

2005

Henry David Thoreau: The Darwinian Naturalist

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**Henry David Thoreau:
The Darwinian Naturalist**

*A Project Submitted in Partial Fulfillment
Of the Requirements for the Degree of
Master of Liberal Studies*

By

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May, 2005*

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Henry David Thoreau: The Darwinian Naturalist

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Preface

One hand has surely worked throughout the Universe.

Charles Darwin, Voyage of the Beagle (1836)

Time is but the stream I go a-fishin' in....

Henry David Thoreau Walden (1845-1847)

My interest in Charles Darwin and Henry David Thoreau ignited from opposite charges: As an English instructor for twenty-three years, I had read only what editors and social convention deemed worthy to publish about Thoreau. His portrayal as a transcendental poet and idealistic naturalist loomed romantically in my mind for years. Thoreau's reputation lapped simply and gently from the tranquil waters of Walden Pond. The more I studied nature, the more I foresaw answers grounded in scientific explanations. The more I delved into Thoreau's latent writings, the more I realized that he, too, recognized the significance of the earth's processing exacted through vast ages of interminable time. In essence, Thoreau and I had courted the same lover – nature – and the more I understood the foundational mechanics of the world, the greater my intimacy with this poet's latter, botanical proofs.

Resting, however, beneath the pleasantries of Ralph Waldo Emerson's Over-Soul idea lay my own treasonous thoughts of evolution. Charles Darwin held before me a forbidden fruit. I felt curious to understand a theorist whose mission determined *how* our earth originated – and not necessarily *why*. This line of refreshing reasoning totally

forbad my former frame of referencing – when trying to discern the finer details related to that grandiose, simplistic question, “How did we get here?”

During Dr. Robert Carson’s Milestones of Modern Science class, I heard an almost matter-of-fact approach to the earth’s origin – from a respected physicist who brought me to the recognition that I had suffered the influences of society’s version of two lives spent in earnest observing a world of which I knew little. Somehow his class gave me permission to delve deeper into the universe.

Hearing James Burke’s wryly rendered view of man’s complex, tragic and comical attempts to place himself meaningfully into the world (through his The Day the Universe Changed: Darwin’s Revolution) cinched my need and resolve to seek the acquaintances of two of the most insightful keepers of the universe’s kingdom. I sought the significance of Thoreau’s trilogy of wisdom generated from his “God man and nature” worship and dissected Darwin’s triangle of science drawn from his “when, where and how” approach to the creation. I worshiped nature through the words of Henry David Thoreau and patted her “thoroughly about the loins” through the intricate, anatomical observations of Charles Darwin.

Thoreau’s edict, “There is no ripeness where something is obstinate in itself,” became an albatross around my unrelenting “stiff” neck – a neck that refused to bend to the facts presented by modern science. It would be an oversight not to mention my philosophic overseer’s pervading influence on my double negatives or conflicts of disinterest, Thoreau and Darwin. My father once implored me, in his own Irishly ironic way, not to throw out Darwin’s theory of evolution for the Biblical bath waters of

redemption. Because he had not read the Bible, I did not entertain his wisdom. It had never occurred to me that because I had never read Darwin, my own opinions served shallow masters.

Overall, I liken my Rollins' experience to the awakening of a poet whose encounters with humankind drove him closer to nature, and equally to that of a naturalist whose desires to understand man's origin drove him closer to the earth. The experience felt like a gentle rising to resurrection from Plato's cave. Dr. Hoyte Edge started the process by actuating an allegory through a sanctioned literary device called "the play within the play" technique – but performed in triplicate. It seemed to me that Dr. Edge had undergone the same process that this tale beckoned forth in us: So through a myth a truth was told by a philosophy professor who understood the vision of a shadow that raised him to the light of self-discovery.

