system rules out critical anomalies. The ecosystem becomes an immersive, impersonal matrix…Systems theory is holism without the sticky wetness, a cybernetic version of the ecological imaginary" (103). Rather than supporting Morton's argument based on the antithesis between fuzzy, sticky, spiritual literary ecocriticism and quantitative, cybernetic, predictive ecosystems

particularly aquariums and greenhouses, flourished over the course of the nineteenth-century; these lead to massive nationalistic undertakings such as Kew Gardens and the Great Exhibition of 1851. Colonial England needed architectural structures to contain the ecological worlds they were scavenging from the edges of Empire.[62] One hundred years before Arthur Tansley theorized the ecosystem for the sciences, poets were noticing how their natural dwellings could, in effect, become subjects through the imaginative, partially-artificial work of microcosmic circumscription.

Wordsworth's *Home at Grasmere* is a rewarding study in the context of an ecological microcosm as an *oikos*, or dwelling place. The long poem was meant as a first section to his unfinished epic "The Recluse," but the introductory fragment was not published until 1888, long posthumous. Wordsworth felt he had failed on the much-contemplated "Recluse" project, but "Home at Grasmere" and "The Excursion" (the epic's second section) together form an appealing rejoinder to his finished epic "The Prelude" (or, the growth of a poet's mind). In "Home at Grasmere," Wordsworth set out to establish a philosophy of organicism between the mind and its natural dwelling. Coleridge recalled that "Wordsworth should assume the station of a man in mental repose, one whose principles were made up, and so prepared to deliver upon authority a system of philosophy. He was to treat man as man, --a subject of eye, ear, touch, and taste, in contact with external nature, and informing the senses from the mind, and not

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science, I contend that his thought is more constructively aligned under mutual, progressive historical influence: "Spiritual" holism as a Romantic philosophy is predecessor to biological systems theory, and systems take part in irreducible biosynergetic wholes that are best approached through a more-than-mechanical understanding. Where Morton undercuts ecocritical readings as naïvely eco-spiritual and implies that its practitioners are unaware of highly quantifiable theories and matrixes of systems ecology, I counter that the quasi-spiritual naturalism of Romantic poetry is conceptually continuous with its twenty-first century outlets in the science of ecological complexity.

[62] David Allen (1976) has a useful discussion of this vogue and the mechanical ingenuity necessary to support it, such as Nathaniel Ward's invention of glazed glass in the 1830s (136).

compounding a mind out of the senses" (Darlington 1977: 3). Wordsworth's verse précis of this philosophical occasion is more inclusive of a two-way exchange of influence:

> my voice proclaims
> How exquisitely the individual Mind
> (And the progressive powers perhaps no less
> Of the whole species) to the external World
> Is fitted; and how exquisitely, too –
> Theme this but a little heard among Men –
> The external World is fitted to the Mind;
> And the creation (by no lower name
> Can it be called) which they when blended might
> Accomplish; this is our high argument. (ll. 815-824)

As philosophers who so deeply valued the imagination's contribution to our perception of the material world, the pair of poets set out to reverse the conventional order of a plastic mind molded by its concrete habitat, substituting (without fully eliminating the obverse) an ecological habitat created by an active brain. The cognitive subjective was to be master for the day, and more was to be known of nature by virtue of its recombination with imagination than could be known by classically scientific, subject-subtracting objectivity. As Milton's high argument had been to "justify the ways of God to men," Wordsworth performed the more secular, modern task of justifying the ways of nature to men (and women), and in fact to elevate humans' agency in the natural world by implicating the power of a vital, cultivated imagination.

Wordsworth's habitat, his adopted home from the middle years to his death, was the microcosm of Grasmere vale. Though Wordsworth was what Schiller called a sentimental poet, a non-native who is aware of the rift between real and ideal, there is very little irony to the Wordsworthian sense of dwelling and belonging in Grasmere's bounds (outsider though he may originally have been). The vale was companion and

counterpart to the heavens reflected in its waters, and Grasmere isolated the perplexing excesses of all nature down to a clarifying unity in which the mind could dwell, and make daily exchange:

> feeling as we do,
> How goodly, how exceeding fair, how pure,
> From all reproach is yon ethereal vault
> And this deep Vale, its earthly counterpart,
> By which and under which we are enclosed
> To breathe in peace; we shall moreover find…
> The Inmates not unworthy of their home,
> The Dwellers of their Dwelling. (ll. 639-644, 647-648)

A dwelling must have dwellers truly to exist, otherwise the dwelling is merely a physical symbol standing in for a narrative of what has been, a notion Wordsworth explored in "The Ruined Cottage." Grasmere is a dwelling both physically and cognitively, and is vital by virtue of the inmates (human and otherwise) who make themselves worthy of their place in nature by their awareness of its exquisite organization. The work of achieving congruence between mind and nature, in effect, settles and coheres both entities; the thesis and antithesis are mutually enabling towards a desired synthesis in which nature and the mind are mimeses of one another, and neither holds precedence. The mind without a proper object of study can be monstrous, as Wordsworth develops in his mode of the cognitive sublime:

> Not Chaos, not
> The darkest pit of lowest Erebus,
> Nor aught of blinder vacancy scooped out
> By help of dreams can breed such fear and awe
> As fall upon us often when we look
> Into our Minds, into the Mind of Man,
> My haunt and the main region of my Song. (ll. 788-794)

However, the poet continues,

> …the discerning intellect of Man,

> When wedded to this goodly universe
> In love and holy passion, shall find these [Elysian fields]
> A simple produce of the common day. (ll. 805-808)

"Simple" and "common" are not yawn-worthy endpoints from the lyrical study of nature, they are the epitome of the Romantic project to re-infuse the building-blocks of quotidian experience with the sublime revelations of the poetic mind wedded to its natural dwelling place. The human mind, which can become more awful and frightening than mythical chaos, finds sublime transcendence in these nuptials recorded line-by-line in *Home at Grasmere*. Wordsworth is self-consciously performing his own intellectual wedding: "Embrace me then, ye Hills, and close me in; / Now in the clear and open day I feel / Your guardianship; I take it to my heart; / 'Tis like the solemn shelter of the night…" (ll. 110-113). Now husband to his desired portion of all nature, Wordsworth's mind and Grasmere's vale make each other nobler by deep appreciation, and the microcosm gains the emergent personable qualities of nurturer, companion, instructor, guardian.

The ecosystem was to become the conceptual theatre in which the drama of daily existence played out; in ecosystem science became the medium in which individuals grew, strove, learned, found provision and in their turn provided. Wordsworth anticipates the scientific drama of evolutionary ecology with his own lyrical drama of cognitive evolution set within a natural compass. Though the voice is necessarily anthropocentric, he frequently consults the seeming ecstasy of other figures, birds, birches, ungulates, who reflect his personal joy back with their own effusions. Whether these subjects are themselves part of the nature he is studying or are in some way separate like himself is answered in the holistic default of "Perfect Contentment,

Unity entire" (l. 151). He arrives at this phrase very early in the poem, as though it is an ideal that he will seek for the whole work as a mantra is inherently reinforced by its very repetition. The phrase is a keystone to a long philosophical perambulation:

> What want we? Have we not perpetual streams,
> Warm woods and sunny hills, and fresh green fields,
> And mountains not less green, and flocks and herds,
> And thickets full of songsters, and the voice
> Of lordly birds – and unexpected sound
> Heard now and then from morn to latest eve
> Admonishing the man who walks below
> Of solitude and silence in the sky?
> These have we, and a thousand nooks of earth
> Have also these; but *no* where else is found –
> No where (or is it fancy?) can be found –
> The one sensation that is here; 'tis here,
> Here as it found its way into my heart
> In childhood, here as it abides by day,
> By night, here only; or in chosen minds
> That take it with them hence, where'er they go.
> 'Tis (but I cannot name it), 'tis the sense
> Of majesty and beauty and repose,
> A blending of holiness of earth and sky,
> Something that makes this individual Spot,
> This small Abiding-place of many Men,
> A termination and a last retreat,
> A Centre, come from wheresoe'er you will,
> A Whole without dependence or defect,
> Made for itself and happy in itself,
> Perfect Contentment, Unity entire. (ll. 126-151)

A wealth of Wordsworthian aporia pushes this passage carefully to its conclusion. The inquisition of his own happiness ("have we not?," "is it fancy?," "I cannot name it") are places of pause in which his intuition comes to terms with his perception before the wedding can move on. Though "a thousand nooks of earth" are microcosms possessing equivalent natural virtues, we sense that Grasmere is unique to Wordsworth (though he "cannot name it") because it holds the center and circumference of his cognitive, emotional, and physical beings. A mind must focus on a subject, and this is his chosen

vale that pales all others. In nature, the unique is the nearly extinct; the epitome, however, is the illustrative case that permits the elucidation of all similar cases. Wordsworth's *Grasmere* carries the cognitive microcosm into the biological realm, but instead of sacrificing imagination for the sake of objectivity, it so infuses the imaginative that reality itself is constituted by the union of thought and material. In science, such weddings (when well-corroborated) grow to the status of theory. Wordsworth's microcosmic theory, borne on the bilateral but chiastic phrase "Perfect Contentment, Unity entire," aids all of his considerable philosophical offspring in their thinking of how a nook of nature might be conceived as coherent, self-sufficient, reducible without splintering into atomies, capable of providing both contentment (emotional) and unity (conceptual). Wordsworth's microcosm is a utopian vision, embellished by a mind set in reverie and drawn along by iambs, but it is more than mere lyrical idealism. It sets a theoretical system around the mystical alchemy of the mind-in-nature, and foregrounds the formalization of insular, unified systems in empirical studies of ecological science.

Dorothy Wordsworth has been known to history mostly as a companion to her more famous brother and his devoted chronicler, whose observations on nature would emerge, reformulated and lyricized, in William's poetry. Dorothy's self-effacing titles often draw attention to self-perceived formal inadequacies of her verse, but the quality of imagery and its symbolic circumspection bring her poems alongside the established writers of the period. Feminist literary criticism has recovered Dorothy's efforts, which reveal notable ecological visions often based on the desire for insulation within the pleasurable vales of a cultivated landscape; this desire lies at the heart of human

bioregionalism, the valuation of self-sustaining and autonomous ecosystems driven by a deep human investment in place.[63]

Dorothy is a more successful observer of nature without imaginative embellishment, as her notebooks from Grasmere prove. Her empirical eye for detail in conjunction with a Romantic's imaginative energy render two of her poems as poignant reflections on microcosmic ecology, and both are *ubi sunt* perspectives of lost worlds. The first, "Irregular Verses," addresses the daughter of Dorothy's close childhood friend, to whom the poet describes the life she had imagined living with Jane Pollard before the women were "by duty led" down separate paths. Their lost "scheme" involves a self-enclosed, self-sustaining feminine space of nature:[64]

> A cottage in a verdant dell,
> A foaming stream, a crystal Well,
> A garden stored with fruits and flowers
> And sunny seats and shady bowers,
> A file of hives for humming bees
> Under a row of stately trees
> And, sheltering all this faery ground,
> A belt of hills must wrap it round…
> Such was the spot I fondly framed
> When life was new, and hope untamed. (ll. 21-28, 35-36)

This highly-idealized, pastoral-agricultural vision is informed by a picturesque aesthetic, with the observer having "framed" a subset of nature as the salubrious balance of sustenance and attractiveness. Importantly, this human-wrought ecosystem is an imagined world, never having been realized in Dorothy's life. It remains through

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[63] Kenneth Cervelli's Dorothy Wordsworth's Ecology (2007) is a major new study of the author's strategies for depicting the natural world, though microcosms and circumscription are not part of Cervelli's argument.

[64] Microcosms need not be "feminine": Robinson Crusoe's island leaps to mind as an early Enlightenment masculine symbol of nature's self-sufficient bounty, which becomes domestic when properly cultivated. Crusoe's primary hazard is the various other humans who might invade his island; these figments come thoroughly to haunt his consciousness.

perpetuity a figure of thought; the "faery ground" of an ecological microcosm is a way of thinking about nature's schemes of organization that can then be read onto various landscapes. In effect, Wordsworth's domicile of the cottage merely broadens its circle to include the immediate natural surroundings, and her study of a dwelling place (an *oikos*) enlarges to the vision of a bioregion; this widened circle of synergetic inclusion invokes Coleridge's doctrine of beauty as *multëity in unity*.

The second of Dorothy's relevant poems is entitled "Floating Island at Hawkshead, An Incident in the Schemes of Nature," which was published in a volume of William's poetry in 1842. The "Scheme of Nature" to which she refers is the phenomenon of a disjoined portion of shore breaking free and sailing on the lake; William had observed it happen at his school in Hawkshead, and he likens himself to this indolent and undirected subject in his *Prelude* of 1805 (13, ll. 339-343). Dorothy takes the natural figure quite differently: she allows the island to remain its own entity, as a proof of how "Harmonious Powers with Nature work" (l. 1). Her descriptive powers demonstrate the coherent vitality of the microcosm. Anyone might view this island,

> Dissevered float upon the Lake,
> Float, with its crest of trees adorned
> On which the warbling birds their pastime take.
>
> Food, shelter, safety there they find
> There berries ripen, flowerets bloom;
> There insects live their lives – and die:
> A peopled *world* it is; --in size a tiny room. (ll. 10-16)

The incident is another illustration of the importance of *perspective* when attempting to understand how natural systems work. The island is transient, soon to be "Buried beneath the glittering Lake," but its very existence is testimony to the small portions in

which it is possible for nature to retain her character of holistic interdependence. By reduction, the microcosm makes natural systems intelligible to humans, but by retaining the heterogeneity intrinsic to a healthy system, the microcosm also preserves the whole. The floating island's inevitable mortality likens it to an organism, simultaneously self-sufficient and vulnerable *as one*. Wordsworth ends her work with an assertion of the island's literal materiality, which makes concrete its empirical legitimacy as a figure of thought: though "Its place [is] no longer to be found, / Yet the lost fragments shall remain, / To fertilize some other ground" (ll. 26-28). Considering how long this island has floated in the subconscious of the poet (William attended Hawkshead in the 1780s, and Dorothy's poem is thought to have been written in the late 1820s, and published in 1842), this ballad is important in the history of ecological ideas: it lies at the convergence of poetic imagination with nature's material systems by framing itself at a conceivable microcosmic scale. As the island of Mauritius was to demonstrate fragility to Darwin in 1836 by virtue of the exotic species that flourished (and native species therefore under threat), Dorothy Wordsworth reads into her model that only its remnants will survive into the future. Her solace lies in its potential to grow as another form.

The Wordsworths were precursors to poets who shared their enthusiasm for nature in detail, and found in the close study of natural forms a way to approach the imaginative transcendence of the quotidian. The rural, naïve poet John Clare composed according to his doctrine of "taste," an individual susceptibility to the small delicacies of nature that he believes few people possess. From his early poem "A Ramble," Clare makes his address: "O taste, thou charm / That so endears and nature makes so lovely, /

Nameless enthusiastic ardour thine, / That 'wildered 'witching rapture 'quisitive, / Stooping bent, genius o'er each object – thine / That longing pausing wishing that cannot pass / Uncomprehended things without a sigh / For wisdom to unseal the hidden cause…" (ll. 42-49). Clare's romance with the minutiae of nature continually appeals to the opening of individual perception, and his favorite subjects are self-contained, such as the series of bird nest poems and the returning theme of a healthy, heterogeneous village commons. Enclosure, a fabricated method of circumscription that forces economic stratification onto natural boundaries, is Clare's anathema.

His devotion to nature in the wild makes for an ambivalent view of the work of scientists in nature, and Clare's ambivalence addresses our inquiry into the microcosmic worldview as distinct from the reductionist practices of normal science. The poem "Shadows of Taste" is crucial to understanding Clare's opinion of scientific epistemology, and the equation of natural taste or susceptibility is understood through minutiae. When compared to the avaricious "vulgar hinds" who look to nature only with "self-interest and the thoughts of gain," Clare's "man of science and of taste" works with a genius borne on the pleasure principle, and this instinctual enthusiasm for nature is largely redeeming in the poet's mind:[65]

> The man of science and of taste,
> Sees wealth far richer in the worthless waste
> Where bits of lichen and a sprig of moss
> With all the raptures of his mind engross
> And bright-winged insects on the flowers of May

[65] The common ground held between knowledge-gaining and enjoyment recalls Wordsworth's "grand elementary principle of pleasure…We have no sympathy but what is propagated by pleasure…[the man of science] feels that his knowledge is pleasure; and where he has no pleasure he has no knowledge" (*Lyrical Ballads* 361 of Longman). Wordsworth characterizes the poet as a man representing the people, whereas the scientist is an isolated thinker. Clare follows this lead, with isolation close to his own sensibilities; "Shadows of Taste" continues: "He [the scientist] loves each desolate neglected spot / That seems in labour's hurry left forgot, / The warped and punished trunk of stunted oak / Freed from its bonds by the thunder-stroke" (ll. 141-144).

> Shine pearls too wealthy to be cast away –
> His joys run riot mid each juicy blade
> Of grass where insects revel in the shade.
> And minds of different moods will oft condemn
> His taste as cruel – such the deeds to them,
> While he unconscious gibbets butterflies
> And strangles beetles all to make us wise. (ll. 107-118)

Clare is drawing a tricky distinction here between the scientist's deep consciousness of his surroundings and his "unconscious" execution of the insects of his interest; again Wordsworth's philosophy is tacitly invoked with the moral statement "we murder to dissect," but Clare's lines have no accusatory tone, especially when the scientist is heralded as avatar of Clare's coveted "taste." The gibbeting and strangling of which the scientist is guilty come off like a child's loving enthusiasm for the insect world, in the vein of Wordsworth's "Nutting," more than they invoke images of the reign of terror or other politically-charged allusions. Clare is a lover of nature in context, partaking of all the wondrous interconnection that makes the study of ecology necessarily sensitive to holism. The scientist without taste, it follows, is the one who extracts portions of the system under reductionist conventions:

> But take these several beings from their homes,
> Each beauteous thing a withered thought becomes,
> Association fades and like a dream
> They are but shadows of the things they seem;
> Torn from their homes and happiness they stand
> The poor dull captives of a foreign land. (ll. 147-152)

The foreign lands of laboratories and cabinets of curiosities become the reductive, and lamented, counterpart to the *in situ* study of nature; Clare's subtle allusion to colonial botanical discoveries indicts the practice of collecting in general; in his view wisdom without artifice or delusion comes from the open participation in nature's rhythms. The driving motive of taming or improving nature's works, Clare claims, is the fastest way

to destroy a holistic entity that we don't yet understand. His final image, an animation of abstract "wisdom" based on taste, is concentric:

> Such are the various moods that taste displays,
> Surrounding wisdom in concentrating rays
> Where threads of light from one bright focus run
> As day's proud halo circles round the sun. (ll. 161-164)

Every lover of nature inhabits a little world in which taste illuminates yet-undiscovered wisdom, and these small encounters with nature accrete in increasing concentric scales to envelop the macrocosm of the inner solar system. Congruence between small and large becomes an epistemology of true circumspection, fully differentiated from the tasteless, detractive acts of avaricious men.