Through these gradualizing steps of increasing knowledge, I came to realize that perhaps no conflict existed between early evolution and a spiritual approach to the creation. Both Darwin and Thoreau counted the earth's creation with a clock called geologic time. This pivotal theory altered how I viewed nature's biologic processional and also gave me greater appreciation for the earth's slow, certain and self-sustaining development. This knowledge helped me to balance the perceived harsh, exacting art of science with the miraculous methodology instituted by nature.

Ultimately, I remained open to contributions that I might make in Mother Nature's behalf – which led me to what became a certain precursor to Dr. Joseph Siry's independent study: the Manatee class. Through this class I discovered who I am in

relation to my age-old surrounds. Armed with an eager willingness to model Dr. Siry's own trusty commitment to the environment, I felt prepared (with this culminating self-awareness) to hopefully pass on my own observations and recordings of nature. Today I rest equally ready to give back to an earth that has not only assured my origin, but one that has continually fostered my survival.

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Introduction

The civilly disobedient American, Henry David Thoreau (1817-1862) had more in common with his English contemporary Charles Robert Darwin (1809-1882) than the Victorian Era (1830-1901) or the 20th century would ever fully realize. Thoreau the poet possessed the methodical research skills of a scientist who intimately understood New England flora and fauna. This transcendental philosopher peered at nature with profound appreciation and purpose—continually honing his powers of observation that ultimately rendered him an astute man of science. Thoreau hypothesized, recorded and retested botanical proofs that divulged revealing, affirming data to substantiate many of Darwin's novice, evolutionary claims. Thoreau equally read and balanced his own findings against other leading botanists and geologists of the 18th and 19th century. A lifetime of curiosity in and among the forests of Concord, Massachusetts compelled Thoreau to evolve past his idealization of his verdant surroundings and acquire a sober, scientific view of the nature he so worshiped. His latter years of life bear written witness to a natural historian who focused the earth's geographic possibilities through the lens of hypothetical probability and verifiable evidence—not unlike his evolutionary counterpart, Charles Robert Darwin.

Henry David Thoreau additionally held his own budding origin ideas up before the light of Charles Darwin's unique theory called natural selection. Thoreau weighed his own earthy observations on the vast scale of similar geographic time and space—supported by the gradualizing forces of nature. Lists of insects, plants and birds

appeared in Thoreau's journals as early as 1851 that spoke of research from Charles Darwin's *Voyage of a Naturalist Round the World* (1845) – published the same year that Thoreau had begun his experiment on Walden Pond; thus, eight years prior to Darwin's 1859 publication of his *then* more highly acclaimed Voyage of the Beagle, Thoreau directly quoted and insightfully interpreted the results of Darwin's intricate lists acquired from his 1831 travels to the Cape de Verd Islands off the west coast of Africa (Darwin, A Year in Thoreau's Journal: 1851 67-8).

To fully understand and appreciate the thoughtful consideration that Henry David Thoreau offered to Charles Darwin's theory of evolution, one must first perceive the corollary concepts that undergirded Darwin's over all theory like gradualization, geologic time, natural selection, and transport. How living organisms appeared in unlikely and seemingly inexplicable locations served to stronghold irrefutable evidence for traditionalists who proffered this seemingly miraculous mystery as a defense for spontaneously generated life. This illogical explanation for the origin of life appeared as a springboard for arguments incorporated by not only Darwin but also Thoreau. The multitude of creative and natural ways that seeds traverse thousands of miles or even halfway around the world had not yet met serious consideration prior to Darwin's and Thoreau's extensive delineation of the subject. Besides, other spiritually disturbing theories made even less sense to the throng of conservatives who hovered near their sacred origin account – like how the earth's surface may not have resulted from one massive flood or earthquake – but perhaps through a series of floods occurring over inconceivable periods of time (“Hutton, James” 1).

Henry David Thoreau in the last decade of his life approached his journeys through Concord more as an informed botanist with a curiosity about the origin of flora and fauna than a poet who applied metaphoric symbols to all of nature. Unfortunately, while still alive, he sustained the Concordian stereotype of surveyor, pencil maker, handyman, eccentric, social reformer, transcendental poet – and an individualist who often took life too seriously. Literary critics and those aware – but not willing to accept – Thoreau’s botanical contributions to the annals of science have yet to fully recognize and honor the detailed body of work that this emerging man of science devoted to the world.

After *Walden*, Thoreau wrote 4,000 pages focused on topics concerned with the natural history of New England. After having read Asa Gray’s *Manual of Botany* in 1852 and eight years later Darwin’s On the Origin of Species in 1860, Thoreau finally possessed a logical context to place all of the observations, data, hypotheses and affirmations – that he had noted and recorded over his brief forty-two year lifespan (Nabhan, Faith in a Seed xiii).

Although Charles Darwin was most probably unaware of his contemporary – the localized, American naturalist Henry David Thoreau, nevertheless, Darwin’s ideas, research and theories had a profound influence on Thoreau’s final journals, botanical reflections and recordings. These two men understood the logic that Mother Nature demonstrated as she slowly and purposefully planted or provided for novel species. These 19th century botanic geologists honored the immense duration necessary for the successful birth and succession of life. These two dedicated biologists spent their lives

journeying through nature, studying the intricacies of a geologically precise system of checks and balances.

Thoreau revered Nature's ability to self-balance – admiring an earth that possessed the uncanny skill to withstand the inhospitable onslaughts often generated by man himself (Thoreau, Faith in a Seed 60). Because of earth's perpetual ability to self-adapt, both Thoreau and Darwin ultimately perceived Nature as a hopeful entity – one with the power and presence to assure her own existence. Charles Darwin expressed his faith in the natural order of the earth by explaining such basic universal laws as “The Law of Correlated Variation” – a geologic principle attributing the differences in species as the basis and means for selecting advantageous variations for continued life (Darwin, The Origin 50). Similarly, Henry David Thoreau understood that the global distribution of fishes indicated what he dubbed “The Law of Fertility” – a fundamental doctrine that ensures the continuance of select (in this observed case) aquatic species. He journalized data that affirmed fish spawn perpetually and ubiquitously occurred on mountaintops as well as in the lowly plains (Thoreau, The Concord and the Merrimack 27). Above all, these evolutionary scientists – Henry David Thoreau and Charles Robert Darwin – understood the mechanics of a world that had run profitably for millions of years, and one whose natural laws not only applied to flora and fauna, but to the origin of all species.

Spontaneous Generation: Earliest Theory of the Earth's Origin

While many Americans still clung to the improbable theory of spontaneous generation, Darwin recognized that by the mid-1800s, evolution, in one form or another had earned the respect of an increasing number of naturalists throughout Europe (Origin of Species 228-9). Darwin enumerated his oppositions to life inexplicably and magically appearing from non-living matter. This idealistic belief popularized in the 19th century, when in 1835, James Duncan coined the term from his book, *The Natural History of Beetles*. More often, however, the term “abiogenesis” pervaded scientific publications whenever concepts surfaced concerning the creating power and probability of abruptly forming organisms (Bothamly 500). Darwin formulated and provided biological evidence in an effort to discount the leading scientifically religious men of the day. Specifically, the term “spontaneous generation” encompassed the belief that organisms generate from “non-living components of the environment by natural processes without the intervention of supernatural powers” (Lincoln, Boxshall and Clark 232). However, long before the Victorian Era, various influential, orthodox-minded individuals and scientists had stretched this origin idea to mean that non-living matter could transform into living organisms given the right set of divinely ordained circumstances.