In *Prometheus Unbound*, Shelley's use of microcosmic imagery goes beyond the cognitive calisthenics of the psychological microcosm by delving into an imaginative global system of intelligible order and interchange. In effect, Shelley pushes his metaphysical ideals into a lyrical exposition of modern science. Shelley based his vision of the 'intertranspicuous orb' in book IV loosely on Ptolemaic theories and on contemporary ideas of matter and electricity, as critics of Shelley and science have shown.[66] Less attention has been drawn to the deep-seeded theme of organicism

[66] Carl Grabo's classic study A Newton Among Poets (1930) traces affinities between Shelley's poetic visions of the earth and the contemporary scientific theories of Erasmus Darwin and Humphrey Davy. Darwin's radical equation of matter with energy (rather than mere substance), and Davy's development of a theory of particle matter revolving around axes in his *Elements of Chemical Philosophy*, Grabo argues, informed Shelley's modern theory of cosmic organization based on inter-contained spheres (141-142). Grabo's citation of Davy's work leads to his remark, "This is the dance of matter, incessant in motion, a microcosm of involved orbits, yet seemingly at rest. So Davy has conceived it to be and so Shelley, with a scientist's grasp and the imagery of a poet, describes it in terms of color, sound, and movement" (142-143). Neil Fraistat observes how "Shelley critics have located a plethora of sources and analogs for the earth orb, ranging from Ezekiel, Bacon, and Milton to contemporary scientific theorists. Perhaps the most complex and syncretic of all symbols in 'Prometheus Unbound,' the orb seems to substantiate most of these critical hypotheses" (The Poem and the Book (1983) 218, n. 36). It is evident that this fantastic image weaves together strands of diverse origin, as Fraistat continues, "That the orb is so clearly modeled after atomic structure should not prevent one from seeing that it is

and biology in this passage, on one hand, and to the industrial conceit of the machine that is a submerged metaphor sustaining motion throughout. Together, the organic richness and the mechanical rigor of Shelley's image create an epistemological balance evocative of ecological conceits like the "earth-system" or "biosphere," ways in which we have come to comprehend global dynamics in the twenty-first century. Shelley's vision runs as follows, spoken by Panthea, one of the Oceaniades:

> A sphere, which is as many thousand spheres,
> Solid as crystal, yet though all its mass
> Flow, as through empty space, music and light:
> Ten thousand orbs involving and involved,
> Purple and azure, white, and green, and golden,
> Sphere within sphere; and every space between
> Peopled with unimaginable shapes,
> Such as ghosts dream dwell in the lampless deep,
> Yet each inter-transpicuous, and they whirl
> Over each other with a thousand motions,
> Upon a thousand sightless axles spinning,
> And with the force of self-destroying swiftness,
> Intensely, slowly, solemnly roll on,
> Kindling with mingled sounds, and many tones,
> Intelligible words and music wild.
> With mighty whirl the multitudinous orb
> Grinds the bright brook into an azure mist
> Of elemental subtlety, like light;
> And the wild odor of the forest flowers,
> The music of the living grass and air,
> The emerald light of leaf-entangled beams
> Round its intense yet self-conflicting speed,
> Seem kneaded into one aerial mass
> Which drowns the sense. (IV, ll. 238-261)

The dualistic nature of this vision pushes our understanding of the earth sphere beyond mechanically-minded chemistry into something organized under higher-order, emergent biological principles. Of mechanism and industry, we have "sightless axels" moving in "self-destroying swiftness," and this structured momentum "Grinds the bright brook

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also modeled after Renaissance conceptions of the cosmos" (165). My reading aims to contribute an ecological valence to Shelley's vision of the many-layered macrocosm.

into an azure mist / Of elemental subtlety." Set within this engine, like an ambrosial fuel for the earth-system, are organic elements "Kindling with mingled sounds" including "The music of the living grass and air." Synaesthetically, Shelley includes kindling for the other senses: "the wild odour of the forest flowers," "The emerald light of leaf-entangled beams," and the aforementioned "bright brook [grinded] into an azure mist." Though the momentum is "self-destroying," it is also eternally creative; the azure mist condenses back to brook form, we imagine, and the "intense yet self-conflicting speed" of the system holds both acceleration and retardation within its grasp.

Though intensely abstract, this system, highly-organized, perched on the edge of chaos but assuredly under control, is an inspired vision of ecological complexity. The interlacing of mechanical structure with organic sensuous energy lends the vision a corporeal symmetry at the forefront of Romantic scientific ideas of the globe. Earth is not merely an exquisite Swiss watch set into motion, neither is it an intensely an-aesthetic morass of biomass with obscure origins and indecipherable purpose. It is an intelligible construct, "inter-transpicuous" from one scale to the next, reducible to components for the purposes of description. Yet the whole of the macrocosmos, conceived as "one aërial mass," inevitably "drowns the sense" (we imagine Shelley's readers crying Blake's "Enough! or, too much!").

It *is* almost too much; the density of imagery at times obscures the clarity of Shelley's vision. Calming the fervor of his visionary inspiration, he locates the infant "Spirit of the Earth" asleep, a symbol of our trust in the self-sustaining properties of "mother" earth. But the poetry immediately takes off again by tracing the beams of a

star on the Spirit's forehead, a light that penetrates the geological and historical secrets that recent Enlightenment science had revealed. Continuing the conceit of machination, the beams "like spokes of some invisible wheel / …Make bare the secrets of the earth's deep heart" (ll. 274, 279). What they reveal is mineral wealth, "Infinite mines of adamant and gold," (l. 280), but more importantly, geological extinctions both human and primordial. The canceling of ancient cycles, Shelley seems to suggest, is essential to the sphere's ongoing creativity. This innermost layer of the orb, where the past is condensed into a vision of all life's future under a mortal fate, acts as a lodestone anchoring the center of ten thousand layers of biochemical activity. This evidence of death is the essential counterpoint to life, as silence itself gives sound the possibility of meaning. Shelley ends the extended metaphor of the orb with the extinguishing words of a comet/God: "'Be not!' And like my words they were no more" (l. 318). The fourth book of *Prometheus Unbound* is regenerative in nature, and this euphoric and utopian passage demonstrates the power of a scientifically-driven imagination rendering old ideas (Ptolemy, Bacon, Newton, Milton) and new theories (Darwin, Davy) into something truly prescient.

Up to now I have discussed the ecological microcosms of poets in the Romantic era. Deeper into the nineteenth-century, concerns about fundamental changes in nature for the worse were part of Victorian anxieties about modernity. In the folds of the world's largest metropolis, Matthew Arnold developed his sense of nature in microcosm using the resource of London's great parks. In some ways a revisitation of Coleridge's lime tree bower, Arnold's "Lines Written in Kensington Gardens" (1852) locates the poet within a minor world of major meaning, where nature holds an ongoing

vitality that is usually forgotten in this urban world of getting and spending. Arnold's lamentory voice draws from his perception of alienation amid the industrial Victorians; famously, he found his generation caught "Wandering between two worlds, one dead, / The other powerless to be born"; the Christian creation story seemed obsolete, but an acceptable secular or scientific worldview had yet to succeed (*Chartreuse*, ll. 85-86). In Kensington Gardens, however, the poet finds a world for himself in the subtle webs of nature that endure despite a cultural hegemony of capitalist production:

> In this lone, open glade I lie,
> Screened by deep boughs on either hand;
> And at its end, to stay the eye,
> Those black-crowned, red-boled pine-trees stand! …
>
> Here at my feet what wonders pass,
> What endless, active life is here!
> What blowing daisies, fragrant grass!
> An air-stirred forest, fresh and clear. …
>
> In the huge world, which roars hard by,
> Be others happy if they can!
> But in my helpless cradle I
> Was breathed on by the rural Pan. …
>
> Calm soul of all things! make it mine
> To feel, amid the city's jar,
> That there abides a peace of thine,
> Man did not make, and cannot mar. (ll. 1-4, 13-16, 21-24, 37-40)

The peace that abides in this insulated, idealized slice of nature (London's parks are highly cultivated) reminds the poet of mightier forces performing their labors beneath the notice of all but the most susceptible, and tasteful, of humans. By looking at Kensington Gardens as a microcosm of nature, coherent, interactive, heterogeneous, whole, and austere, Arnold taps into a modern environmental sense of hope. Nature

finds a place in the epicenter of industrial modernity, both beneath and above the scales of modern human consciousness.

Where Arnold tapped a well of hopefulness from the resource of London's parks, counseling himself all the way to feel good and keep at bay the hounds of modernity, Gerald Manley Hopkins, to the obverse, focused on the disasters of new development. Like social philosopher William Morris, Hopkins held moral outrage in the destruction of stately natural places for capital gain.[67] His famous extemporaneous poem, the 1879 "Binsey Poplars," laments the felling of a stately row of poplars on the Thames between Oxford and Binsey. This poem is less of a microcosm poem (he speaks mostly of the trees, hardly including their natural milieu) than it is an illustrative example of the more-than-aesthetic treacheries of manhandling the monarchs of the natural world. Of course, the row of trees, like the well-planned Kensington Gardens, is the product of human stewardship rather than "wild" nature, but the destruction of anthropogenic nature can be a more poignant event than the human colonization of wilderness, which does not benefit from participating in human history. Hopkins refers to "country" as an antithesis to "city"; country is the locus of human agriculture and national identity and is decidedly *not* wilderness. Its callous destruction, nevertheless,

[67] William Morris's essay "The Beauty of Life" (1880) is best known for its domestic advice, which can be isolated to a thesis that connotes ideals of aesthetic utility during an era of rampant consumption: "Have nothing in your houses which you do not know to be useful or believe to be beautiful." In reference to landscaping in the new suburbs of London, Morris defends the trees planted along the river both as natural and artistic gifts: "I must ask what do you do with the trees on a site that is going to be built over? do you try to save them, to adapt your houses at all to them? do you understand what treasures they are in a town or a suburb? or what relief they will be to the hideous dog-holes which (forgive me!) you are probably going to build in their places? I ask this anxiously, and with grief in my soul, for in London and its suburbs we always begin by clearing a site till it is as bare as the pavement: I really think that almost anybody would have been shocked, if I could have shown him some of the trees that have been wantonly murdered in the suburb in which I live (Hammersmith to wit), amongst them some of those magnificent cedars, for which we along the river used to be famous once. But here again see how helpless those are who care about art or nature amidst the hurry of the Century of Commerce."

is the large-scale environmental pattern epitomized by the small-scale act of felling the poplars:

> Since country is so tender
> To touch, her being so slender…
> even where we mean
> To mend her we end her,
> When we hew or delve:
> After-comers cannot guess the beauty been…
> The sweet especial scene,
> Rural scene, a rural scene,
> Sweet especial rural scene. (ll. 12-13, 17-19, 22-25)

The hazard of this legacy of felling trees is that the "after-comers," those generations who will inherit the earth, will have no ties of sentiment to its beauties. The "scene" that Hopkins lyrically circumscribes is an endangered landscape; the trees are both center and circumference of a moral argument borne on this minor landscaping event. I would call Hopkins's poem more environmental than ecological (though he includes a Darwinian entangled bank image of the trees' shadows "that swam or sank / On meadow and river and wind-wandering weed-winding bank" (ll. 7-8)); his poem, like Seuss's Lorax of a century later, speaks for the trees who have no tongues. With their deaths dies a small, riparian ecosystem, perhaps insignificant in itself, but holding ample information about the insidious transformation of values that accompanies any act of violence against nature.

This chapter has been dominated by poetic works that develop conceits around small natural systems. These microcosmic conceits afford perspective on the patterns inherent to nature on a larger scale. It is not surprising that poetry would be a favored medium for exploring such inter-scalar congruence; one of the celebrated features of lyricism is its habit of circling around images, juxtapositions, rhymes, and rhythms in

order to gain deep perspective on a discrete subject. Lyric poetry's lens focuses in close to the subject, the lime-tree bower or floating island, before drawing back into the placement of this little world in the larger cosmos.

By the turn of the twentieth-century, ecology was an established international discipline and Stephen Forbes had drafted the microcosm trope into his experimental designs. A tropological reading of literary works during this time provides some perspective on the versatility of microcosm figures. Originally a convention that served as an aesthetic scheme of cosmic inter-scalar organization, placing each individual body within a coherent network of reciprocating structures, the microcosm trope evolved into several distinct philosophical offices, eventually to be adopted as a tool of ecological science. British poetry of the nineteenth-century, written in the context of industrialization and the large-scale transformation of natural landscapes, was provided with an occasion to push the potential of the microcosm towards the elucidation of nature's systems. Ecology would subsequently use the microcosm literally as an empirical strategy; environmentalism drew argument and energy from the notion that small, individual acts aggregate to large affects, and from this alignment of microcosm with macrocosm environmentalists drew the popular mantra, "Think globally, act locally." Chapter five, the final chapter of this study, will concentrate on how the microcosm's enduring relevance to ecological inquiry relates to the modeling strategies we employ to understand climate change. Another aspect of climatological modeling is the difficulty of anticipating the emergent effects and random behaviors that characterize meteorology; these bring microcosmic epistemology into play with chaos, the trope that directed the environmental narratives of chapter two.

Before moving to the twenty-first century, however, I would like to concentrate more in-depth on a single author who, perhaps unconsciously, integrated both tropes into his poetry. John Keats's legacy as a genius whose potential was undermined by tuberculosis elides the well-developed ideas that his diverse poems realized in spite of his short years. In fact, his life's brevity makes for greater coherence in the small body of his works. I hope to show that Keats's deepest ontological moments evolved from an understanding of history as a chaotic narrative into what might be called a microcosmic worldview.

Chapter Four: Keats's Ecological Visions: A Tropology

"There is a delicate empiricism which makes itself utterly identical with the object, thereby becoming true theory. But this enhancement of our mental powers belongs to a highly evolved age."
-- Goethe[68]

I: Introduction

Keats has been an appealing figure for the focus of literary critics interested in science largely due to his early medical education, hints of which are abundant in his poetic images, and the convalescent psychology that impacted his later works. His biography supports book-length studies of this intellectual synthesis: the born poet is forced by financial necessity into a medical education during an age rife with science and literature as dual, legitimate epistemologies.[69] The youngest of the high Romantic poets has always inhabited a liminal space between scientific practice and humanist philosophy, and his ambivalence on the subject of his occupation only heightens the potential for interdisciplinary insight in his poetry. The medical Keats, however, I wish to leave behind in this study. For this chapter, I will look at specific ways in which Keats's poetry is thoroughly ecological.

[68] "Es gibt eine zarte Empirie, die sich mit dem Gegenstand innigst identisch macht, und dadurch zur eigentlichen Theorie wird. Diese Steigerung des geistigen Vermögens aber gehört einer hochgebildeten Zeit an" (Maximen und Reflexionen 509).

[69] Studies that consider Keats and his poetry in a medical context include Goellnicht's The Poet-Physician: Keats and Medical Science (1983), De Almeida's Romantic Medicine and John Keats (1991), Richardson's British Romanticism and the Science of the Mind (2001), Bewell's Romanticism and Colonial Disease (1999), and Allard's Romanticism, Medicine, and the Poet's Body (2007). Richardson's essay on "Keats and Romantic Science" is devoted almost exclusively to the aesthetic influence of Keats's medical training at Guy's hospital, but Richardson gestures to the ecological spirit of the age: "With the mechanistic scientific paradigm associated with Newton giving way to a biological emphasis typified by Darwin, science and medicine took on a "Romantic" character, featuring a naturalistic ethos, an attention to "organic form," and developmental and ecological models that show more than superficial resemblance to analogous impulses in the arts" (231).

By calling Keats's poetry ecological, I mean more than his setting poems in nature or immersing his subjects in a Keatsian, sensuous natural world. His works contain at least two proto-scientific ecological visions that I will explore in depth: the first is the theme of contingency in the narratives of natural history, which finds a prosodic outlet in two of Keats's prominent epic fragments. My reading of *Hyperion* argues that critics have overemphasized Keats's use of coherent succession from Titans to Olympians in order to highlight its precocious use of evolutionary theory and to reinforce the Romantic theme of political revolution;[70] instead, I argue that a radically contingent environmental dynamic catalyzes the fall of the Titans, and this narrative catastrophism can be traced to Keats's knowledge of French geology and his belief in the governance of 'chance' rather than classic religious Providence.

The second innovation in ecological vision involves Keats's circumscription of natural spaces into observable, intelligible systems. The lyrics preview a conceptual strategy for isolating and simplifying parts of nature for the purpose of study, and anticipate the ecological microcosm introduced to science by Stephen Forbes in 1887. I will also suggest that Keats's Odes anticipate the ecosystem theory that Arthur Tansley would define in the early twentieth-century. With Tansley's advance, an ecosystem came to mean a natural unit or area consisting of biotic and abiotic factors in synergy, but whose isolation is at least party conceptual. By reading several of Keats's prominent lyrics as epistemological advances in the science of ecology, I hope to show that these aesthetic successes are more useful than pure art

[70] *Hyperion* has often been read as a teleological evolutionary poem, with Oceanus's speech that invokes the "beauty" principle governing the defeat of one ruling class by another as a "law of nature." Keats's knowledge of science and theories on how his medical training influenced *Hyperion* are detailed in DeAlmeida (1991); Bewell (1999) reads Hyperion as an allegory of political revolution at the time of Napoleon's decline.

for the sake of beauty. I organize Keats's spread of ideas, from the early lyrics to the fragmented narratives of his *Hyperion* poems, and ending with the systemic wholeness of his celebrated Odes, using this bivalent relationship between narrative chaos, chance, and evolution, on one hand, and lyrical cosmos, coherence, and stasis, on the other. This chapter will show how Keats's ideas about the individual agonist in the natural world evolved during his career through an openly inquisitive mediation between chaos and the microcosm.[71]

Criticism of the last twenty-five years has emphasized Keats's political engagement in order to touch up the older portrait of an aesthete interested only in pure literary production. Jerome McGann began this type of revisionism by claiming that Keats's renowned poem *To Autumn* should be read in the context of the Peterloo massacre rather than as simply a beautiful lyric of escapism (1985: 58). Jeffrey Cox has argued that even in the early lyrics of 1817 the influence of Leigh Hunt is evident, revealing "the self-consciously ideological content of his poetry…[that] demands to be read not as weak apprentice work for the future odes but as a key statement in 1817 of the Hunt circle's project and self-definition" (85). The Keats figured as Cockney, these critics contend, allows us to read his political and ideological maturation alongside the evident growth in style and prosodic mastery. Keats certainly deserves such attention since the biting criticism levied at his early work

[71] The sub-dividing of Keats's brief career into distinct phases of composition style is common in his biographies. Christopher Ricks's Keats and Embarrassment (1974) demonstrates how the poet's social rank made him hyperconscious of failure and prone to make large shifts in his poetic strategy. James Chandler adds to this periodic patterning that "A particularly recurring occasion of embarrassment for Keats was the thought of his own prior work and of the conditions in which it was produced. It was a response in which we can imagine Keats identifying, in effect, with the posture of superiority struck by the notoriously hostile reviewers of his early published work. Through a succession of embarrassed disavowals of his own prior writings, Keats effectively created a sense of staged progress in his literary career" (395).

was often politically-calculated to embarrass and exclude the lower classes from literary success.

My ecological readings of Keats, which often rely on the aesthetics of his imagery, might seem to fray off that recent thread of politicizing Keats and figure him again in the older light of the poetic genius living in a socio-political vacuum. Instead, I aim to engage the Keats-in-his-context critical frame by appealing to his knowledge of science, which was one of the major forces providing thrust to political reform in the tumultuous eighteen-teens. Keats was forced by his social standing into medical studies, and though he vacillated between the necessity of a practical medical education and the gravitational pull of a literary one, many of his poetic works are doubtless enriched by his knowledge of geology, chemistry, and biology. While the Keats of this chapter is not particularly political or Cockney, I consistently contextualize the poet by figuring him as an innovator in biological concepts. As innovator, he participates in the same cause of reform as enlightenment "political" scientists so well-known to this era, Joseph Priestley, Erasmus Darwin, Humphrey Davy, and young Percy Shelley who conducted chemistry experiments in his rooms at Eton and Oxford. Keats's experiments in verse are interdisciplinary, effecting recombinations among canonical literature (Chaucer, Spencer, Shakespeare, and Milton especially) and contemporary scientific understandings of the world. The revolutionary chaos envisioned in *Hyperion*, and the several microcosms described in his lyrics, are attempts to create systems of understanding the world using the complementary tools of science and literature. The applicability of Keats's verse to early nineteenth-century concepts of nature both installs his poems among

contemporary scientific-industrial innovations and links his intuitive ideas about organization of the natural world to twenty-first century ecological theory. *Hyperion* was likely influenced by Keats's reading of Buffon, the French natural historian who wrote voluminously about the importance of environmental catastrophe.[72] Criticism that touts the physiological Keats, the blushing Keats, the gustatory Keats, is part of the same project of reclaiming the poet from the idealisms of New Criticism and planting him firmly in his environment, and our own.

Keats's letters can fruitfully be read in dialogue with his verse, permitting a thread to be drawn between the poet's quotidian experiences, his prose-based distillation of life-guiding philosophies, and his articulation of these insights in his poetry. Before involving his poetical works, it will be useful to discuss a few turns of thought that Keats developed in a long 1819 letter to his brother George, who had ventured into the wilds of the young United States. Written from February to May of that crucial year of intellectual development, the letter lies at the juncture between Keats's abandonment of the epic *Hyperion* and his rejuvenation under the Ode form. Late in 1818 Keats lost his youngest brother Tom to consumption, and the poet had been struggling with chronic ill health since his early return from a walking tour of Scotland in summer 1818. From these misfortunes among other social and financial hardships, Keats was to revise his tepid faith in Providence towards a new evaluation of the power of Chance, a word that frequently appears in his letters and poetry after

[72] Peter Bowler has pointed out that Victorians like Samuel Butler, a critic of Darwin, argued that Buffon had identified all the major components of evolutionary theory a full century before The Origin of Species was published (2003: 75). Buffon's encyclopedic Historie Naturelle (1749-1788) was translated into English and Keats read the copy in Guy's Hospital library. Its vacillations on crucial topics like species definition and fixity versus mutability make a clear interpretation of modern evolutionary theory difficult. However, Buffon's materialism, his interest in environmental upheaval, and his struggles to accommodate these ideas into the Classical hegemony of predetermined design in nature make Keats's reading of Buffon germane to this study of ecological Keats.

the death of 'poor Tom.' He writes to George, recalling an opening image from the abandoned *Hyperion*,

> Circumstances are like Clouds continually gathering and bursting. While we are laughing the seed of some trouble is put into the wide arable land of events. While we are laughing it sprouts, it grows and suddenly bears a poison fruit which we must pluck…There is an ellectric [*sic*] fire in human nature tending to purify, so that among these human creatures there is continually some birth of new heroism. (Scott 270-271)

This agricultural allegory plays out on the stage of environmental contingency. Keats's metaphor involves both the unpredictable weather events of storm clouds "gathering and bursting" as well as the pernicious seeds that germinate as a result. Circumstance, then, involves both the contingencies of weather and of the presence or absence of the organic matter responding to these conditions: the seed, the wide arable land, the poison fruit. His chemical opposition between ill circumstance (poison) and fiery heroism (purification) is the alchemy of epic agony, and *Hyperion* grasps after different modes of self-empowerment exhibited by the Titans, gods dwelling in the common misfortune of obsolescence.

John Kerrigan's (1995) essay "Keats, Hopkins and the History of Chance" pursues the reasoning behind the stochastic aesthetic demonstrated in the *Hyperion* poems. He writes, "As Keats's faith in 'providence' was sapped by Tom's and his own 'misfortune,' he became, on the contrary, less 'orthodox' and more convinced of the power of 'chance'" (289). In the same letter of spring 1819, Keats's *chance* comes to inform his notion of an individual's robustness in the natural world. Unlike Millenarian philosophers like William Godwin, Keats does not believe in the complete improvement of nature through idealistic philosophy or technological manipulation. Adversity is an essential component in his scheme of "soul-making":

> The whole appears to resolve into this; that Man is originally 'a poor forked creature' subject to the same mischances as the beasts of the forest, destined to hardships and disquietude of some kind or other. If he improves by degrees his bodily accommodations and comforts, at each stage, at each accent there are waiting for him a fresh set of annoyances…in truth I do not believe in this sort of perfectibility. The nature of the world will not admit of it; the inhabitants of the world will correspond to itself. Let the fish philosophise the ice away from the Rivers in winter time and they shall be at continual play in the tepid delight of summer…suppose a rose to have sensation; it blooms on a beautiful morning, it enjoys itself. But there comes a cold wind, a hot sun; it can not escape it, it cannot destroy its annoyances. They are as native to the world as itself. No more can man be happy in spite, the worldly elements will prey upon his nature. (Scott 289-290)

To suffer life is to grow into one's own potential, if the experience does not kill one first. Using this modern, post-Providence convention of history as chance, Keats has opened an avenue for his materialist spiritualism, which he describes using a scientific trope that had recently been envisioned by John Dalton (in 1808), the ultimate chemical unit of the atom:

> Call the world if you Please 'The vale of Soul-making.' Then you will find out the use of the world…I say '*Soul-making*,' Soul as distinguished from an Intelligence. There may be intelligences of sparks of the divinity in millions, but they are not Souls till they acquire identities, till each one is personally itself. Intelligences are atoms of perception; they know and they see and they are pure, in short they are God. How then are Souls to be made? How then are these sparks which are God to have identity given them so as ever to possess a bliss peculiar to each one's individual existence? How, but by the medium of a world like this? This point I sincerely wish to consider because I think it a grander system of salvation than the chrystian [*sic*] religion, or rather it is a system of Spirit creation. This is effected by three grand materials acting the one upon the other for a series of years. These three Materials are *Intelligence*, the *human heart* (as distinguished from intelligence or Mind) and the *World* or *Elemental space* suited for the proper action of *Mind and Heart* on each other for the purpose of forming the *Soul* or *Intelligence destined to possess the sense of Identity*. I can scarcely express what I but dimly perceive, and yet I think I perceive it…Do you not see how necessary a World of Pains and troubles is to school an Intelligence and make it a soul?...This appears to me a faint sketch of a system of Salvation which does not affront our reason and humanity. [italics in original] (Scott 291)

Keats's "faint sketch" is a metaphysical anticipation of evolution by natural selection. The atom of perception is animated by a spark of intelligence, and the individual charged atom is pushed towards a state of soul through the unpredictable circumstances of life, both natural and social. Though mischance and circumstance are lamentable for the woes they bring, natural extremes are essential to a life experience of depth and quality. Though the *meaning of life* is a grandiose phrase, nothing else captures what Keats is grasping at through this series of rhetorical questions. It is for each individual to use her intelligence to vie with the vicissitudes of circumstance, and with success that individual will grow into something more complete: an intellect guided by a soul of survived experience. Finding an identity is the heart of salvation; it is a personal acquisition achieved by the few possessing enough pith and energy to survive the chance-driven world of elemental space.

These ideas have evolved from Keats's more famous formulation of the mind as a mansion whose corridors and apartments are brightened by trial and experience, which he articulated in a letter to Reynolds from a year earlier (May 3, 1818). The above passage goes beyond cognitive architecture (whose ideas clearly relate to the psychological microcosm of chapter three); Keats's "vale of Soul-making" is a dwelling place in which each atom of individuality comes to reckon with its existence *in nature*. The essential components of Keats's system are the atom of being (which models all other beings), comprised of the intelligence and the soul, and the narrative of unforeseen circumstance that plays out in the elemental world. Our tropes come clearly into the foreground: Keats's subjects and ode-spaces can be viewed as microcosms existing within the hazards of a chaotic world. The remainder of this

chapter will explore the poetic routes by which Keats approached his naturalist system of salvation: the fragmented narrative and the modeling lyric epitomized by the ode.

II: The Early Poems

Before moving into an analysis of Keats's best-known verse, it will be useful to take a brief look at some of his earliest lyrics as a primer for his later work with the Odes. These early poems were written with a casual, exploratory confidence and are unencumbered by the emotional drag of his life's misfortunes and the weight that poetic production would come to bear on Keats. They show which images and tropes the young poet found most appealing from the start, when he was first exploring his affinities. His visions quite often benefit from the clarifying nature of circumscription that we have seen in the many microcosmic poems analyzed in chapter three; again, islands, coves, and lakes become figures of thought as well as intelligible, material subsets of nature.

Lyric poetry in the English tradition possessed, from the time of the Renaissance metaphysicians, a potential for scientific exposition. James W. Johnson (1974) notes how "the new geographical concerns of the Renaissance supplemented the pastoralism of the traditional lyric to produce an imagery that enforced a fusion of the scientific and poetic perspectives" (468). Though scientific tropes were essential to Keats's perspectives on nature, beneath the imagistic level the lyric possesses an inter-referential structural coherence based on its musical origins; Johnson identifies this inherent quality of the modern lyric as poetry that is "mechanically representational of a musical architecture and which is thematically representational of the poet's sensibility as evinced in a fusion of conception and image" (462). Highly formal lyrics are literary prosodic structures built around the parameters of rhythm and rhyme, parallelism and juxtaposition, and their architectural soundness

effectively shelters and contextualizes the images (or themes) the poet seeks occasion for. Though Keats would eventually find his métier in his personal evolution of the Horatian Ode, his early lyrics based on Spenser have a similar virtue of dwelling in a small, highly organized system of language. Keats found his natural subjects within the little worlds that lie at the junction of form and theme.

His "Imitation of Spenser," which dates from 1814 and is his earliest known composition, uses a "little lake" as the medium of reflection for "woven bowers," the king-fisher and the swan overhead, the fish they eat, and "in its middle space, a sky that never lowers" (ll. 7-14). In these figures of nature Keats clears a conceptual space from the anxiety of influence that so often stamped his youthful work (and the title of this poem):

> Ah! could I tell the wonders of an isle
> That in that fairest lake had placed been,
> I could e'en Dido of her grief beguile;
> Or rob from aged Lear his bitter teen:
> For sure so fair a place was never seen,
> Of all that ever charm'd romantic eye:
> It seem'd an emerald in the silver sheen
> Of the bright waters; or as when on high,
> Through clouds of fleecy white, laughs the cerulean sky. (ll. 19-27)

By way of clearing space from earlier literary genius, Keats discovers the quintessential Romantic subject in the vision of nature's heterogeneous coherence. This is clearly a song of innocence, where the fish may laugh in the gorge of the kingfisher, where grief and tears are exposed as human distractions from a larger harmony. The lyric, guided by the demanding rhythmic and rhyme requirements invented by Spencer for the *Fairy Queen*, quite naturally circles around its figures and resists narrative advancement. The lake and the isle simply exist, outside of time but

in an intelligible relationship with space; they are an idealized model of nature. Though Keats's virtuosity with the Spenserian form remains uneven, the stanzaic structure nonetheless opened an avenue for modeling nature within lyrical prosody. Keats's visions would grow morally more complex, particularly regarding predation and evolution, but for the eighteen-year old poet, the pure symbolic model of natural synergy is a starting place, and a jumping-off point into murkier waters.

He would continue similar inquisitions into nature as an escape from human agony in his poetry through 1817. The long, couplet-driven "Sleep and Poetry" was the dramatic finish to his first published volume; in it, Keats distances himself from the verse nested "in the bosom of the leafy world" in preference for "a nobler life, / Where I may find the agonies, the strife / Of human hearts" (ll. 119, 123-125). But the true aim of poetry, to give pleasure and comfort, acting as "a friend / To sooth the cares, and lift the thoughts of man" (246-247) lies somewhere between harmonious enervation and realist violence. Keats finds imagination to be the key, and the following passage shows a debt to Wordsworth, while establishing a telescopic vision that he would develop with greater success in future years:

> Is there so small a range
> In the present strength of manhood, that the high
> Imagination cannot freely fly
> As she was wont of old? …
> Has she not shown us all?
> From the clear space of ether, to the small
> Breath of new buds unfolding? From the meaning
> Of Jove's large eye-brow, to the tender greening
> Of April meadows? Here her altar shone,
> E'en in this isle; and who could paragon
> The fervid choir that lifted up a noise
> Of harmony, to where it aye will poise
> Its mightly self of convoluting sound,
> Huge as a planet, and like that roll round

Eternally around a dizzy void? (ll. 162-165, 167-177)

Small adjustments of his images, such as the 'fervid choir' soundtrack for this vertigo vision, would be mellowed into a 'mournful choir' of gnats in his final "Ode to Autumn." Keats is gesturing at the largesse of his imagination and his desire to tame it without compromising its brilliance; the successful zoom-in from infinite clear ether to the opening bud is succeeded by an ill-realized fusion of Jove's eyebrow with an April meadow, and the reader carries the sense that the poet was forced by rhyme into this sticking place (he would smooth out and develop that particular image in the second stanza of the "Ode on Melancholy"). Despite the somewhat bewildering conjunction of images in this passage, the theme of imagination as an adjustable lens on the natural world at all scales, from the bud to the planet and beyond, comes to be essential to Keats's poetic vision. Like the metaphysical poets of the Renaissance, Keats sought the elucidation of his subjects by looking deeply at the organization of the material world, whose scalar correspondences inform emotional affinities by way of physical, chemical, and biological conceits.

The continuum between poetic form and nature's organization continued to interest Keats. In February of 1817, he extemporaneously composed a sonnet inspired by a Chaucer tale, "The Flower and the Leaf," in the margins of his friend Charles Cowden Clarke's volume. The Petrarchan sonnet, entitled by its first line, creates a lyrical world for the reader to inhabit just as though it were a literal space in nature:

> This pleasant tale is like a little copse:
> The honied lines do freshly interlace,
> To keep the reader in so sweet a place,
> So that he here and there full hearted stops;

> And oftentimes he feels the dewy drops
> Come cool and suddenly against his face,
> And by the wandering melody may trace
> Which way the tender-legged linnet hops. (ll. 1-8)

In this lyric with intimations of indolence yet to be realized, Keats finds comfort in dwelling in Chaucer's pleasant woods distilled from worries of the wider, epic world. After the volta, he acknowledges how the tension of striving after some monstrous narrative can be eased within these moments of microcosmic lyricism:

> What mighty power has this gentle story!
> I, that do ever feel athirst for glory,
> Could at this moment be content to lie
> Meekly upon the grass, as those whose sobbings
> Were heard of none beside the mournful robbins. (ll. 10-14)

The poem is an ecological vision not only in the natural setting composed by Chaucer, but also in Keats's use of synaesthetic interlacing among setting, sensation, and sonnet. The reader/poet is entangled in honied lines, dewy drops, and wandering melodies, each of which informs him of some material or process active within the little copse. This microcosm also gives the gift of greater self-awareness to the pitiful, sobbing, restless agonists of a larger troubled world; here a small *place* is exchanged for a small *moment* of peaceful balance. The copse is a model ideal. This sonnet is utterly self-contained, within its bounds lyrically as well as philosophically, and it anticipates the somewhat broader terrain of the Ode that Keats was to inhabit with such assurance in a few crucial years. But first, his epic ambitions required a series of trials with the narrative form, which opened his visions of a darker, more threatening nature built around the agony of the tragic figure in chaotic nature.

III: Narrative Chaos in Hyperion

Keats versified his idea of the elemental world as a vale of soul-making with his narrative fragment *Hyperion*, an epic that successfully depicts the agony of circumstance for both the vanquished *and* the victor in an ontological study of evolution. Because the poem commences with a series of truly superlative images supported by strong and stoic blank verse, *Hyperion* has gained the admiration of readers from its public beginnings in Keats's best published volume: *Lamia, Isabella, The Eve of St. Agnes, and other poems* (1820). The 'other poems' included all of Keats's Odes (save *Indolence*) and the unfinished *Hyperion*. The concentrated brilliance of his last two years of writing demonstrates his open experimentation with epistemology in the poetry of nature. The story of *Hyperion*'s abandonment due to the poet's fear of his blank verse being too Miltonic is well known; what my reading of *Hyperion* contributes is evidence that this 'finished fragment' effectively animates the chaotic narrative patterning that ecologists have theorized as endemic to evolutionary history. Readers usually view the scheme of evolution expounded in Oceanus's philosophy as teleological, the doctrine that "first in beauty must be first in might" (II. 229), and critics have linked the narrative to the patterning of political revolution so pertinent to the Napoleonic era and its end in 1815.[73] I will show that the Olympian's accession is by no means the result of Providential causation or political succession, and that ecological degradation is an equally compelling cause

[73] Alan Bewell has argued that *Hyperion* is, in part, a poem about political agency and succession during the time of Napoleon; he cites the noticeable imagistic links to Egyptian culture in Keats's descriptions of the fallen Titans (1986: 220-229). Marjorie Levinson picks up on Bewell's lead by describing the aborted book III of *Hyperion* as "an expression of ambivalence toward the progressive figure of Napoleon" (1988: 208).

for the Titans' downfall. The quixotic character of the natural environment is essential to a modern understanding of atelic evolution; Keats's *Hyperion* is a modern poem, and a coherent fragment, because a learned faith in the narrative of Providence quakes under an instinctual fear that chaos and contingency are rulers of nature's changes through time.

The poem takes place during the interregnum between the rule of the ancient Titans and that of their offspring and successors, the Olympians. The narrative rests in the wedge of punctuation between two stable states, and yet Keats's scenes of action depict not the desperate battles between two world orders, the new and the old, but instead in the desperate but passive ontological self-questioning that both Titans and Olympians face as a consequence of their new realities. Rather than utterly differentiating the two classes of gods, Keats is careful to draw parallel scenes between the Titans, Saturn and Hyperion, and the new Olympian sun god, Apollo.[74] Perhaps the most important of these parallels comes at line 103 in books I and III of the epic, when Keats's colliding heroes seek to understand the office of holding power over nature. The fallen Saturn asks in book I,

> Who had power
> To make me desolate? Whence came the strength?
> How was it nurtur'd to such bursting forth,
> While Fate seem'd strangled in my nervous grasp? (I. ll. 103-106)

The soon-to-rise Apollo asks in book III,

> Where is power?

[74] In her study of narrative Keats, Judy Little (1975) suggests that these "similar incidents and images emphasize an evolutionary, genealogical relationship rather than one strictly of combat and conquest…this repetitive structure of parallel incident was creating a poem that stood monumentally still" (140). In common with other critics, Little views *Hyperion*'s stasis as fatal to its narrative vitality.

Whose hand, whose essence, what divinity
Makes this alarum in the elements,
While I here idle listen on the shores
In fearless yet in aching ignorance? (III. ll. 103-107)

The locus of power lies in controlling the chaos of the elements, and Saturn's family has spontaneously lost this power that was a temporary gift of circumstance; Apollo receives power by having the disparate elements of history driven into his brain by Mnemosyne, the goddess of memory. Again we have contrastive parallels that help us locate contingent dynamics in evolutionary time. In his eagerness to re-mold his lost identity from a Deist's understanding of how nature works, Saturn asks,

But cannot I create?
Cannot I form? Cannot I fashion forth
Another world, another universe,
To overbear and crumble this to nought?
Where is another Chaos? Where? (I. ll. 141-145)

Apollo, the child of fortune for this era, has the ambiguous power of historical knowledge thrust upon his brain,

Knowledge enormous makes a God of me.
Names, deeds, gray legends, dire events, rebellions,
Majesties, sovran voices, agonies,
Creations and destroyings, all at once
Pour into the wide hollows of my brain,
And deify me… (III. ll. 113-118)

The chaos of elemental creation that Saturn desires for his workshop is effectively translated into the chaos of contingent history in Apollo's brain, a history that requires acts of destruction before a new creation can find its form articulated in the elements. Apollo leaves the Titanic world of prehistory when Mnemosyne renders him a god for modern times. And so the poem ends, mid-air, in this truncated leap towards modernity: "Celestial * * * * * * * * * *" (III. l. 136). It is one of the more

famed and celebrated endings in a literary period known for fragmented narratives.[75] Though history may appear to have patterns and linear causations that lend information and purpose to our actions in the world, those patterns may be as illusory as the stellar constellations around which humans have woven legends from our evolutionary beginnings. Where we seek purpose and design, we are cognitively predisposed to find it; this is an evolutionary inheritance because it conscribes advantages to its possessor. But Keats leaves the design of history incomplete in *Hyperion*, and the question of indeterminacy reigns paramount in the minds of his readers because Apollo's apotheosis is cryptic. Some readers would argue that the history imposed on Apollo by Mnemosyne effectively sullies the perfect new god and makes him into a more earthy, knowledgeable, pragmatic figure (and "Lo," the stars fall from his limbs). But knowledge of history fails to make either class of gods more powerful; if anything, mnemonic history and the wisdom contained in Titanic tomes is humbling to its possessor because it fails to explain the present circumstances.