Throughout The Origin of Species (November 24, 1859), Darwin's most popular publication, he intermittingly addressed the various creationist theories of the opinionated, passionate and prominent Catholic and theistic evolutionary biologist, St. George Jackson Mivart (1827-1900). Mivart contributed sizable, exacting data

concerning the anatomy of insectivores, carnivores and primates within his lifetime; but ultimately, after his own struggle to equate evolution with creationism, Mivart would end up excommunicated from both the Church and fellow scientific believers (with whom he had previously shared a common belief in natural selection). Additionally, Darwin's refutations against a good many of Mr. Mivart's assertions proved convincing – erupting to what later surfaced as Mivart's unfounded, subjective assumptions. This instantaneous creation theory had rested comfortably in the religious, scientific and public domain from as early as the ancient Romans to the 19th century (“Spontaneous Generation,” Origin of Life Studies 1). Prior to The Origin of Species' release, however, Darwin had diligently read and astutely anticipated each of his opponent's objections – having painstakingly researched background concerns and criticisms surrounding each argument.

By his having meticulously investigated what he expected would serve as substantial arguments against his ideas, Darwin mitigated any serious, scientific questions or challenges (Darwin, The Autobiography...123). Besides, the historically entrenched theory of special creation provided Darwin with the itemized blueprint from which he could categorically address each creationist conviction. Darwin walked into a well thought-out battle and armed himself with the observable ammunition known as gradualization, geo time, natural selection and transport.

One of Darwin's defenses for his evolutionary theory stemmed from the logic that original species could not result from one special act of creation because he discovered (during his 1831-6 *Beagle* voyage) that invariably, in each country that he

visited, the larger the species, the greater the structural diversity. Consequently, the more abundant genus populations turned out to have a greater tendency and ability to vary in form, which made it easier for these plants to proliferate and ultimately survive. This realization punctured one argument inherent in the spontaneous generation theory. Because Darwin identified a conclusive pattern – that notable structural variation increased with the size of the form--the obvious question arose: *Why then would nature program greater variation if each species required only a singular form to successfully survive* – irrespective of size (The Origin of Species 71)? These enhanced structural types determined dominancy and produced variations which equally manufactured greater alterations through their subsequent inherited dominancy (73). Such a stark claim – and one offered as argument against the less-demanding creation theory did not daunt Darwin. He delineated and clearly summarized how he determined that plants universally possessed a pattern of gradual anatomic enlargement spurred by more pronounced modifications.

To prove his point that the most modified forms were also structurally the largest, Darwin tested twelve plants – each from a different locale, separating the genera by size and keeping the bigger plants and insects separate from the smaller. He discovered that the larger genera produced greater varieties, and from these altered forms came novel variations or incipient forms which in turn demonstrated a slow but ongoing propensity to create more pronounced versions from that of even their parent species (72).

Henry David Thoreau also believed that life reproduced itself in a manner most conducive to its own survival. Thoreau's latter recordings as identified in his *Dispersion of Seeds* (1860-1) originated not merely as a means to describe how forests reproduced themselves in Nature, but this sizable "book-length study" primarily served as an extensive and detailed argument against the theory of spontaneous generation (Thoreau, Faith in a Seed 13). Thoreau, like Darwin, in order to explain how nature assured her own propagation, found it necessary to methodically denounce the theories of historically sanctioned, New England scientists. Any variant claims or versions of this faith-filled proposition that erupted from Concord and continued in its obstinate belief met with a sobering, written contestation from Thoreau. In his latter records from *The Dispersion of Seeds* (1860-1), Thoreau communicated that if trees or plants appeared in an area that the local people could not readily identify or explain, they rested in the comforting thought that the fauna spontaneously and auspiciously occurred. Because of Thoreau's intimate history and association with areas credited with such miraculous makings, his long-standing observational powers provided the historical basis to confound such localized legends.

When considering the genesis of flora around Concord, diverse spontaneous generation postulates repeatedly cropped up and continued to take on new but similar forms of explanation. In *Faith in a Seed*, Thoreau distinctively refers to select men of science like a certain Dr. Carpenter – and other men of botanical bent – who had too quickly come to conclusions without considering the full scope of influential factors – like their misjudgment of time and means through which seeds travel from one

geographic location to another. Additionally, Thoreau had to contend with the frustration of other more prominent botanists whose reputations preceded and obscured their observations; however, like Darwin, these shallow claims provided the backdrop from which Thoreau could confront specific charges.