With so little agency afforded to his major characters, we are set to wondering, along with them, *where* power lies in the universe. Though critics have identified the non-combative nature of the Titanic overthrow in *Hyperion*, not enough emphasis has been placed on the ecological malaise that sows the seed of their

[75] Marjorie Levinson's book The Romantic Fragment Poem (1986) analyzes the period's romance with indeterminate endings according to several categories of fragmentation. She creates the term 'dependent fragment' to categorize the two *Hyperion* poems in relation to one another, and she reads through biography: "the dependent fragment figures as the produce of an episode or interval in the poet's or persona's career; the fragment thus invites the reader to rationalize its irresolution with reference to its situation within a continuum of episodes, moments, and their respective objectifications. The formal determinacy of such poems depends on the reader's propensity to relate the fragment to relevant precursors or successors in the author's canon" (172-3). I would like to retain *Hyperion*'s cogency independent of Keats's later revision in *The Fall of Hyperion*, which is by no means a more successful poem despite its later date of composition. I will address *The Fall* later in this chapter.

downfall.[76] Rather than the battles that rise to near-fetish levels in the great epics of Homer, or the angelic foment of Lucifer's minions against God in Milton, Keats keeps his poem gore-free, and instead infuses his characters with *existential* agony. This is a passive, rather than active, downfall, which leaves us to locate action and agency in Nature, whose organisms make what they can of their capricious environment. The tide of natural circumstance has turned before the first, quiet line of *Hyperion*, which locates Saturn

> Deep in the shady sadness of a vale,
> Far sunken from the healthy breath of morn,
> Far from the fiery noon, and eve's one star…
> No stir of air was there,
> Not so much life as on a summer's day
> Robs not one light seed from the feather'd grass,
> But where the dead leaf fell, there did it rest. (I. ll. 1-3, 7-10)

This somnolent and beautiful vision of a new seed sown in a natural tomb, which holds the remnants of extinction, is subtly geological.[77] But the poet must animate his doomed fossil race so they can testify to their fate. Thea, wife of Hyperion, wakes Saturn by telling him of his lost control over the elements:

> the earth
> Knows thee not, thus afflicted, for a God;
> And ocean too, with all its solemn noise,
> Has from thy sceptre pass'd; and all the air
> Is emptied of thine hoary majesty.

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[76] I am referring to Bate, Little and De Almeida's readings of *Hyperion*. Alan Bewell (1999) mentions the ecological poisoning that sickens the Titans' environment in his study of epidemiological fear in the Romantic period, and he relates it to early nineteenth century visions of America that deeply interested Keats, who had lost one brother to tuberculosis, and the other to the hazardous New World (169).

[77] Keats had overtly alluded to the ontological shocks afforded by geological science in his epic *Endymion*, which implicates extinction as a necessary event preceding new creation; environmental catastrophe set in deep time is the author of these sudden changes: "skeletons of man, / Of beast, behemoth, and leviathan, / And elephant, and eagle, and huge jaw / Of nameless monster. A cold leaded awe / These secrets struck into him" (3.133-137). See also Richardson's (2001b) discussion (240).

> Thy thunder, conscious of the new command,
> Rumbles reluctant o'er our fallen house;
> And thy sharp lightning in unpractised hands
> Scorches and burns our once serene domain. (I. ll. 55-63)

Since they have no notion of the "hands" that brought their fate to bear, the unguided elements of sea and storm merely haunt their consciousness of vulnerability. Nature becomes a curtain of adversity that shades them from viewing the enemy they believe must be in the "new command," but later we learn that Apollo has no hand in directing this sea-change of circumstance. Instead, Apollo is thoroughly incapacitated, with "half-shut suffused eyes," "melancholy numbs [his] limbs," and feeling "curs'd and thwarted" (III. 44, 87, 92). Agency is left with Nature.

Keats hints that what specifically has weakened the Titanic grasp over the elements is a twofold coherent catastrophe of environmental pollution and apocalyptic upheaval. Evidence for the first contingency of disease comes when Hyperion burns ceremonial incense, "his ample palate took / Savour of poisonous brass and metal sick" (I. 188-189); he describes his fallen comrades as "lank-eared Phantoms of black-weeded pools" (I. 230); from these pools "A mist arose, as from a scummy marsh" (I. l. 258); the Titans' hearts are "Heaving in pain, and horribly convuls'd / With sanguine feverous boiling gurge of pulse" (II. l. 27-28); Saturn's blanched face reveals that "Fate / Had pour'd a mortal oil upon his head, / A disanointing poison" (II. l. 96-98). Apollo was to become god of medicine; he is an unlikely candidate for sickening the old gods. Denise Gigante has theorized from these passages in *Hyperion* that Keats was developing an "allegory of taste" in which the Titans as tragic heroes are predisposed to feel disgust rather than pleasure (149). The visceral, literally ingested senses of smell and taste provide Keats, lover of poetic

"gusto," an intensive, synaesthetic image set for depicting epic agony in a specifically revolting setting. The Titans's environment, independent of will or purpose, has degraded into a toxic habitat; it infects their conscience as well as their bodies as they contemplate the new condition of mortality.

The concept of pollution was first used in English around the fourteenth-century; since then it has subtly evolved from its earliest denotation as spiritual or ceremonial desecration, as when the conscience is polluted by an evil act or the ears are polluted by blasphemy. Pollution soon came to be linked to physical contamination, and by the eighteenth-century it came to have what we consider the most relevant definition to modern concerns: to pollute the natural environment with the effluvia of industry, petroleum emissions, and waste disposal (OED online). By the nineteenth-century, especially in Keats's environment of London, water and air pollution were quotidian observations. His battle with tuberculosis, previewed by the deaths of his mother and brother, forced him to develop an industrial-era concern that spiritual and physiological contamination are related.[78] Especially considering Keats's recent trauma with the death of his brother and the miasmic theories of disease transmission circulated in the early nineteenth-century, Keats would have ample reason to be apprehensive about the dangers of unhealthy, damp environments and the people who fall sick within them. Saturn, the real tragic hero of the Hyperion fragment, is a pre-modern God polluted by sudden environmental changes. He and his family fall by maladaptation to the cruel new conditions.

[78] Alan Bewell discusses Keats's anxiety about miasmic places, and usefully points out how Keats was worried that his remaining brother George had gone to a disease-ridden place by emigrating to America (1999: 169). Bewell reads the *Ode to Autumn* against the eco-critical grain (see, for example, Bate 109), as a miasmic poem rather than a healthful one (177-181).

Further undermining the infirmities of the vulnerable race of Titans are the environmental cataclysms that overthrow their civilization. Huge disasters that change the face of the landscape like earthquakes, meteors, and tsunamis (to name only a few) are distinct from plagues and pollution, which are often wrought by the habits of the denizens. The Titans seem to be suffering from a coherent catastrophe involving both. Keats's use of simile to describe the feelings of the Titans obscures a clear causal relationship between, for example, an earthquake and the toppling of Hyperion's palace. But his use of natural apocalyptic parallels to capture the condition of the Titans is consistent, and it ingrains our sense that environmental contingency is not just the metaphorical vehicle that drives the plot forward, but also the conceptual foundation around which Keats organizes evolutionary change:

> Blazing Hyperion on his orbed fire
> Still sat, still stuff'd the incense, teeming up
> From man to the sun's God; yet unsecure:
> For as among us mortals omens drear
> Fright and perplex, so also shuddered he –
> …horrors, portion'd to a giant nerve,
> Oft made Hyperion ache…
> His winged minions in close clusters stood,
> Amaz'd and full of fear; like anxious men
> Who on wide plains gather in panting troops,
> When earthquakes jar their battlements and towers.
> (I. ll. 166-170, 175-176, 197-200)

The blindness of dire apprehension is horrific to a class of gods who have no history to consult beyond the stability of their own long reign. Therefore the Titans seek deeper historical knowledge to understand their place in the order of things (order is assumed), using two distinct methods: Saturn's 'old spirit-leaved book' and Oceanus's evolutionary principle of beauty. Saturn's tome, a variant on natural

theology, provides no perspective; he finds no reason why the Titans "should be thus [fallen]":

> Not in the legends of the first of days,
> Studied from that old spirit-leaved book
> Which starry Uranus with finger bright
> Sav'd from the shores of darkness…
> the which book ye know I ever kept
> For my firm-based footstool: --Ah, infirm!
> Not there, nor in sign, symbol, or portent
> Of element, earth, water, air, and fire, --
> At war, at peace, or inter-quarreling…
> not in that strife,
> Wherefrom I take strange lore, and read it deep,
> Can I find reason why ye should be thus:
> No, no-where can unriddle, though I search,
> And pore on Nature's universal scroll
> Even to swooning, why ye, Divinities,
> The first-born of all shap'd and palpable Gods,
> Should cower beneath what, in comparison,
> Is untremendous might. (II. ll. 132-135, 137-141, 147-155)

Nothing in the recorded natural history of the Titans prepares them for extinction, because their existence is relative to nothing else, they are "first-born." History is to make an example with their sad case rather than providing them a context for evolutionary succession. Apollo subsequently inherits this history, but to little use in a poem that consistently chagrins progress, and that truncates with Apollo's apotheosis.

Oceanus, whose speech is often viewed as the locus of Keats's philosophy in the poem, is more circumspect than Saturn. He chooses (like Wordsworth's speaker in "Expostulation and Reply") to lift his face out of books and scrolls and look deeply into the nature of power as an aesthetic, rather than muscular, competition. In an epistemological image that reminds us of Keats's "Chamber of Maiden-Thought" from his letters, Oceanus begins,

> We fall by course of Nature's law, not force
> Of thunder, or of Jove. Great Saturn, thou
> Hast sifted well the atom-universe;
> But for this reason, that thou art the King,
> And only blind from sheer supremacy,
> One avenue was shaded from thine eyes,
> Through which I wandered to eternal truth. (II. ll. 181-187)

The light at the end of the tunnel is a backwards perspective on Titanic origins, from "Chaos and parental Darkness came / Light," and the "atom-universe" fell into increasing order and articulation in which each earlier stage clears the foundation and outlines the primitive form of the next (II. 191-192). Oceanus's reassuring, if humbling, teleology spans the many forms of biological life:

> Say, doth the dull soil
> Quarrel with the proud forests it hath fed,
> And feedeth still, more comely than itself?
> Can it deny the chiefdom of green groves? …
> We are such forest-trees, and our fair boughs
> Have bred forth, not pale solitary doves,
> But eagles golden-feather'd, who do tower
> Above us in their beauty, and must reign
> In right thereof: for 'tis the eternal law
> That first in beauty should be first in might…
> Receive the truth, and let it be your balm. (II. ll. 217-220, 224-229, 243)

This breath of wisdom falls like a lead balloon among the Titans, who are in no humor to swoon, or abdicate under the light of Apollonian beauty. Though its teleology towards ever-greater beauty (easily accommodated in evolutionary terms as 'fitness') is provisionally comforting, gods of might are not likely to fall without a fight, and no direct fight has ever been realized. The Titans spend many of their words fantasizing about a battle, but their number has fallen by the mediation of Nature, which is not an entity that can be battled *with*. Their environment falls to shambles around them, their health decomposes, and the Titanic body seems destined

to be recycled back into the atom-universe. Though Oceanus's speech deserves the critical attention it has received, in many ways his teleological, constructive principle of beauty is a red herring that distracts from the chaotic contingencies of environment that punctuate evolutionary history. Unable himself to buy into "nature's law" and fall in love with Apollo, Keats sloughs off 135 mediocre lines of book III before splintering his new god in the sky, "Celestial * * *...". A manuscript revision continues this line as "Celestial glory dawned: he was a god!" but this conventional plot elaboration was not kept in the published poem.

In a letter to his brother one month after the Peterloo massacre in Manchester (September 1819), Keats is struggling with a theory of historical progress that sheds off the superstitions of Christianity. Noting the recent marches in London after Peterloo, Keats continues, "I know very little of these [political] things. I am convinced however that apparently small causes make great alterations. There are little signs whereby we may know how matters are going on" (Scott 367). His appreciation for historical chaos, where "apparently small causes make great alterations," bears resemblance to modern chaos theory.[79] In 1819 this small, violent incident in Manchester mushroomed into a defining moment of the age and a rallying cry for reform. Far from steady upward progress towards comprehensive human rights, Keats finds the narrative of history to be surprisingly contingent. Since Keats found contingency to be the pattern of history that narrative can not quite capture, how was Keats to weave verse around the dynamics of natural systems? What role could poetry play in elucidating nature holistically, so that it plays a different and

[79] James Chandler (1998) notices Keats's interesting observation and links it to chaos theory, but does not develop the relationship further (432).

complementary part to reductionist science? The next section will consider Keats's odes as his antidote to narrative fracture.

IV: Microcosmic Odes

Earlier in this chapter I introduced the idea of an intensive poetic structure like a lyric as an interconnected system of words predisposed to support ecological dynamics in the poem's imagery. The ode, as the most complex and ornate of the forms with which Keats tested himself, represents the lyrical high water mark for his flood of inspiration in 1819. From spring to autumn of that year, Keats's brain had ripened into readiness, and he had found his oeuvre in this tangled, energetically self-organized poetic form of ancient praise. Odes don't move like narratives do; they stay in a comfortable dwelling place and draw at the strings of the world around them.

New criticism often praised the Odes' formal perfections by finding the prosodic structure and gallery of images in synergy with the philosophical occasions of the work; this organic whole was seen as an object of aesthetic self-containment that kept the poems austere from their context in Keats's society, his politics, and his views of history. These reverent close readings from critics like W.J. Bate, Helen Vendler, and Geoffrey Hartman have been complicated in the last twenty-five years by Romanticists interested in the historical and political valences at the edges of the odes. Jerome McGann began the historical infusion of *To Autumn* by suggesting that the poem is contextualized by the Peterloo Massacre of 1819, which occurred four days after Keats's arrival in Winchester (1985: 58). McGann calls the poem "an active response to, and alteration of, the events which marked the late summer" (61). He defines a Romantic epistemology of poetry as "an art that can imagine the

sufficiency of the imagination" exclusive of other ways of knowing the world (60).[80] James Chandler continues with this line by suggesting that the Ode can be read as a poem about death (thanatopsis) that is very much engaged with the broiling history of 1819 (427, 430). Chandler makes analogous points about historical engagement in other great Odes of 1819: the extinction of the Urn's civilization, the tears of historical Ruth and her bird-song link to the emperor and clown and to Keats himself (408). With these poems, Chandler argues, Keats is testing out his idea of the world as a "vale of soul-making" by studying permanent symbolic objects as evidences of the transience of any one life, any one civilization. These are not poems breathing in their own rarefied, atemporal atmosphere; they allude to Keats's concerns about his own time in history. Chandler notes that the Ode to Psyche is "implicitly characterized by a skeptical empiricism" because the goddess is intractably curious and visual, insisting on a "show-me brand of empiricism" (414).

My reading of the Odes is distinct from Chandler's political, spirit of the age treatment without being contrary to his points. In my readings, the empirical eye of these poems is trained on the material, natural surroundings the poet describes in such careful detail. By studying natural systems acutely and in partial isolation, Keats is able both to create and describe a series of microcosms in verse. He repeats the

[80] In McGann's reading, this primacy of imagination delimits the work of poets from that of contemporary scientists and industrialists because the latter created conditions that "only exacerbated suffering and social injustice," whereas the "Romantic manoeuvre…was to turn to poetry and the fine arts as the only available instrument of human melioration" (1985: 57). Either poetry was used as a direct public attack on targeted social structures, or it created an "alternative geography, [where] personal and social tensions could be viewed with greater honesty and intellectual rigour" (57). Such alternative geographies are colonized by imaginative acts and recombine external "reality" with elements of history, myth, and universality (Keats's *To Autumn* animates all three). Science, however, continually uses natural history and imaginative speculation (hypothesizing) to seek universal laws and theorize truths about the material world. The microcosm is perhaps the epitome of an empirical object that is universalizable, and requires a strong influence from imagination; its utopian potential often tends towards therapeutic melioration.

microcosm experiment six times in a single year, keeping relative controls over the prosody (only Psyche varies greatly in formal structure), and varying by subject, season, and personal mood. If one definition of Romanticism is that it is a literature that resists the contemporary hegemonies of Christian doctrine and Enlightenment ordered empiricism, we find in Keats's work a theory of secular salvation in the "vale of soul-making," and a theory of epistemology by scientific but non-reductive close study. Such devotion is the work of a chameleon poet who studies so stridently that he annihilates himself and grows into the color of his subject; this is Keats's uniquely intimate empiricism.

Keats's odes represent a clutch of related but distinct episodes that delve into relations between perceiver and environment. Since Keats self-identified as a chameleon poet, ready to blend into his surroundings and subjects to become one with them, there are frequently passages that erase the speaker altogether, permitting a vision of the relations among nature's many selves.[81] The words become an *oikos*, a dwelling place. The identity of the dweller is unimportant; simply *being* there is the occasion for the ode. Readers of Keats are easily able to squeeze themselves into his "I," and his frequent use of dream and drugged states of consciousness loosens identity from I to We, the *we* experiencing the poem. We're not certain we can trust

[81] Keats's capability for intense empathy with his subjects is known to be one reason he found medical surgery of his day, performed without real anesthesia, to be intolerable in spite of his high aptitude for the work. The poet-scientist Goethe, one of continental Romanticism's great figures, theorized an empathic, non-invasive science he called "delicate empiricism, which makes itself utterly identical with the object, thereby becoming true theory. But this enhancement of our mental powers belongs to a highly evolved age." Keats's close attention to the forms and developments in nature could be seen as delicate empiricism for poetic ends, and some of his odes, particularly Autumn and Nightingale, amount to lyrical natural histories (see also Brady's [1998] essay).

what we see, smell, hear, feel, and taste, but the impression of *being* in these aesthetic little worlds is so strong that truth may as well be the same thing as beauty.

These are dwelling places that are inhabited with pleasure by the subject and the reader: Psyche and Cupid are "couched side by side / In deepest grass, beneath the whisp'ring roof / Of leaves and trembled blossoms, where there ran / A brooklet, scarce espied: / 'Mid hush'd, cool-rooted flowers, fragrant eyed…" (ll. 9-13); the lover of the nightingale sits, "in embalmed darkness" with "The grass, the thicket, and the fruit-tree wild; / White hawthorn, and the pastoral eglantine; / Fast fading violets cover'd up in leaves; / And mid-May's eldest child…" (ll. 43-48); the Grecian urn depicts "marble men and maidens overwrought, / With forest branches and the trodden weed" (ll. 42-43); the melancholy escapist is told to "glut thy sorrow on a morning rose, / Or on the rainbow of the salt sand-wave, / Or on the wealth of globed peonies" (ll. 15-17); the indolent soul becomes "a lawn besprinkled o'er / With flowers, and stirring shades, and baffled beams" (ll. 43-44);[82] and, in perhaps the best-measured natural system of the whole clutch, the autumn afternoon holds the hum where "the small gnats mourn / Among the river sallows, borne aloft / Or sinking as the light wind lives or dies; / And full-grown lambs loud bleat from the hilly bourn; / Hedge-crickets sing; and now with treble soft / The red-breast whistles from the garden croft; / And gathering swallows twitter in the skies" (ll. 27-33). Finding sensuous spaces in Keats is an easy task; what my argument suggests is that

[82] In the *Indolence* ode Keats rejects his role as a cockney poet among haughty critics, the "pet-lamb in a sentimental farce" (54). He would, he claims, rather remain in bed with a black eye and convert his soul into a wildflower field, where any lamb would be delighted to nibble and grow, by the time of autumn, into a full-grown lamb that "loud bleat[s] from hilly bourn" (*Autumn*, l. 30). By pointing out clichés of the pastoral genre that emphasize its past-ness and relegation to sentimental farce, Keats clears new ground for his own deep identification with nature involving a *human* consciousness of complexity, namely a soul with "flowers, stirring shades, and baffled beams" instead of outworn pastoral theriophily, where the pet-lamb is assumed to live in a blissful state of intellectual oblivion.

these spaces are not merely beauty for beauty's sake, or the escapist aesthetic idealisms of adolescence, but that they gesture towards a new way of understanding organizational scale in nature. The odes are ecological microcosm experiments of the mind, meted out by the line and the rhyme.

This thesis is defensible partly because Keats's odes are much more complex in their views of nature than the simple time-honored pastoral (or sylvan, or great-house) eclogues of his literary ancestors. Confusion, dissolution, and mortality play indispensable roles in Keats's visions of nature, and even the most vapid-seeming of celebratory lines ("More happy love! more happy, happy love!") can be drawn into more penetrating light with an ironic reading. On the other hand, though joy and sadness have complex relations in these poems, Keats has no desire to engage in what he calls *consequitive reasoning*, an epistemology of the "sciential brain" that seeks, as he says in *Lamia*, "To unperplex bliss from its neighbor pain; / Define their pettish limits, and estrange / Their points of contact" (I. ll. 191-194). His odes hold the wholeness of existence in nature as a dear value of the en-souled individual, whose atoms of intelligence have been schooled by experience in the world he calls "elemental space." I am alluding again to the spring 1819 letter to America with which I opened this chapter, in which Keats sought to describe his "system of Salvation." Nowhere in his works does he seem closer to saving himself from oblivion in death, the great fear he had engraved on his tomb, than when his final ode closes with an atomic pattern of organization, where "gathering swallows twitter in the skies." With these words, the naturalistic impressions of a single man on an

afternoon's walk in Winchester in autumn 1819 are embedded in the consciousness of Keats's epistemological inheritors.

These poems succeed because they lend us an intense vision of how nature can be perceived, without reducing our experience to its literal components or overwhelming our minds with diluted universalities. Each ode finds its proper scope, then stays there to ponder a while. Part of this all-important scope, which elsewhere I have called circumscription, is assignable to form: ten or eleven line stanzas with sonnet-like rhyming, and the whole between thirty and eighty lines. But the images superadded to the formal system of prosody are also sheltered, veiled (vale-d), drawn within semi-theoretical boundaries. The odes are poetic ecosystems, turned and gently manipulated by the voltas of mood and inspiration. Ecosystem science of the twentieth-century would negotiate its terms with remarkably similar methods. Here I return to Arthur Tansley's theory of circumscription in ecology, discussed more thoroughly in chapter three. Ecosystems

> are of the most various kinds and sizes. They form one category of the multitudinous physical systems of the universe, which range from the universe as a whole down to the atom. The whole method of science…is to isolate systems mentally for the purposes of study, so that the series of *isolates* we make become the actual objects of our study, whether the isolate be a solar system, a planet, a climatic region, a plant or animal community, an individual organism, an organic molecule or an atom. Actually the systems we isolate mentally are not only included as parts of larger ones, but they also overlap, interlock and interact with one another. The isolation is partly artificial, but it is the only possible way in which we can proceed. (1935: 299-300)

The boundaries of ecosystem ecology are half-imagined for the sake of coherent study, and they half-exist as distinct sub-structures of organization in nature. To *imagine* their existence is a necessary condition for theorizing how they might work:

how inclusive to be in the model (including the inorganic components of the system as well the organic), how to measure the impalpable entities (like energy exchange), and to account for unpredictable events set in time (droughts, storms, human impacts, climate shifts). The ecologist dwells in a liminal terrain between theory and material entity, and the dimensions of this meta/physical space are largely subject to her own definition (though the terms and rationale of ecosystem boundaries will inevitably be vetted by the scientific community).

Keats was thoroughly aware that his little worlds of isolation were stolen from larger places, often temporarily or arbitrarily. He cleared semi-theoretical contemplative space away from, for example, "busy common-sense" (*Indolence*, l. 40), he diverted from the path of emotional oblivion to stay in the experiential world ("go not to Lethe," *Melancholy*, l. 1), he often set himself up for loss in the end when the theoretical circumscription melted back into the wide world outside of his ode-system, as it does at the end of *Nightingale*: "Forlorn! the very word is like a bell / To toll me back from thee to my sole self / …adieu! thy plaintive anthem fades / Past the near meadows, over the still stream, / Up the hill-side; and now 'tis buried deep / In the next valley-glades" (ll. 71-72, 75-78). The next valley over is someone else's enclosed terrain, and the poet has no choice but to give freely what he never truly possessed. His surroundings have changed and the vision is gone, but thankfully the ode holds the moment in energetic stasis, mimicking a stable ecosystem.

The imagination, or theory, of a natural space delimited from larger places is a repeating theme of Keats's odes. It suits that a poet seeking to weave a soul using the atoms of mere intelligence would repeatedly build religious structures to celebrate the

gods of his imagination. A building is a place in which to dwell, and Keats's imagined temples and fanes clear space for a worship and study set apart from the Whole of nature. Keats wrote the earliest *Ode to Psyche* in a "more peaceable and healthy spirit" that would guide future writing efforts, and further delineates the Odes period from the dark mood that drove the epic *Hyperion* (letter to George Keats, April 30th 1819, see Scott 294). Though this first Ode to the "hethen Goddess" is one of his more uneven in structure and image, it sets the stage for this series of poems, each of which delineates a microcosm as the locus of attention. Keats usually populates these small spaces with mysterious and powerful females, welcoming the interpretation that nature's dark workings are just beyond the ken of the inquiring male, but must be strived after. This time, rather than dressing himself as a Galilean scientist, or a miner with an avaricious eye for veins of gold, the poet is a priest and a gardener at once. The strongest stanza in *Psyche* is the final one:

> Yes, I will be thy priest, and build a fane
> In some untrodden region of my mind,
> Where branched thoughts, new grown with pleasant pain,
> Instead of pines shall murmur in the wind:
> Far, far around shall those dark-cluster'd trees
> Fledge the wild-ridged mountains steep by steep;
> And there by zephyrs, streams, and birds, and bees,
> The moss-lain Dryads shall be lull'd to sleep;
> And in the midst of this wide quietness
> A rosy sanctuary will I dress
> With the wreath'd trellis of a working brain,
> With buds, and bells, and stars without a name,
> With all the gardener Fancy e'er could feign,
> Who breeding flowers, will never breed the same… (ll. 50-63)

Keats seeds his mind within concentric layers of the garden, the sanctuary, the fane, the dark-clustered trees, and the wild-ridged mountains. A close reading of the stanza reveals the Aeolian trope of inspiration where "mind" slant rhymes with "wind";

"pleasant pain" facilitates the extended development of bio-diverse components before the pain is assigned to the "working brain" of creativity; these natural elements created between uncharted "mind" and "working brain," in effect, colonize a new ground and cultivate a garden of pantheistic, and psychological, worship. Its consistent pentameter, which Keats would vary more in later odes, has the breath to support this rich excess of cognition, the "zephyrs, streams, and birds, and bees," the "buds, and bells, and stars without a name," and of course the evolving flowers. It is an active stanza; the limp passivity that often weighs down Keats's subjects is passed on to the Dryads, and the poet/gardener exudes creative energy and control over the system. Pain is only pleasant to Keats when it is productive; like the sensual image of "aching Pleasure nigh" in the *Ode on Melancholy*, this enviable state of striving *and* accomplishing (by "breeding flowers" and "burst[ing] Joy's grape") yields an emotional and intellectual apex. The union of conscious effort with progress aligns with Keats's admission that this was the first poem that required "even moderate pains." The cognitive ecology of the passage, which is its own sonnet, demonstrates how a brain might be worked into a self-sustaining, heterogeneous ecosystem that celebrates all the virtues of the human mind, just as a natural microcosm embodies the general dynamics of Nature.

Alan Richardson's cognitive science reading of Keats theorizes that the brain has greater potential and power than the mind for Keats, it "reveals its capacity in moments when consciousness fails just at the point of revelation" (2001a: 148). Richardson develops the idea that Keats's medical knowledge allowed his poetry to entertain mind-body interactions as fundamental to consciousness, and phrases such

as the "dim-conceived glories of the brain" in effect "broach something new in British poetry, a sense of the embodied mind's unconscious and ineffable magnitude that might be termed the 'neural sublime'" (148). By the time of the Odes, Keats was able to theorize the physiology of brain to such an extent that it became its own ecological-evolutionary system within the cranium, a distinctive advance in the trope of the psychological microcosm.

Keats has found a theoretical place for dwelling with Psyche, and he seeks to cultivate its potential both as an insulated, prosperous niche and as the seed of all natural potential yet unrealized, selectively breeding new flowers into futurity. He succeeds: we might name those flowers *Odus nightingalus, O. Urnus, O. Melancholus, O. Indolencus,* and *O. Autumnus*. Each poem finds a slightly different way to organize the same general prosodic scheme in genus, but the spots and stripes and colors of species contrast, highlighting the virtues of thematic variation. I will discuss two of these odes using this notion that a small natural system can be modeled in a stanzaic scheme, where meter and rhyme exercise control and draw on affinities among the components of the image.

The *Nightingale* ode uses its first four stanzas, fully half of the long poem, to nudge away the sorrows and annoyances of life in the mainstream so as to settle in a self-contained space of nature and the bird, the promised "melodious plot" (l. 8). The poet will not escape using opiates or wine, agents of enervation and forgetting that work decidedly against perceiving any veritable reality. Instead, he pushes his unaltered brain towards the poetic station where it "perplexes and retards" with the

nightingale (l. 34). This enables an alchemical *in*sight that draws his visions from the clean celestial expanse down to the perplexing haven of biological life on earth:

> tender is the night,
> And haply the Queen-Moon is on her throne,
> Cluster'd around by all her starry Fays;
> But here there is no light,
> Save what from heaven is with the breezes blown
> Through verdurous glooms and winding mossy ways. (ll. 35-40)

With this ambiance set by the enclosed, welcoming gloom of a bower, the poet is positioned to recreate a microcosm of the natural world using his imagination. Between theory and reality, Keats articulates a haven of heterogeneous life borne on the boughs of ode-verse, and his musical bower becomes a resting place where he would be perfectly content to "become a sod," and forever remain (60). He writes, in this complacent, dark stanza,

> I cannot see what flowers are at my feet,
> Nor what soft incense hangs upon the boughs,
> But, in embalmed darkness, guess each sweet
> Wherewith the seasonable month endows
> The grass, the thicket, and the fruit-tree wild;
> White hawthorne, and the pastoral eglantine;
> Fast fading violets cover'd up in leaves;
> And mid-May's eldest child,
> The coming musk-rose, full of dewy wine,
> The murmurous haunt of flies on summer eves. (ll. 41-50)

Time passes; this stanza marks the floral continuum from early spring all the way to full summer; and the fixed position of the speaker keeps his observations of the seasons coherent. Though the whole stanza is framed in negative sensory terms ("cannot see" precedes "guess"), the speaker's familiarity with the "seasonable month" helps with the accuracy of his guesses about how nature is developing around him, from the grass and thicket to the rose and the flies. As in Psyche, a list of

entangled elements fills the sestet from “grass” to “summer eves,” and “mid-May’s eldest child,” set alone in trimeter, sounds backwards by rhyme to “the fruit-tree wild” and forwards by consonance to the “coming musk-rose” and the “murmurous haunt.” This wild eldest child, which is the musk-rose and an allusion to Keats himself, mumbles the infantile M and enters a transcendent state of meditation. It is a world the poet knows well enough to see without seeing it because the other senses are enough; he has turned the bower into a concept.

His ecosystem has its essential three components: an observer (the poet), an occasion or subject (the nightingale), and its biotic and abiotic medium (the flowers, the leaves, the light, the sod). Without the nightingale, Keats would have no reason to focus on this place; it is the charismatic fauna that so often focuses conservation efforts on a particular place. Though this suburban plum-tree bower is not endangered in the modern sense, it is assuredly a little haven set amid the slightly larger haven of Hampstead, which lies within sprawling industrial London. Self-sufficient and yet vulnerable, the nightingale bower occupies real and symbolic worlds simultaneously, and Keats is able to deal between these realms using free play between his senses and imagination. The specifics, the flora and fauna of this space and their particular interactions, are accessible by scale and enable extrapolation onto larger places like the near meadows and the next valley-glades. The nightingale is a fleeting visitor, and the poem’s final seam is sewn with the bird’s flight and the poet’s wakening back to the quotidian world. The circle of song is broken, and the poet is forlorn; so forlorn that we carry a sense that the entire complex scene has fallen away with the loss of the bird. Even amid the new silence, though, the poet remembers and

records his vision, which has become an archetype of the contemplative lyric. A plum-tree bower has enough space to balance a complete little world, for a moment.

The final ode, *To Autumn*, is known as the most perfect of the odes, the one that leaves the fewest open questions, the most balanced in stanza, movement, image, the most settled in its contentment with place. It is a fitting work to finish the clutch, a paused balance between life and death that celebrates a season turning back to darkness. It is a poem that prizes natural processes as indefinite rather than finite, and it impresses images of real, material nature more than the other Odes that circle around escapist ideals and abstractions. As an embedded, earthy, oozing lyric, it reveals itself as the product of the poet's experience over the course of a year of writing about small-scale nature.

To Autumn has already roused the attention of ecocritical scholars as, in Jonathan Bate's words, "a well-regulated ecosystem" and "an image of ecological wholeness which may grant to the attentive and receptive reader a sense of being-at-home-in-the-world" (ll. 106, 109). Bate's reading traces the string of good weather in relation to Keats's moods and his enthusiasm for the riparian walk out of Winchester. Finding respite from the perpetual internal chill of a mid-tubercular patient, as well as delighting in the best weather since the Tambora volcano had caused the year without a summer in 1816, Keats delights in the easy overabundance of nature that draws humans into its open rhythms rather than sequestering them in man-made, fire-warmed, smoky inside spaces. One way this ripe overabundance is attained is by his addition of an eleventh line to each stanza; all three eleventh lines are images of excess fecundity ("summer has o'erbrimm'd their clammy cells" [l. 11]; "Thou

watchest the last oozings hours by hours" [l. 22]; "gathering swallows twitter in the skies" [l. 33]). Though the stanzas are highly self-contained, one rhyme threads through the whole work, joining "core" and "more" (in the first stanza) to "store" and "floor" (in the second) to "mourn" and "bourn" (in the final); this affinity of sound escorts the poem through three stages of production (core/more), inventory or possession (store/floor), and depletion (mourn/bourne). These seasonal movements shadow the three-part mood of the Ode, the triptych of mid-year dissolving into end-year, and nature and the poet's resistance to this inevitable dissolution.

Human figures only half-exist in the poem: Autumn herself is the addressee who takes the various forms of "bosom-friend" and conspirer with the sun, winnower, reaper, and gleaner; humans share the scene equally with bees, birds, gnats, lambs, crickets (l. 2). The somnolent state that transposes imagination over reality is here exported to his figures of nature, and the observer remains austere like the ideal scientist, acting only as observer behind the lines that conjoin at rhymes and part ways by stanzaic decree. The speaker asks important rhetorical questions ("Where are the songs of spring?"), and his position remains that of a reader of a pleasant chapter from the book of nature because the setting has an infused instinct for call-and-response. The songs of spring are gone, but the music of autumn is a symphony: a wailful choir of gnats, loud-bleating lambs, singing crickets, whistling red-breasts, and twittering swallows. The atmosphere circulates from "mists" to "barred clouds;" the fields from "sweet kernel" to "stubble-plains," and the poet vividly observes these evolutions while preserving the static suspension of a *realized* natural entity, one that has been in the works since the chilly greens of spring.

Though the poem is the product of a walk on a single afternoon, it possesses the wisdom of a full cycle of life where another year has been fostered by birth, growth, production, and reproduction. Seasonally it joins with the spring-time Ode to Psyche, where the poet vowed to build a fane to his brain and breed flowers of insight, as he has now done. The autumnal system is pitched on the edge of dissolution, but Keats's treatment is so gentle that we hardly notice the ominous moments, like when the fat bees "think warm days will never cease," when "barred clouds bloom the soft-dying day," and when "in a wailful choir the small gnats mourn" (ll. 10, 25, 27). Because he does not push autumn over the equinoctial edge, Keats's poem stays living in this state of dynamic suspense, "gathering" its energies like a cloud of swallows in the "skies" (l. 33). The final word recalls its rhyme-pair from where "the light wind lives or dies" (l. 29), and the skies, like the ode itself, cradle life and death in the same cornucopia. The scene that is suspended in the last line draws a trophic link between swallows, who partake of the gnats, who feed off the mature fruits from the first stanza. Swallows invoke the global implications of this small scene: they migrate from northern Europe to southern Europe and Africa in yearly patterns. Their gathering in the skies is harbinger of the population's exodus to warmer climates for the coming winter season. But the rupture of this ecosystemic circle is forever suspended, and the scene auditorily sustained by rhyme and meter is ecologically sustained by the cosmic balance of Keats's images, flora with fauna, light with darkness, life with death. The swallows are forever going, but they are never gone; the microcosm holds moment and space perpetually.

V: Frayed Epics and Reconciliations

By the time he turned back to the *Hyperion* endeavor, Keats may have learned from his Odes experience that his systemic lyrical vision had a strengthening effect on poetic synergy. The first *Hyperion* assured that a narrative form supported chaotic stories of succession in the natural world, but it suffered from eschatology fatigue, the labor of finding purpose and telos in a world that he believed was guided largely by circumstance. The Odes escaped time by focusing on a time-transcending subject (the urn, the nightingale), by deifying an eternal mood (melancholy, indolence), or by suspending unidirectional process in a solution of cyclical, ongoing interconnection (psyche, autumn). When Keats made the decision to have another try at the Hyperion story, he obviously integrated these conceptual successes into his new lyrical scheme of epic narrative. *The Fall of Hyperion* attempts to harness its narrative inertia on the shoulders of the poet-agonist, who, as the new Apollo figure, struggles to find place and purpose in the fallen world of history.

The Fall of Hyperion earns its readers through an earnest attempt to engage with the problems of being a worthy poet in a scientific, industrial, profit-oriented modern world. By placing himself as the central subject in a post-Edenic garden, the poet is positioned to look realism in the face. His desire to re-work a long mythical narrative into a personalized allegory about the offices of poets and dreamers demonstrates an anxiety about the value, including fiscal value, of literary effort in his time.[83] Where Keats was bothered by the contrary concerns of "busy common-

[83] Marjorie Levinson has discussed the Hyperion dyad in terms of "their common subject matter and…antithetical ways of framing this material…Roughly, then, we find in *Hyperion* and *The Fall* a concrete expression of a familiar epochal dualism: naïve – sentimental, ancient – modern, mimetic – expressive, ethos – pathos … male – female" (1988: 193). Though this relationship built on antithesis

sense" in the *Ode on Indolence*, here he is seeking a positive response from his mere hope that valuable work can still come from literary minds. Value, here, goes beyond remuneration for successful publications; the poet asks his prophet to be assured against his own nagging fears: "sure not all / Those melodies sung into the world's ear / Are useless: sure a poet is a sage; / A humanist, physician to all men" (ll. 187-190). But Moneta the blind prophetess gives no direct answer that would align the work of a poet with the progressive theories of political humanists or the practical treatment of physicians - a profession that Keats might well have advanced. Instead, Moneta draws a contrast between poets and dreamers by calling them "antipodes," but ironically this contrast actually likens them because she fails to clarify any true distinction.

Aspiring to a grand epic but in a state of trepidation from the start, the poet sketches and erases his philosophies on the horrific blank face of Moneta. He seeks to behold "What in thy brain so ferments to and fro" (l. 290), and Moneta, who represents memory, brings the poet into the world of her mind by placing her companion in the cold comfort of his old poem, "Deep in the shady sadness of a vale" (l. 294). Memory draws the features of this fallen environment, and the old opening lines have an uncanny, haunting effect on the reader familiar with *Hyperion*. We feel as though the original work, which described a degraded natural environment, has been transformed into a psychological relic of a place (or a Keats) that used to be, but

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is similar to Bloom's Hegelian reading of the paired poems, Levinson argues that "by its truncation, *The Fall* interferes with the two-text dialectic, or with the rationally progressive, self-totalizing teleology promoted by that intertextual model…The object of the latter work is to effectuate the earlier, not escape it. The irresolution of *The Fall*, a foreclosure, executes a refusal of the form to which both works allude: that of the progress poem" (192). Levinson's reading reinforces the view that *The Fall* provides a fresh angle by which Keats approached the same form, the narrative epic. Though the framing is antithetical, the subject matter is revisionary; both poems end in literal narrative disintegration: *****.

that is no longer. Keats's self-consciousness about the relation between material place and neural spark is palpable, as when he calls the request to see Moneta's vision a "conjuration"; an invocation of magic and spirits. Once given Moneta's vision, the poet's body wastes away under the energetic demands of his "burning brain" (l. 393), and the distinct tension between the material and imaginative worlds pulls him towards the desire for "death [to] take me from the vale and all its burthens" (l. 397-8). The cognitive architecture that might have organized and clarified the vision has instead become a forbidden threshold for the poet/dreamer:

> [Moneta] spake on,
> As ye may read who can unwearied pass
> Onward from the antechamber of this dream,
> Where even at the open doors awhile
> I must delay, and glean my memory
> Of her high praise: perhaps no further dare. (ll. 463-468)

Indeed, he does not *much* further dare; the poem delays with the angry Hyperion for 60 more lines before disintegrating in the anti-climax of the sun god's escape from existence. Here, rather than finding a synergy in which material nature and imaginative cognition are mutually-enriching, as they had been with the Odes, the poet and his characters are consumed in the fire. The narrative drive seems to be incommensurable with the lyrical linger. Why should we integrate this aborted poem into a reading of Keats's great successes in imagining and advancing proto-ecological concepts?