For example, after having found several beach plums forty miles from the shore in Maine, said local botanist, Dr. Carpenter, deduced that these plums “sprang up,” and using this rationale, he further attempted to “... prove that the seed had lain there a very long time.” Others argued that the coast must have retreated for these plums to be found so far from shore. Thoreau questioned Dr. Carpenter’s hasty assumption and did not consider this plum tree a geographic anomaly. Just because Dr. Carpenter claimed that these plums “...had never before been seen, except immediately upon the seashore, ” did not make their appearance miraculous. Carpenter’s assumptions that these plums only grew on the beach appeared false first of all because of the breadth of experience that Thoreau had had with them. Thoreau had previously noted and recorded that the beach plums grew not uncommonly twenty miles inland from Concord, along with other plums that he had personally discovered twenty-five miles inland from the Maine beach. To substantiate this claim, Thoreau quotes another man, a Doctor Charles T. Jackson, who additionally had reported finding beach plums in Maine “more than a hundred miles inland.” Thoreau realized that not only had the natural geography of the beach plum undergone too cursory a study, but because of the unscientific, superficial approach to this common New England fruit, less tenable ideas

had sprung up like the beach plums' exaggerated time spent in the ground or their supposed sudden appearance (Thoreau, Faith in a Seed 112-3).

Darwin initially observed, hypothesized and tested species from both the plant and animal kingdoms in his effort to deflate illogical origin ideas. Thoreau, too, observed, hypothesized and tested how familiar flora grew in atypical places – which eventually resulted in animals serving as a primary causal factor for the transport of seeds. The aforementioned and admired biologist, Professor Mivart, whose talents assured him a prosperous career in law, made claims that Darwin soundly refuted (“St. George Jackson Mivart” 1). Darwin denounced Mivart’s assertion that birds and bats developed abruptly – because their wings did not indicate the proper embryonic modifications necessary for such abrupt formations and eventual flight. Darwin’s embryology experiments had led him to understand that “the embryo serves as a record of the past condition of the species” and in this developing stage, likenesses to “ancient and extinct forms belonging to the same class” can be identified, (The Origin of Species 231). And, as previously indicated, Darwin’s plant research further revealed that the greater part of species’ diversity evolved by way of variation – not special creation – because the larger genus (or group that possessed related characteristics [or variations]) underwent a slower development (Darwin, The Origin...230).

In comparison to Darwin’s origin discoveries, Thoreau’s microscopic approach to species’ creation in Concord, Massachusetts rendered surprisingly similar results. A more localized approach to answering concerns about the origin of species presented itself to Henry David Thoreau as he addressed the area husbandmen who “knew” that

foreign forests must have sprung through miraculous means. Because of Thoreau's in depth reading, he realized that agriculturalists and botanists would admit to the idea of a seed representing a singular and sometimes unique means of plant propagation, but they still deeply believed that universal growth generated from a spontaneous source. Thoreau, however, saw past the confusing cloud of medieval superstition that continued to descend on people's minds despite concrete evidence. He, like Darwin, had a whole host of observable data to display to those interested in nature's reasonable start:

... the notion is still a very common one that when the trees which bear these spring up where none of their kind were noticed before, they have come from seeds or other principles spontaneously generated there in an unusual manner, or which have lain dormant in the soil for centuries, or perhaps [*sic*] been called into activity by the heat of a burning. (Faith in a Seed 67)

Thoreau understood that seeds traveled in natural and numerous ways to ultimately arrive to receptive and fertile soil. By observing the behavior of these miniscule nuggets of life, Henry David Thoreau discovered that nature provided her own answers for her seemingly miraculous undertakings. That singular and well-endowed mistress of the universe—the earth—had allowed for and processed something as simple as a seed as her initial and primary means to self-propagate and flourish. Through years of having personally observed and recorded the creative ways nature provides for seed conveyance, Thoreau's myriad accounts of this natural

phenomenon served as his major argument against the proponents of spontaneously generated life.