W.J. Bate's classic biography points to Keats's increased poetic maturity during the late summer Winchester visit (where Keats officially abandoned the *Fall of Hyperion*) as a sticking point between revisions:

> a central premise of the first *Hyperion* had been the widening of human consciousness throughout history…there had been a real struggle against the anxiety that little was left for the modern poet to do…We can hardly help feeling that by the summer of 1819 Keats had really outgrown the first *Hyperion*, and that he was searching his way to a fundamentally different poem. (587)

Taking a similar tack of identifying Keats's anxieties as he turned to the work of revising, Michael O'Neill argues that in the *Fall of Hyperion*, "the poet-dreamer exists in a world of leavings…a state of epistemological doubt…worried about the role of poetry in the modern world…For all its wish to believe in the usefulness of poetry, the poem also believes – and herein lies its modernity – that the utilitarian and the imaginative are likely to be in tension with one another" (161). This charged atmosphere of circumstance, where use and imagination are at odds, provides Keats's readers with an enticing study of the imagination *put to use* in the natural world. The history of nature must be written with an involved imagination, because the physical evidence provides only shambles of the past, or "superannuations of sunk realms" (*Fall*, I. l. 68). The *Fall of Hyperion* is Keats's final poetical effort to synthesize chance with progress, effectively replacing religious Providence with naturalist evolution based on opportunity.

Keats's revision is fundamentally different because it focuses on the poet's struggles in the context of the fallen Gods; the two plots play out on the same stage, or, perhaps more accurately, the poet's evolutionary play occurs on the lapserian stage of the fallen Titans. It remains with the poet to render an object in verse that will aid in secular human salvation, something of true value to humanity rather than the false decorations of artifice. Keats felt that he had failed on this account. His

letter from September 21 attempts to schematize this failure, but with limited patience:

> I have given up [the *Fall of*] *Hyperion*…I wish to give myself up to other sensations…It may be interesting to you to pick out some lines from *Hyperion* and put a mark X to the false beauty proceeding from art, and one ↕↕ to the true voice of feeling. Upon my soul 'twas imagination – I cannot make the distinction…The fact is I must take a walk… (Scott 345)

Haunted but still enticed by the specter of Milton, the poet is chary of the "false beauty" that emerges from mimesis and detached art, but his imagination is so involved in the project as to frustrate his own strong powers of distinction.

What we can derive from this failed revision is evidence that Keats could not fully answer the question of a poet's role in a business and science-oriented world. He could not call the poet the representative of social man, Wordsworth's idea, nor the legislator, as Shelley had claimed. He felt that he could not find the artistic truth about history, even mythological history that relies on the proper emotional queues to be successful. Within the world of Hyperion, the lost realm cannot be made over anew by the same actors; nature in shambles must be adopted by a new species for its metamorphosis to take place, and both the species of gods (the Titans) and that of poets (Milton and Keats) had grown obsolete in that fallen environment. Keats, never a successful avatar of Apollo in the context of the Titans, did not get to the point of introducing the new god to his terrain in the *Fall*, and so the later poem is left uninhabited, in a perpetual punctuation between the ancient species and the modern. Species narratives in nature most often do end, sooner or later, in a state of extinction, so perhaps Keats's * * * * * * * ending is the most poignant truth the *Fall of Hyperion* has to offer. By revoking his scheme of control on the revision, which was

to insert himself in the action, Keats allows the Hyperion series to lie down in its proper fossil layer. Where his conscience demanded answers about the praxis of poetry in the industrial and colonial nineteenth-century, he emerged with an impression about which of his works arrived at some "truth" about the world (an aim also shared by philosophy and science), and which were merely the veils of artifice. To his credit, he could not live with merely producing what he called "the false beauty proceeding from art," seeking instead "the true voice of feeling" (Scott 345). The letter in which these personal standards are established was written on the autumnal equinox of 1819, from Winchester: the scene of his great success with the final Ode. With the ecological vision of discrete, synergetic systems observable in nature, intelligible in scale, and provisionally balanced, Keats and many generations of his readers have located a use for his poetry in the modern world.

These poems display an open inquisitiveness with contingent narrative and self-enclosed modeling schemes of the natural world. Keats's genius for verse allowed him to push the narrative and lyric forms, partly by mimesis, partly through his own ingenuity, to intriguing new stases on the page. The strength of the Odes, renowned as parcels of artistic truth, is borne on their scope, their organization, and their accomplished theory of lyricism, which might synaesthetically be called the poet's light touch. Tearing at the seams of the *Fall of Hyperion* is a conceptual struggle with what constitutes progress, purpose, and valid knowledge, and an aesthetic struggle with how to tell a tragedy and a comedy in one continuous narrative. These themes anticipate the epistemological trials that ecological science would face as it grew into a formal inquiry during the twentieth-century. What is the

role of ecology, superadded atop biology, geology, chemistry, and physics? If ecosystems are necessarily partly conceptual, how do we justify the arbitrary elements inherent in the science, and translate an 'objective' knowledge set? How do we overlay a narrative onto an experimental plot or model? When dealing with complex, irreducible systems that change over time (both coherently and incoherently), what is the proper perspective or level of analysis? Who is the perceiver? Is the poet-scientist justified in taking center stage, since the boundaries of the ecological stage are his own definition? Are ecologists just dreamers of inter-biotic holism who use the tropes of science, and not scientists at all? I will address some of these questions in the next chapter, as I take a look at narrative chaos and the microcosm in relation to the age of ecology.

Chapter 5: Models and Narratives in the Ecological Sciences

"Chaos theory is practically impossible to test outside microcosm, because of the large number of generations required. Because chaotic dynamics are possible in many population-dynamic models, empirical work is desperately needed to discover whether real systems are governed by initial conditions and transient dynamics or by equilibrium dynamics."
-- Sharon Lawler (2004), *Ecology in a Bottle*

I: Introduction

This study's scope has been defined by its close attention to the use of two tropes in British literature of the nineteenth-century. Fictional narratives about chaotic events in nature were inspired not only by biblical eschatological traditions, but more relevantly by a new concern that the force of environmental disasters could be catapulted from the levers of human industry. These concerns grew into a genre of science fiction that focuses on extreme but tantalizingly possible future scenarios, often borne on the scientific-industrial devolution into a moral and ecological wasteland.[84] The new anti-teleological vision of history was also enabled by science's elucidation of geology and biology, since neither deep geo-history nor evolutionary theory needed the support of a Providential deity and both inquiries suggested that random rupture and dissolution play major roles in the natural history of Earth. Philosophers of science continue to identify the crucial conceptual and

[84] The nineteenth-century narratives I read in Chapter Two are models for more recent proleptic apocalypse fiction like George Stewart's Earth Abides (1949), which uses the plague device to envision a founder community in twentieth-century California, Stephen King's related novel The Stand (1978), Margaret Atwood's Oryx and Crake (2003), and Alan Weisman's The World Without Us (2006), a scientifically-driven thought experiment about how human infrastructure would decay in a post-human era. Mary Shelley's The Last Man (1826) is often cited as the founding work of the genre, which repeatedly explores the dynamic between utopia and dystopia in post-modern, post-industrial contexts.

methodological issue in ecology of whether nature's processes are governed more by laws or by historical contingency, and "Chaos Ecology" has become an important paradigm in the last few decades (Craig 2008).

As a complement to chaotic environmental narratives, nineteenth-century lyric poetry became fascinated with nature's minutiae as potential models and recapitulations of much larger, even global, environmental dynamics. With the use of the microcosm as a figurative and literal tool for understanding the complex natural systems that the science of ecology was to serve, Romantic poetry reveals its crucial work as a facilitator between the individual imagination and the existing natural world that is the object of the poet's intimate scrutiny. Betty and Theodore Roszak's idea of "Deep Form" suggests that the Romantics pushed individual consciousness towards the intuition that higher powers operate mysteriously behind the forms of material nature:

> From the Romantic perspective, a landscape by Constable makes our knowledge of nature bigger; art adds to what we learn from any combination of physics, biology, geology, and chemistry. It tells us the world is magnificent, perhaps sacred, therefore deserving of reverence... recognizing this congruency between creativity in art and in nature was not a mere subjective reflex; it was as much a fact as anything a botanist tells us about photosynthesis or a geologist about continental drift. Deep Form offers us the knowledge that an authentically deep ecology requires in order to place us in a respectful, sustainable relationship with nature. (In Coupe 2000: 224)

Readers of Romanticism see this poetic epistemology in complement with scientific knowledge, but with an inherent moral ingredient that often chastens the scientific imperative of forwarding factual knowledge. As we will see in this chapter, moral environmentalism and scientific ecology have a fraught relationship, but they share conceptual tools to organize nature. Experiments based on microcosms became

indispensable to ecological empirics by the twentieth-century, and though their limitations are well-known, microcosms provide essential material systems for testing abstract theories, including chaos.

We may now inquire into the fate of nineteenth-century literary efforts to comprehend the newly anthropogenic environment. Many of the literary works discussed in this study are firmly established in the canon of English education at the university level, and are taught as superlative examples of nature writing, or Romantic naturalism, or Victorian colonial science. In this final chapter I would like to survey some ways in which the viability of these literary ideas has been sustained in ecological science of the last 125 years. The relationship, I suggest, is one akin to phagocytosis: in establishing their science through the turn of the twentieth-century, ecological theorists co-opted intellectual strategies that had sustained many fields, including literary tropes that seem well-removed from scientific methods. Perhaps the perennial human struggle to understand the natural environment and bring parts of it under our control has resulted in this aesthetic binary between chaos and microcosm. There is an intrinsic appeal to both ways of conceptualizing nature, as microcosmic, containable and intelligible at certain scales and as chaotic, recalcitrant, mysterious, and quixotic through time. This dialectic of perceiving nature has been sustained by human experience. This final chapter aims to bring the study of these two tropes into the twenty-first century by looking briefly at the intervening history of microcosmology, the state of narrative in contemporary ecology, and the implications that modeling and narrative hold in relation to our major conundrum of global climate change.

II: Empirical Microcosms

Incidental microcosm experiments began appearing in the form of glass-encased aquaria during the nineteenth-century. Aquaria became a popular hobby for well-heeled naturalists to study the dynamics of aquatic nature in a domestic setting.[85] Before Londoner Robert Warington's 1857 breakthrough of adding live seaweed to a bowl of fish, the water in the tank had to be replaced frequently in order to provide enough oxygen for the animals, at great trouble and expense to the owner. Once the complementary relationship of nutrient exchange was announced to the public as involving the three trophic levels of producers, consumers, and decomposers, aquaria became very popular for their aesthetic and instructional appeal (Beyers and Odum 179). The microcosm's intrinsic value lay in its analogical power: what it revealed in miniature could often be extrapolated to nature's grandest scales, which lie on higher levels of organization and complexity. Warington's success with aquaria remained largely with the hobbyists, and microcosm techniques were not adopted into the sciences until later. Microcosm biographer Howard Odum writes: "With the exception of a few scientists such as Warington, microcosmic theory in the 1800s was the realm of the philosophers. However, in the first part of the twentieth century, the history of microcosmic thought shifted from philosophy to science, mainly biological science" (181). In the first chapter I described how small systems in nature like islands and gardens became informal microcosm studies, especially for colonial naturalists.

[85] Another microcosm vogue of the Victorian age is the Crystal Palace at the Great Exhibition of 1851, the great glass and iron construction that was celebrated as housing the botanical and artistic spoils of the globe under a single roof.

The microcosm was not to become a formal scientific tool until it was adopted by Stephen Forbes, an American naturalist who was an innovator of experimental ecology in the late nineteenth-century. Forbes fought for the Union for the duration of the Civil War, and was a mainly self-taught naturalist who focused on plains species, especially insects, and fish mortality in lakes (his site was Lake Mendota in Wisconsin). He accepted a position at the University of Illinois in 1885. His work serves as a fulcrum that shifts our attention from literary precursors to scientific inheritors of microcosmic thinking, so I will return to it now. Often read as an originary study in ecological survey courses, Forbes's "The Lake as a Microcosm" (1887) steps between the rich conceptual ground of the microcosm and the literal, cataloguing, and reductive strategies of a nineteenth-century naturalist's inventory. Like Keats's odes, which rely on an engaged theory of imagination for their circumscription, Forbes requires his readers to engage their imaginations in order to conceptualize the laucustrine ecosystem set apart from the larger natural world. Forbes's literary instincts are enlivened by his figure of study; he finds that the small lake occupies a liminal sphere in relation to time, space, and autonomy. This scientific paper is not a dull catalogue of species composition and physical parameters:

> One finds in a single body of water a far more complete and independent equilibrium of organic life and activity than on any equal body of land. It is an islet of older, lower life in the midst of the higher more recent life of the surrounding region. It forms a little world within itself, -- a microcosm within which all the elemental forces are at work and the play of life goes on in full, but on so small a scale as to bring it easily within the mental grasp. (77)

A microcosmic system, Forbes claims, creates a small window into the wilderness that the human eyes can peek through. Though atavistic, the life-forms within the

lake are also denizens of a modern age; though set behind the water's edge, they exchange nutrients and chemicals with the shore; though they are isolated in the "play of life," they are vulnerable to changes on land. Forbes was one of the vanguard of American limnologists who discovered that lakes can be more vulnerable to landscape alteration than adjacent plots of land, and that they can be hotspots of chemical concentration that become indicator systems for the effects of anthropogenic pollution. Therefore the microcosm strategy can demonstrate both the self-sufficient stasis of a semi-closed system and the wild disequilibria that can shift a laucustrine ecosystem into an unrecognizable new order, or alternative state. In this way lake microcosms are similar to island microcosms. In Forbes's crucial early vision, though, the lake is an idealized microcosm of life simplified, down-sized, and recalcitrant to evolutionary change; these virtues of easy intelligibility earn it a place at the table of the new ecology.

For his audience to understand the experimental conceit of a microcosm, Forbes asks that they read his words and attempt to form a "mental picture" of his holistic descriptions; the series becomes an extended ekphrasis on the artistic scenes of life under water. As a descriptive supplier, Forbes aims to "furnish you the materials for a picture of life that swims, and creeps, and crawls and burrows and climbs through the water, in and on the bottom and among the feathery water plants with which large areas of these lakes are filled" (79-80); however, the scientist does not deign to force order on the elements of nature that he supplies to his readers, his lyrical description is meant merely as a "background or setting of the picture of laucustrine life which I have undertaken to give to you" (81). Nature's hierarchical

holism, the scheme of ecological order, necessarily comes through each individual imagination rather than finding obvious demonstration through the eyes of a strictly rational viewer. He writes, "I will next endeavor – not to paint in the picture – for that I have not the artistic skill – but I will confine myself to the humbler and safer task of supplying you the pigments, leaving it to your own constructive imaginations to put them on the canvas" (81). What follows is a passage akin to the boat scene in Shelley's "Ode to the West Wind," except that the language is inlaid with scientific nouns:

> When one sees acres of the shallower water black with water-fowl, and so clogged with weeds that a boat can scarcely be pushed through the mass; when, lifting a handful of the latter he finds them covered with shells and alive with small crustaceans; and then, dragging a towing net for a few minutes, finds it lined with myriads of diatoms and other microscopic Algae, and with multitudes of Entomostraca, he is likely to infer that these waters are everywhere swarming with life, from top to bottom, and shore to shore. (81)

Though ecological systems largely exist on a middle scale, the same scale as humans and therefore directly accessible to our senses (unlike DNA and black holes), we are nonetheless left to inferences and hypotheses, borne on imagination, that permit us to gain access to the parameters and dynamic relationships that make the scene a *Concordia discors*, a scheme of order amid the chaos.

Since the circumference of our attention is limited to this small lake and its complement of species, scientific order has a better chance of emerging from the bewildering heterogeneity of life. Forbes is able to use his laucustrine microcosm to support the tenets of two crucial contemporary theories that were the great advances in nineteenth-century biology: biological mutualism and evolution by natural selection. Ecology is a science recalcitrant to laws, as a long century of normal

scientific investigation has demonstrated, but these two oft-inverse doctrines bring us a long way towards explaining the phenotype of any ecological system. Forbes explains,

> Two ideas are thus seen to be sufficient to explain the order evolved from this seeming chaos; the first that of a general community of interests among all classes of organic beings, and the second that of the beneficent power of natural selection which compels such adjustments of the rates of destruction and of multiplication of the various species as shall best promote this common interest. (87)

Very much impressed by the aesthetic of balance that seems inviolable when nature is left to her own devices, Forbes's order is akin to a climax community that has reached its final stage of maturity and remains in a virtually static state unless disturbed by untoward forces. The aesthetics of economy and balance in nature are seen by some modern ecologists as quaint ideas derived from Enlightenment economics, and there is no doubt that Forbes has a slightly antiquated view of ecological organization, by contemporary standards. But those of us born in the late twentieth-century have had very little experience of any ecosystem that has not been disturbed by human activities, both primary (clear-cutting of forests, dredging of lakes) and secondary (introduction of invasive species, boundary effects). Perhaps a Midwestern lake in the nineteenth-century carried its own sense of austerity and maturity because it really was virtually unaffected by humans (Thoreau's Walden pond was, by comparison, an accessible suburban lake that nevertheless inspired the long celebrated narrative of 'man meets wild and survives without conquering'). For the early ecologist, some initial precepts were essential for teasing cause and relationship from the overabundance of nature-at-large. Forbes's microcosm paper was a blockbuster when it was published and is still relevant for several reasons: it reinforces the ecosystem

concept that Darwin introduced as complex and essential relations of animals and plants in The Origin of Species; it supports Darwinian evolutionary theory as a game both of vicious competition and of synergetic fostering; it simplifies the cornucopia of all nature down to a single empirical object that can be approached as a whole through scientific methodology.

Forbes concludes his study with an overtly Darwinian passage reminiscent of the entangled bank trope, which excited the imaginations of so many thinkers who were not thrown into despair by the implications of 'survival of the fittest':

> In a system where life is the universal good, but the destruction of life well nigh universal occupation, an order has spontaneously risen which constantly tends to maintain life at the highest limit, -- a limit far higher, in fact, with respect to both quality and quantity, than would be possible in the absence of this destructive conflict. Is there not, in this reflection, solid ground for a belief in the final beneficence of the laws of organic nature? (87)

These laws, Forbes trusts, extend to the concerns of humans as a social, cooperative species, but the paradox between destruction and evolutionary change remains indissoluble at the heart of biology. Where "order has spontaneously arisen," we are compelled to believe that the chaos of daily "destruction of life" is a beneficent force in the long run, that elemental chaos leads to some hierarchical order, and that the microcosm is a ready way to shed light on this insight. Forbes's legacy influenced the experimental strategies of ecologists through the twentieth-century, and as the science became more formalized with an increasing number of crises to understand and redress, microcosm experiments came to the fore as an effective technique for down-scaling, simplifying, and accelerating ecosystem dynamics.

Though Forbes's scientific microcosm, like the microcosm images offered by nineteenth-century poets, takes place outside, *in situ*, microcosms were quickly

brought indoors. In a laboratory setting they are more controllable, more artificial systems that attempt to model the dynamics of real ecosystems. Ecologists often adopt microcosms as pet projects, and grow fond of their constructions as super-organisms of their own right. As an example I quote a college-level text entitled Ecological Microcosms (1993), used as an instruction manual for constructing and maintaining (mainly aquatic) microcosms that can be manipulated along myriad variables according to the experimenter's particular interest:

> The variety of intricate, small, experimental worlds constructed by various investigators rivals that of nature developed without human hands…we hope our readers can share our love of little systems, their mystery, their creativity, their domesticity, their immortality, and the guidance they provide for the larger realms. As living models, microcosms help bridge the details of reality with the abstractions of general systems, revealing the principles of the way all systems work. (Beyers and Odum vii-viii)

The enthusiasm of this passage, which touts microcosmic "immortality" and paints the microcosmologist as a minor god manipulating her own worlds, points to both the strengths and the hazards of lab-based microcosm experiments. Simplicity and intelligibility are highly valued virtues in the tortuous paths of ecological science, and remote, contained experimentation is much less invasive than direct environmental manipulation, which can result in spreading chemicals, dredging, and over-sampling. James Drake (1996) argues that laboratory microcosms, despite their simplicity, afford the clearest possible perspective on bedrock questions in biology, such as Forbes's concern with the nature of the chaotic forces that direct evolutionary patterns:

> How much of the pattern of nature is the result of stochasticity and simple environmental filtering, and how much is the result of chaotic dynamics, assembly mechanics, and self-organization? This question is fundamental to all aspects of biology, and clearly the first analytical approach must be

> conducted in the laboratory where tight control is possible…The utility and power of microcosm analyses to provide insight into ecological systems is limited only by imagination and creativity. We can think of no questions, from the most applied to the most abstract, to which microcosm analyses cannot be turned and insight gained. The potential for more microcosm studies has steadily increased as new questions concerning biological invasions and introductions, species richness and productivity, global climate change, release of genetically engineered organisms, species extinctions, and other problems facing ecologists are addressed…Theory suggests rich dynamics at the cusp of chaos and anti-chaos, dynamics that are best explored initially under the highly controlled conditions of the laboratory…We stress that these systems are but models of the real world and are designed to address specific questions. (675)

Perhaps it is the potential specificity, and not the potential universality, that now makes microcosmology a powerful strategy in ecology, but that perspective frustrates the original microcosmic ambition to apply a representative case to explain the workings of the ineffable macrocosm, supposing there is such a global unified construct.

Still, the transition from abstract theory (such as chaos) to specific material demonstration is enabled by the strict control of the artificial environment. Drake's words contribute the notion that ecological experiments begin with a spark of imagination, and microcosms are often the smoothest way of transferring the spark to ready kindling, and thereby eventually to set a controlled blaze. Sharon Lawler's sampling of important microcosm experiments in the second half of the twentieth-century shows how broadly microcosm experiments can be applied to test ecological theories, including predator-prey dynamics, succession, and alternative community states (236). E. O. Wilson's theory of island biogeography (with Robert MacArthur) was emerged from an island microcosm experiment in the Florida Keys that tested

colonization and succession dynamics from zero (the experimenters fumigated the mangrove island to ensure they were starting with a dead zone) (Simberloff 1969).

Microcosms have become the major empirical tool for the sub-disciplines of ecotoxicology, soil biology, genetic engineering, and systems biology, and Lawler's quote with which I opened this chapter suggests that microcosms are the best material method for testing chaos theory in ecological systems (237, 248). These claims have major implications for scientific theories of natural states. Microcosms are our keystone for constructing a temporal theory of nature, and for understanding whether natural systems are best represented as coherent, balanced, autonomous, and organized or, as more recent ideas propose, erratic, patchy, contingent, and chaotic. As controlled and domesticated systems, microcosms provide an alternative to the statistical sampling of species composition in natural environments, another mainstay of experimental ecology.

Critics of modern microcosmology comment that the practice is an artificially hygienic, and therefore misleading, approach to a naturally muddy set of inquiries. Limnologist Stephen Carpenter (1996) worries about the demise of a practical education in nature-based ecology:

> Who will train the ecologists needed for field science? It is irresponsible for academic ecology to produce larval microcosmologists by canalizing graduate students into careers of small-scale experimentation. There is cognitive danger that the microcosm (rather than the ecological system) will become the object of study, leading to needless confusion as results are over interpreted and over extended. As ecology becomes more and more a science done indoors by urbanites, there is significant risk of losing our sense of context. (679)

Working in the older tradition of Stephen Forbes, who found his microcosm in the natural world, Carpenter's concern is well-founded because it reminds us that the

isolated experiment can itself become so compelling as to obstruct the relationship between model and target system. Ecologists can become so involved in getting the model correct (often a very delicate juggle of elements and energies) that the actual ecological system in peril continually degrades within its vulnerable state; the mechanical songbird by default replaces the abolished natural species.

To consider an analogy in literature, the Romantic movement circled its energy for organicism around a newfound valuation of holistic nature, and the poet was drawn outside to find representative subjects within the true context. These poets were reacting to their perception of an overly artificial set of subjects (and prosody) borne on eighteenth-century Enlightenment science, which prized reductionist laboratory empiricism as the unique new knowledge. Carpenter, it might be said, is concerned that the Ode is a fast-fading violet covered up in leaves; students of ecology are only learning techniques of the laboratory by harnessing heroic couplets together. Carpenter's implicit aversion to "urbanite ecology" reminds us that the roots of the science grew, by necessity, out of sinewy, mucky empirical enterprise. By keeping attention on actual nature, rather than proxies of natural systems or samples removed from their natural context, Carpenter is revisiting the protests of John Clare, who defines "taste" in scientific practice as inherently contextual:

> But take these several beings from their homes,
> Each beauteous thing a withered thought becomes,
> Association fades and like a dream
> They are but shadows of the things they seem;
> Torn from their homes and happiness they stand
> The poor dull captives of a foreign land. (*Shadows of Taste*, ll. 147-152)

For better or worse, from the time of Forbes scientific microcosms have often moved indoors to take advantage of highly controlled conditions. In the last three decades,

microcosms and modeling techniques in all the sciences have moved from the laboratory into the *virtual* world, yet a further level of abstraction that affords exponentially higher levels of variation and manipulation. Computer models of global climatology attempt to approximate the actual complexity of the system they model. These techniques are particularly valuable in the sciences that are nearly impossible to domesticate, such as climatology, which in some cases entertains millions of variables in its predictive analyses. Climate change science is heavily invested in the viability of computer modeling, which uses the data provided by worldwide statistical sampling. The various groups that design and maintain computer climate models demonstrate, by their frequent points of disagreement, how many strategies could potentially result in an accurate model of the Earth's emergent fate over the next few hundred years.

Computer-based global climate models (GCMs) hardly need avatars to argue for their necessity, for when it comes to predicting climate change for centuries to come, they are the only card we have to play. These models are distinct from classic microcosms because they provide predictions of the future course of the whole globe, and they do not use a representative micro-system to do so. However, the notion that we can contain and manipulate all the pertinent variables within a single model might be seen as a new species of virtual microcosm. Another microcosmic feature of GCMs is that their data points, taken from experimental stations that sample relatively small areas, are extrapolated onto global dynamics. GCMs are scrutinized by intellectual skeptics whose concerns are based in the hazards of solipsism. The model run by the computer is itself so complex and compelling to its creators that

reality in any physical sense vanishes behind the daily need to tinker and perfect the simulacrum. This is Stephen Carpenter's argument from the discipline of experimental ecology. The virtue of computer models including GCMs is also a hazard: their complexity helps in the prediction of global outcomes, but the way they arrived at these outcomes is only comprehensible by a small cohort of experts, often only the model-builders. By aiming to preserve natural complexity, GCMs can be as difficult to understand as the global system they emulate (Dodson 19). Environmental philosopher Lucien Boia (2005) assigns heavy responsibility for the spread of "the most alarmist scenarios" to our dependence on models, which easily conflate existing reality with the virtual predictions that come out of these extreme, parameter-driven systems. But with proper caution, he allows for their necessity, as "reality is too vast, too complex and chaotic to approach directly…They are extremely useful as long as we remember that they are not the real thing: they are methodological fictions" (177).

Of course, we have little way of empirically, physically, demonstrating the superiority of one model over another because the essence of prediction is to prognosticate, and then to wait and see. Part of the computer modeling controversy is philosophical, as Amy Dalmedico (2007) has pointed out: "Modeling practices, always pulled between abstraction and application, now found themselves subjected to another set of contradictory forces: should they be first and foremost predictive and operational, or cognitive and explanatory?" (126). Ideally a model that is explanatory (or able to accurately recapitulate earth's climate for the last several millennia) would serve as a precursor to a model that is predictive (able to suggest one or several future

scenarios according to the manipulation of variables). But then the model must traverse the shadowy chasms of emergent effects, tipping points, and similar chaotic behavior; few experts believe that climate change is a linear phenomenon and much consternation surrounds the potentially virulent tempo of glacial melting, the oceans turning from carbon sinks to carbon flows, increasing industrial emission, and collapsing ecosystems. To elucidate these alarming potentials, global warming scientists turn to mathematical models of chaos.

Philosopher of science Mary S. Morgan (2007) cites the epistemological doubt that plagues the practice of virtual modeling because the "medium of representation found in mathematical models differs so much from the real geological or weather events they are taken to represent…Even for believers, the inference power of experiments with such [virtual] representations is necessarily weaker compared to those from experiments with representative whole-life models" (270). As we have seen, microcosm science has evolved over 150 years from nature-based, sampled systems to lab-based, representative systems, and finally to computer-based, virtual systems that are the farthest removed from physical nature, but may well be the best equipped to simulate natural complexity on a global scale. Morgan has recently developed her ideas about a science that is not dependent on laws, but that uses representative cases, model systems, and exemplary narratives to move inquiry forward. The latter strategy, an exemplary narrative that "converts our experiments in life into experiences" involves narratives that "are taken to say something about a wider set of particular cases or situations than the ones from which they grew. This

wider relevance indicates how such objects gain the autonomy to function more broadly as instruments of inquiry" (269, 273).

As a complement to any type of ecological modeling, I would like to consider the potential of narrative in ecology. This discussion rejoins chapter two's attention to chaotic narratives in environmental novels of the nineteenth-century, and extends its implications by bringing narrative theory into twenty-first century ecological science.

III: Science Non-Fiction

What role might narrative play in ecological theories of a chaotic anthropogenic environment of the twenty-first century? It is somewhat surprising that narrative has been so little acknowledged in scientific ecological understanding. Narrative in literary studies is an enormous field of inquiry, and its most basic tenets question how meaning is created by telling stories. Reflective, intentional, and constructionist theories of narrative each suggest different roles that narrative can play in relation to truth, from pure relation (reflective), to authorial designation (intentional), to the very creation (or construction) of meaning from a meaningless world (Cobley 2005, citing Stuart Hall). The telling of tales is fundamental to our cognitive development, effectively weaving a series of discreet events into the coherent articulation of individual experience that constitutes self-identity, acculturation, and identification with nature, or a particular home place. Perhaps ecology's fascination with modeling the system, set in three dimensions of space, has abbreviated its attention to the spatial dimensions set in time, or narrative. But other mainstays of ecological science, such as evolutionary theory and succession from a simple to a climax community, counter the a-temporal, static bias of systemic thinking. Darwin's evolution by natural selection is biology's best example of an attempt at a purely reflective narrative of species in nature through time.

Gillian Beer's literary study of Darwin complicates his reflections by theorizing how science is imagined, or constructed, out of particular cultural contexts. As outlined in chapter one, Darwin's ideas of evolution depended on a slow, constant tempo of natural selection working on variant forms, and this progressive gradualism

may well have been a construct of mid-nineteenth-century British narratives of purpose. This study has questioned gradualist norms by examining nineteenth-century fictional narratives of environmental chaos based on natural disasters. Often narrative is an embedded engine that lurks beneath accounts of natural history written by scientists more interested in facts than in stories, which can frightfully be likened to myth-status. Peter Bowler discusses the tension in evolutionary science surrounding narratives of human phylogeny that "resemble folktales or creation myths, a suggestion which horrified modern paleo-anthropologists who thought that it implied that they too were still only 'telling stories.' In fact, all explanations of particular events in phylogeny which invoke adaptation have a narrative structure (often called an adaptive scenario)" (2003: 282). Whether these narratives are purely reflective of an external truth, or constructs of particular authorial egos or cultural conditions is, of course, an ongoing source of debate.

I would like to consider the facts of evolutionary history as narrated by H.G. Wells, a man very aware of the rhetorical power of a story, but still dedicated to establishing a correct narrative of evolutionary patterns within a scientific discourse. Wells is one of the few thinkers who straddled science and literature well into the twentieth-century, and his book The Science of Life (1929)[86] seeks to narrativize modern understandings of the life sciences without depending on fictional scenarios to illustrate them. Wells's scientific account of evolutionary history weaves together the facts of evolution with threads of modernist ideology, which makes his work a

[86] The book is written with co-authors Julian Huxley (grandson of Thomas Huxley and brother of Aldous Huxley) and H.G.'s own son, G.P. Wells. Huxley, who is celebrated as one of the architects of the modern synthesis in Biology, helped to lend this encyclopedic book validity within scientific spheres.

scientific narrative rather than simply a description of observed processes in nature. Where the Victorians were enamored with coherence and increasing complexity, we see how Wells's twentieth-century science narrative comes to deny anything resembling teleology or "purpose" in evolution:

> Variation is at random; selection sifts and guides it, as nearly as possible into the direction prescribed by the particular conditions of environment. Once we realize this, we must give up any idea that evolution is purposeful. It is full of apparent purpose; but this is apparent only, it is not real purpose. It is the result of purposeless and random variation sifted by purposeless and automatic selection. The term purpose has a very definite meaning. It is a psychological term, describing a certain familiar state of our own consciousness: it implies the prevision of an end, and a determination to reach that end. (641)

Though purpose is useful in helping us conceptualize how comparative order has arisen from comparative disorder through evolutionary time, Wells *et al.* here banish purpose from explanations of physiological change, and assign it to our brains as a particular perspective. Further, they do not deny the overwhelming task of conceptualizing this "drama" or the very small and recent part we have been given on the ecological stage:

> Evolution is the sum of a swarm of processes, now independent now mutually interfering. The plot of the drama is not a single thread but a tangled skein of hundreds of threads of which our own is only one. (786)

They chastise the antiquated view of purely-gradualist evolution by gesturing to the mass-extinction events that Gould and Eldredge would use in the 1970s to make the case for evolution by punctuated equilibrium. In the story of the Cretaceous extinctions sixty-five million years ago, which put an end to dinosaur rule,

> the pressure of environment on life, *a pressure quite external and fortuitous*, makes itself felt. The great climactic revolution that killed off the dominant reptiles opened the door of opportunity to the mammals: their warm blood enabled them to withstand the cold, their very smallness and insignificance

> was now a help when climate cut down the world's vegetable supply…finally climate comes in again to extinguish many of the strange and exciting creatures which the same blind agency, by removing their competitors, earlier started on their evolutionary career. Change of climate may cause extinction directly, as it did with so many of the larger herbavores during the Ice Age, or indirectly…Looked at thus, *Evolution would seem to be a chaotic affair,* its changes dictated by one accident after another, each one the outcome of the chance advantage of the geological moment. (My italics, 788-789)

By making these bold and unflinching statements of historical relativity, Wells *et al.* begin the important work of introducing chaos to scientific natural history of the twentieth-century. Passages like these are baldly opposed to designed, balanced, economical aesthetics of previous centuries, and the authors take care to explain how our cognitive processes would have given us such former illusions in the guise of indomitable truths. Though Wells is attempting an objective description of biological processes, he is indebted to narrative devices of order and causation in this history of evolution, even when that order arises from fortuitous and chaotic events. Wells's The Time Machine, which tells the narrative of divergence of Eloi and Morlocks within industrial society, relates to his twentieth-century fact-driven narrative of evolutionary tempo. Historical contingency is the basis for major trends in evolution, as illustrated in the working classes in factories evolving into spidery Morlocks as well as the ancestral mammals rising and radiating into a wealth of niches newly opened by the end-Cretaceous catastrophe. It must merely be imagined for it to be possible, and once it is possible, scientific evidence accumulates to verify or nullify.

Ecological historian Donald Worster (1994) emphasizes the paradigm shift in ecology that has taken place within the last few decades, after the science of chaos had been established in the 1960s using computer-based mathematical models. Ecologists began to look with experimental scrutiny on the classic concepts of

succession, climax, and equilibrium advanced especially by Fredric Clements and Eugene Odum, and these later scientists found a very different dynamic operating in nature (9). Replacing the older aesthetic of the mature climax ecosystem that is reached when undisturbed was a vision of a continually-shifting mosaic of species and communities that never reaches a point of stability because disturbances (small and large) are always occurring. In the words of Drury and Nisbet (1973), succession was merely the observation of "differential growth, differential survival, and perhaps differential dispersal of species adapted to grow at different points on stress gradients" (quoted in Worster 1994: 9). This conceptual shift permitted the discovery of ecological chaos, wherein nature is seen as inherently erratic, contingent, and very difficult to model for predictive purposes. If success in science is the ability to predict outcomes, chaos is a fundamental rift in the road of ecological modeling that has driven many ecologists inside, into computer-based virtual spheres where such complex behavior is somewhat more approachable (13). Chaos in population dynamics can also be modeled using physical microcosms, as noted above. This revolution in thinking about nature, Worster contends, rivals the conceptual revolutions of quantum mechanics and relativity that marked the beginning of the twentieth-century, and it signals a further break from the Newtonian worldview (14). It also reminds us of the central importance of environmental disturbances in subsequent ecological communities, disturbances that are constant and myriad: variations in wind and rain patterns, storms, tornadoes, earthquakes, volcanoes, climate change. These kinds of major environmental disturbance drove the dynamics of the chaotic narratives I surveyed in chapter two, and show how a narrative

interpretation of geological catastrophism in the nineteenth-century was prescient of concepts that ecology is now citing as fundamental.

Environmental history is a useful resource for understanding how stories about nature contribute to our comprehension of nature's processes, and how narrative plays a shadow role behind reductionism and systems modeling in explaining ecological dynamics. Environmental historians often make use of literary theory to explain how their work affects the public's vision of particular places in nature, and especially how humans have used these places both at particular points in time and over wide sweeps of human history.

William Cronon is prominent among environmental historians who use a foundation of narrative theory to inform their work. Known for his carefully detailed, yet philosophical environmental histories of the Midwestern United States during industrialization, Cronon's work sits at the crux between objective history and polemical treatise. He is familiar with the post-modern critiques of false coherence and embedded value systems in the narratives that form the foundations of human cultures, but he notes that narratives (unlike chronicles that impose no relationship between events) have the power of making an audience care about the landscape or ecosystem at the center of concern. He argues for the efficacy of the motivational power in responsible narrative:

> Despite the tensions that inevitably exist between nature and our narrative discourse, we cannot help but embrace storytelling if we hope to persuade readers of the importance of our subject…Narrative is thus inescapably bound to the very names we give the world. Rather than evade it – which is in any event impossible – we must learn to use it consciously, responsibly, self-critically. To try to escape the value judgments that accompany storytelling is to miss the point of history itself, for the stories we tell, like the questions we ask, are all finally about value. (1992: 1375-6)

Though a skeptic might comment that "value" here is most often imposed by the hegemonic cultural forces in charge of telling heroic stories, value systems are most often overt in environmental narratives and recent histories work hard to critique the hegemony of industry and capital that has come to command many of the nature's landscapes during the nineteenth and twentieth-centuries. Cronon notes that the same set of events can yield several stories that are utterly at odds when it comes to a sense of value, and his words echo literary theories of comedy and tragedy:

> Stories are intrinsically teleological forms, in which an event is explained by the prior events or causes that lead up to it…if the tale is of progress, then the closing landscape is a garden; if the tale is of crisis and decline, the closing landscape (whether located in the past or future) is a wasteland…A trackless waste must become a grassland civilization. Or: a fragile ecosystem must become a Dust Bowl…However serious the epistemological problems it creates, this commitment to teleology and narrative gives environmental history – all history – its moral center. (1370)

Compelling narratives with a critical eye on the values of the culture from which they've emerged, such as the narrative that renders the Dust Bowl event a tragedy of human hubris, can cause serious problems for the *status quo* that directs industrial or agrarian operations within a particular ecosystem. Narrative, so closely tied to our cognitive process of learning, has a unique facility of changing opinions when it comes to our relations with the natural world. The morality that seems inherent to narrative (with apologies to Oscar Wilde) is particularly powerful in environmental stories because it continually relates human activity to observed changes in nature.

Environmental history, at least, has its conventions and methods established by the long legacy of historical theory. But ecological science, which usually studies systems heavily altered by human activity, has the difficult task of remaining

objectively scientific while keeping an open eye for impacts and effects that are degrading to the environment and therefore fraught with values. Should value be left with the environmentalists, and ecology remain austere by keeping its attention on mechanism rather than narrative? Ecological science, many would argue, is not even intelligible without the services of causal narrative, and so value (translated into legislation) may be an inescapable outcome of scientific studies set in impacted ecosystems. It follows that the funding sources of ecological studies must be taken into account; the EPA, Fish and Wildlife Service, and other governmental groups whose role is to monitor and legislate anthropogenic activity must consider both industry-based and third-party impact assessments (which often contribute very different kinds of narratives based on the same study) before making decisions about, for example, the effects of agricultural chemicals on surrounding environments. Ecology's moral problem is whether or not to engage in morality. Nuclear science could be said to have had a similar debate in the middle of last century; what distinguishes ecology's moral bind is that its subject encompasses every niche that life has filled, yet its directives are so often guided by financial imperatives inimical to the inherent valuation of life for its own sake, a biocentric ethic.

The proleptic narrative of a changing environment has become a new genre in science writing, and it aspires towards the realm of non-fiction. The stories about possible futures that make climate change models intelligible are based on scientific details that are our closest prognoses. Chaos, of course, complicates these scenarios. Turning the predictive powers of models into narratives that envision the future is essential to seizing widespread public attention and changing policy. A computer

model might predict that sea levels will rise by one meter in the next century, but that prediction only gains power when a narrative draws out its consequences: coastal cities engulfed, arable land lost, more virulent hurricanes, the spread of disease, and so on. Alan Weisman's The World Without Us (2007) accommodates the predictions of many scientific disciplines into a coherent, wide-ranging story of what would take place on Earth if humans disappeared. Weisman's vision includes the fate of different types of buildings, nuclear power plants, farmland, synthetic compounds, species biodiversity, and landmarks such as Mount Rushmore (which is carved out of stoic granite that would remain recognizable for 7.2 million years) (182). These narratives are more than scientifically-detailed versions of 'past is prologue,' because they attempt to conceive of the unprecedented. But evidence of past upheaval is still our best method for futurizing non-fiction narrative, and climate scientists look to the evidence of major landscape shifts and mass extinctions that define past geological epochs in order to figure on the next few centuries.

The novels explored in chapter two of this study take a narrative approach to describing ecosystems in chaos, and that perspective allows them to juxtapose levels of impact across scale and time. Gilbert White's narrative, for example, achieves a decades-long perspective of environmental change through the accretion of quotidian impressions and deductions; each anecdote he carefully relates (such as the mother bird killed by the felling of her home oak tree) comes into a relationship with higher-order events (such as increasing deforestation in Selbourne through the eighteenth-century); similarly, patterns of constancy (the return of migratory birds at very specific intervals) find context only in relation to violations of those consistencies

(the birds' absence, as well as extraordinary weather events that might explain anomalous behavior in a particular year). The fictional novels studied in chapter two effectively involve the reader in radical environmental fluxes using the intermediary of a charismatic protagonist. The narrative strategies in these novels allow the wild manipulation of time (particularly in Shelley and Wells) and vivid accounts of the transformation of ecological place (in all three). Without narrative as the organizing, causational, and momentum-generating device, Gilbert White would only have compiled anecdotal lists of seasonal birds, Lionel Verney's epidemiological observations would lose their relationship to human extinction, Felix Aquilas's post-apocalypse fauna would be a merely fictional catalogue of taxonomic data, and the Time Traveler would have no deep evolutionary future to articulate. The manipulation of conventional linear narrative into its fragmenting, pogo-stick condition in each of these works effectively conveys the many-leveled, interrelated, and yet chance-driven condition of the natural world, and particularly the ecologies of an anthropogenic future.

Science writers and environmental historians are well aware that narrative is essential to widespread intelligibility, and much of their work involves accumulating individual studies or events and stringing them together with some believable sense of causation. The general public generally does not listen to ecological information until it appears in narrative form: Rachel Carson seized the public's attention with a narrative about the effects of industrial chemicals on watersheds in Silent Spring (1962); James Lovelock took an idea constructed around analogy and modeling and emerged with a sensational narrative starring Gaia; Alan Weisman wove together

many threads of scientific theoretical eschatology to produce a bracing vision of the post-human globe in The World Without Us (2007). With the components of mechanism and model arranged linearly and hierarchically by the device of narrative, ecological science may be able to move fully into the public notice where it is most able to provide important answers and directives.

There is a sub-culture of ecologists who aspire to narrative as part of the real work of their science. Because this practice is avidly interdisciplinary, extending well beyond the sciences to embrace the humanities, its practice is at the margins of scientific ecology and articles on the subject are few, and recent. Part of the drive to bring narrative into the practice of scientific ecology emerges from the desire to make the scientific work accessible and intelligible to a wider audience. If ecological studies are wedged between the pages of disciplinary journals, they are unlikely to have an effect on the populace unless the study is picked up by a science writer who employs narrative to translate the case into a general discursive condition or trend. Only with the final step of the story told can a sense of value emerge from a scientific study. These radical ecologists (I mean in the epistemological sense) contend that narrative can resolve inconsistencies in scientific modeling and provide intelligible protocols for further investigation and action:

> The power of science comes from the capacity of its narratives to convince us that something is general, and we should agree on it. And this agreement arises even when the story is quite long and encompasses inconsistencies. Furthermore, we seem to be able to agree even when there is no logical necessity in the outcome. We agree on evolution and global warming, even when many of the detailed models are at odds with each other…the story of anthropogenic global warming just feels right, and the science of it is confident…The power of narratives, as with the power of myths, is their capacity to rise above contradiction, when the juxtaposition of large disparate issues is given meaning. (Zellmer *et al.*, 2006: 179-180)

Zellmer's characterization of narrative in ecology proposes that scientists create many conflicting models to explain natural systems, but that a kind of uber-narrative of overall processes (species evolve; the climate is changing because of industrial emissions) might serve as a point of resolution and unanimity. It may not even matter whether the meaning that is created by narrative is reflective of external truth or merely constructs a façade of truthfulness; a simple consensus about meaning promotes changes in practice. Literary scholars with an interest in the twenty-first century environment should find themselves fully equipped to instill ecological principles, controversies, and eventualities in their students in a way that complements the work of their colleagues in the sciences. Ecology is not merely a set of empirical strategies continuous with physics, chemistry, and biology; it now finds that it must form theories accounting for unprecedented events. Narrative is essential to the practice of prediction in addition to being the vehicle of calls to action; it is capable of bearing the weight of predicting outcomes and instilling values to an inclusive audience. Mathematical chaos is an abstraction that is impossible to narrate, but ecological models of chaos in nature rely on narrative to find a voice. The chaotic narrative of outcomes in anthropogenic nature meanders, branches, joins, and, we all hope, does not drop off the edge around the next turn.

But nature is fraught with edges. Most organisms make their niche in liminal spaces where elemental exchange is maximized, such as at the edges of bodies of water (rather than in the open ocean), and in terrestrial ecosystems. This reliance on interfaces demonstrates how the minimum requirements for life, water and an energy source, are clustered in specific places on the globe and their desirability heightens

interspecific competition and allows evolution.[87] Eugene and Howard Odum, two prominent microcosm ecologists of the twentieth-century, took their study of the ultra-liminal estuary ecosystem into the theoretical realm by including chaos theory in the dynamics of general complexity. With the new suggestion of "pulsing" as a fundamental pattern, the Odums critique the conservationist ethos with the suggestion that random variations are endemic to the behavior of any complex system. The Odums's pulsing paradigm (1995) welcomes chaotic narrative into the mainstream of ecological understanding:

> One of our comfortable concepts of nature visualizes growth followed by a leveling. In these days when society is beginning to recognize the limits of the biosphere, people, scientists, and governments talk of sustainability, that is, managing growth so that the life-support carrying capacity of the earth is not exceeded. The steady state is seen as a goal for such efforts as well as the final result of self-organization in nature. However, there may be a more realistic concept, that nature pulses even after carrying capacity or saturation limits are reached – a new paradigm we define and present examples of in this paper…We suggest that if pulsing is general, then what is sustainable in ecosystems, is a repeating oscillation that is often poised on the edge of chaos. (547)

This influential paper dating from 1995 sent legions of ecologists to look for the pulsing phenomenon elsewhere, and chaotic ecology buoyed these efforts to understand the nuanced relationship between stability and disorder in nature through time. Carolyn Merchant's recent history of environmentalism (2007) includes chaotic ecology as one of only four fundamental approaches to the science (the others are human, organismic [population], and economic [systems]); again, we are given the

[87] G.E. Hutchinson has a brief but enlightening discussion of the phenomenon of liminal preference: "The two conditions of liquid and an energy source are presumably fundamental. It is almost impossible to imaging anything like an organism developing as a pattern in gaseous mixture, and though an adult completely solid-state organism might be thought of, it is difficult to conceive how it could develop. It is also important to note that although organisms can live in the free liquid phase of lakes and oceans, most species prefer an environment of interfaces; this may well have been a primitive preference." (3)

impression that 'balance' in nature is really only a temporary state of poise before rapid reorganization changes the system. She writes,

> The chaotic model of nature allows for the full expression of nature as an actor and shaper of history, rather than a passable backdrop to the inorganic machine. Unpredictable natural events and climatic conditions can trigger changes and transitions in local places, the impacts of which may be felt at great distances. (2007: 116)

Following the lead of the Odums, Merchant's humanistic perspective on the patterns of ecology imposes a narrative of complexity that complicates classic environmentalism:

> …recent work in complexity theory characterizes a complex system as one that exists on the edge between order and chaos…Whereas an ethic based on the balance of nature grants humans the capacity and power to restore degraded systems, chaos and complexity theory challenge humanity to recognize nature as both predictable and unpredictable, orderly and disorderly. (190)

Though this paradigm of universal indeterminacy could have a handcuffing effect on such an important science in the twenty-first century, complexity, the science of order versus chaos, provides an intriguing new avenue towards elucidating nature that goes well beyond classic reductionism. Though ecological science built its foundation on the traditional scientific epistemology of simplifying complex systems down to their components, studying parts of the system in isolation, and manipulating simplified models, the new emphasis rests with narrating the flux among natural forces in their play of perpetual dynamism. Narrative has greater respect for holism than does the mechanist or systems approach, and it is usually more supportive of an imaginative approach to science. Donald Worster celebrates the recuperation of mythology in chaotic ecology:

> If the ultimate test of any body of scientific knowledge was its ability to predict events, then the sciences, despite so many grand successes, were frequently failing the test. Making sense of that failure was the mission of an altogether new kind of inquiry calling itself the science of chaos… For whatever reason, whether because the empirical data suggested it or because extrascientific cultural trends did – the experience of so much rapid, unpredictable, disturbing change in the world around them – scientists were beginning to pay attention to what they had long managed to avoid seeing. Nature was far more complex than they had ever realized, or indeed, some were beginning to hint, than science ever could realize. Chaos was, like Gaia, a word that came welling up from the lost pagan cosmology of ancient Greece to seize the imagination of avant-garde scientists. If the earth goddess had long ago brought life an order into existence, then chaos had been her opposite: the realm where disorder still ruled, a dark underworld…The scientific study of chaos began… (1994: 406-7)

Chaos, far from its own agent in the universe, requires the complement control to have context, and the ancient mythological intuition of a balance between ordered harmony and an elemental tumult seemed at last to have some empirical basis, corroborated by mathematical and observational methods. With Bill Cronon's evidence that historical environmental narrative connotes values, Zellmer et al.'s hypothesis that narrative is an essential tool for telling tales of ecological complexity, and the Odums' pulsing paradigm that narrates ecosystems' position between stability and flux through time, ecology has arrived at a post-normal condition that is its own unique epistemology.

IV: Ecological Futures

Global climate change is the dramatic ecological process that we have come to expect as a future reality, and which has come into the public ken using a coordination of models and narratives. Certainly the Keeling curve, itself a visual narrative of increasing carbon dioxide concentrations in the northern hemisphere for the past half century, is the most immediately accessible heuristic that has made the public aware of a direct relationship between industrial emissions and atmospheric carbon concentrations. This relationship began in earnest in nineteenth-century England, the first nation to witness both the objective and subjective bi-products of industrial productivity. Industrialism quickly laid its thumbprint on the immediate landscape and on the visages of its workers. Only slightly more gradually, in a narrative of two centuries, have the global implications of large-scale fossil fuel consumption become apparent.

Lucien Boia's book length meditation on the ways weather has affected human imagination identifies the turn of the twenty-first century as unique in history. Though the nineteenth-century grew accustomed to the tension between technological millennium and apocalypse (as shown especially in Wells), the plausibility of humans permanently changing the course of climate and extinctions has now become almost commonplace. As Boia notes, the agent of disruption has shifted from capricious nature to hubristic humans:

> For the first time in history, catastrophe scenarios based on humanity's ability to trigger the forces of destruction have become plausible. This goes far beyond anything imagined at the turn of the century, when sensitivities were attuned to cosmic and natural disasters. An incipient anti-utopianism had drawn attention to the possible drift towards a world dehumanized by

> technology, but technology had not yet been seen as an agent that might destroy not only the human soul but the entire human race, or at least might completely disrupt conditions of life on the planet. This is the new danger, the technological 'flood' of the future. (150-151)

True to the cognitive ingenuity that launched *H. sapiens* onto the top of nature's pile of consumers around 50,000 years ago, we continue to imagine solutions to the climate conundrum based on new technologies, from light bulbs to hybrid cars to wind farms to a sulfur dioxide parasol in the atmosphere. Technology must evolve according to environmental imperatives, just like species evolve or lose their niche. But emphasis on reduction of uses (and the triangulation of reduction through more efficient technology) is still most often an economic imposition rather than a free choice.

Even with all our epistemological devices turned on the problem, the future remains a dark casement and we imagine many scenarios beyond. The term scenario itself captures the hybrid offspring of a predictive model joined with a narrative, and gives some footing to policy decisions such as the emission protocols many developed nations are now pursuing. Scenarios are politicized stories about the future, and we have a diverse family of them ranging from apocalyptic to soporific. A recent article in *Science* magazine by Richard Kerr (2007) shows the necessity of cooperation between climate modeling and narrating the proleptic realities of the twenty-first century. Kerr quotes two scientific experts on their frustrations with the parallax between evidence and action; this gap lies between our ability to model the future and our powers of narrating what must be done to redress the situation. The first reviewer, a climatologist, says, "The IPCC [Intergovernmental Panel on Climate Change] gets an A+ for scientific assessment, but a gentleman's C for

communication." Similarly, his geoscientist colleague laments, "All the facts are there in the [main-report] chapter, but the SPM [Summary for Policy Makers] didn't tie those facts together in a coherent statement of risk that would allow a policymaker to make an informed decision" (1413). Kerr identifies the over-reliance on models as an issue that needs correction in future action; scientists working with the IPCC feel the pressure to rely heavily on models for generating data because anything else, including narrative, is "speculation." But modeling, he suspects, is a new way for policymakers to stick their heads in the sand: "By ignoring factors that can't yet be modeled, IPCC came up with deceptively reassuring numbers." Such factors would certainly include the tipping points theoretically associated with the polar icecap melting, boreal methane release, oceanic carbon dioxide sinks filling, and decreasing planetary albedo (reflectivity) as less ice and snow cover the dark faces of water and ground. In the last 250 years a fundamental shift in the relationship between human activity and the natural environment has set the global system on a new, cryptical course. Industrialization, begun in England but rapidly emigrating to the European continent and America, and later to the Middle East, the Far East, and the Southern Hemisphere, has overtly turned the natural environment into a resource base, and the atmosphere now contains 37% more carbon dioxide than it did in 1750.[88]

Perhaps scientists should not be expected to earn an A in communication; after all, their training has circled around the scientific touchstone of model-based prediction. The humanities can take full part in the late-industrial future by helping scientists communicate with policymakers, and aiding the public imagination with

[88] The World Meteorological Organization keeps records of yearly carbon dioxide increases; see Press Release #833 for specific information on overall industrial shifts since the mid-eighteenth-century: http://www.wmo.int/pages/mediacentre/press_releases/pr_833_en.html

behavior modifications, homegrown solutions, and adaptive management in a changing set of environmental imperatives. The metaphor of a model, and the narrative of a prognosis, are grown from the ground of humanistic inquiry, and literature has historically been our best device for proving the hypotheses of metaphors and narratives. With such an intriguing set of stories to tell, the issue of climate change will continue to grow in public intrigue, perhaps permitting individual action to prescribe legislation rather than the reverse. With our powers in narrative and metaphor, humanists may be able to help make fictional what is now a proleptic non-fiction.

The nineteenth-century gave us both the seed of a future problem, in the form of industrialism, and the early impetus for solving that problem by developing conceptual techniques for investigating nature. Two of these concepts are the tropes of chaos and the microcosm. Romantic and Victorian perspectives on ecology were often strained between the aesthetic appreciation of natural beauty and the scientific investigation into how natural systems work. This dissertation has sought to resolve these contrasted modes of dwelling in nature by proposing that two essential tropes provided both the aesthetic and the empirical grounds for study; extending this relationship is the complementary role of microcosm as model, and chaos as a narrative practice. Tracing specific relations of influence between disciplines, countries, and centuries is an elusive goal. Instead, I hope to have demonstrated that both the humanities and the sciences have sought answers to how industrialism might change future conditions for our species and all the others. The insight pursued by environmental narratives and lyrics of the nineteenth-century is essential to

humanistic origins of ecological knowledge in the modern industrial world. The more we appreciate that ecology of the twenty-first century is more than just a scientific discipline, the closer we come to a personal investment in ecological praxis.

Epilogue

This study examined the history of two ideas in the ecological context of the nineteenth-century. I focused on British literature because England was the first industrialized country to recognize anthropogenic shifts in its climate and landscape, and the literature and science of Great Britain are recognized as pushing the vanguard of knowledge in the nineteenth-century. The conjunction of eco-historical moments with epistemological innovations has been a fruitful way to approach the interdisciplinary history of ecological thinking ever since the early stages of industrialism. I have analyzed innovative novels that envision contingency in nature and drive their plots using the radical notion of ecological punctuations, rather than coherent gradualism, in narratives of nature through time. I have identified the conceit of the microcosm as a way to delimit and organize nature, and shown how it was a particularly powerful trope in formal lyric poetry due to interdependent systems of prosody. These perspectives on chaotic narrative and microcosmic lyricism suggest that the tropes were useful literary tools for analyzing nature's behavior, and I noted affinities between these humanistic works and methods that have subsequently been developed in modern ecological science.

The tropes of chaos and microcosm have a more rich and subtle relationship than mere opposition. In literature, the focal power of the microcosm proved to be a powerful way to envision fragility in natural systems, since anecdotes of local despoilment could readily be extrapolated onto larger landscapes. Scientific microcosms, as physical models of natural systems at large, are the most feasible way to foster and analyze chaotic dynamics under controlled settings. In both disciplines,

the microcosm is a method of analysis, and chaos is a pattern that both resists and rewards the analytical attention made possible by modeling. The terms of this relationship between controlled stability and chaotic reorganization are tested with every new experiment, whether in the field, the laboratory, or the library. I have suggested that our literary ancestry from the nineteenth-century provided important early hypotheses about the new relations between control and disorder in anthropogenic environments.

One might argue that the relationship between disciplines has changed in the last 200 years from a condition of mutual discovery using similar methods to one of subordination, where science "discovers" with its esoteric and highly quantified methods, and the humanities reacts to these findings but has little role in their generation. I would contend that interdisciplinary mutualism in ecology lives, perhaps closer to its nineteenth-century form than we would have thought. Science has indeed assumed dominion over the analysis of natural systems, but experimental findings are evidently not sufficient in themselves to shift the behaviors of large populations towards sustainable practices. William Morris's 1880s lamentation that British culture cared for pictures of ideal landscapes but was indifferent to the preservation of those natural places revealed a troubling gap between representation and reality. It is now no longer legitimate to feature the Bengal tiger in a nature show without describing its many sources of endangerment. The humanities hold a unique role in accommodating ecological realities and futurities for popular consumption; novels, documentaries, feature films, blogs, and web resources devoted to developing widespread environmentalism participate in such enterprise. Writing about climate

change, especially in relation to dystopian narratives of the future, and writing about sustainability using microcosmic ideals like bioregionalism and community gardening, are essential mediation points for the humanities of the twenty-first century.

This interdisciplinary perspective is essential to our teaching literature to students (and their parents) who often have a more straightened notion of the practical value of a college education than the liberal arts curriculum originally conceived. By legitimating the power of creativity and imagination not only in literature but also in science, we dislodge a few bricks from the walls between specialized disciplines. Literary ecocriticism highlights the necessity of collective enterprise when it comes to facing off the looming environmental problems of the twenty-first century, none of which fall entirely within a single building in the university.

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