Nature and all of her resilient power had not received the proper scientific regard from botanists and scientists; and therefore, Thoreau realized that without previewing the full aspect of Nature as an entity and life form in and of itself, false conclusions would arise concerning natural origin and profitable, prolific succession. He pointedly revealed his intention to present the necessary empirical evidence to refute the believers of special creation: "... I do not believe these [special creation] assertions, and I will state some of the ways in which, according to my observations, such forests are planted and raised" (68). More specifically, Thoreau contested the findings of such men as Dr. Manasseh Cutler, who in 1785, had determined that the Northern wild cheery tree appeared abruptly on the White Mountains. Thoreau equally protested and cited the results of the noted 18th Century French explorer, artist, naturalist, and botanist, André Michaux (1746-1802), who credited spontaneous generation with the creative means through which rare species of cheery trees and canoe birch reproduced themselves (70). One of the strongest comments that Thoreau made in relation to miraculous manifestation of life forms evinced when he pointed out the previous finds of such noted men as John Evelyn (1620-1706), whose book, Of Sylva, or a Discourse of Forest-Trees, greatly influenced Henry David Thoreau's ideas in natural history – particularly because the respected 17th century botanist and author realized that trees often experienced the planting of their seeds by birds. Evelyn's Latin recitation further indicates the intricate observations and knowledge occurring over a

hundred years prior to the Victorian era concerning the reasons for the planting of flora and fauna: ““*Turdus exitium suum cacat* – There goes a tradition that they [holly seeds] will not sprout till they be passed through the maw of a thrush” (71).

On September 20, 1860, Thoreau had addressed the Middlesex Cattle Show for the purpose of clarifying key points in the essay on “Forest Trees” written by Charles L. Heywood from Concord. Thoreau answered questions focused on occurrences that spoke of, for many, spontaneously generated forests. One of the questions that Thoreau specifically answered read, “Why when a pine forest is cut down, does a hard wood forest take its place?” Notes from the meeting revealed Thoreau’s response as indicating “... that the vitality of seeds under favorable circumstances, and the means nature had provided for scattering and planting the seeds of trees and plants” served as major contributors to forest succession (“Spontaneous Generation,” Thoreau Lecture 74). A few months later, Thoreau sent a letter to Horace Greeley (1811-1872), the noted founder and editor of the New York Tribune and The New Yorker (1834). Greeley’s gritty editorials and quotes influenced not only the growing anti-slavery movement in America, but his newspaper enjoyed one of the largest reading audiences of the time (“Horace Greeley”).

On September 29, 1860, Thoreau submitted his agricultural lecture to Greeley, informing him that the section he addressed came from “The Succession of Forest Trees,” a segment of a chapter from a larger work, *The Dispersion of Seeds*. Although Greeley published Thoreau’s piece in the October 6th edition of the New-York Weekly Tribune, and this publication resulted in Thoreau’s “most widely circulated shorter

essays during his lifetime,” Greeley, almost a month later, on December 13, wrote to Thoreau expressing his doubts about several of Thoreau’s comments made to the Middlesex Agricultural Society. Both of Greeley’s questions suggested his personal belief in spontaneous generation. Thoreau responded that just because a forest has had a fire does not mean that all of the seeds have met with destruction. He also alleviated Greeley’s concerns when he explained that some of the trees that Greeley believed had randomly grown in the forest – the canoe birch – for example, were actually indigenous to not only Concord, but the state that Greeley had originally questioned, Maine (“Spontaneous Generation,” Lecture 74 7-8).

It appears, too, that Thoreau did not want to be dubbed a naturalist who theorized about evolution or creationism, because Thoreau promptly corrected Greeley when he called Thoreau’s explanations *his* “theory on spontaneous generation.” Thoreau commented that his experience with burned, bare fields still containing healthy, indigenous trees served as purely “observation” not theory. Further, Thoreau explained that the burden of defense for theories should originate not from close observers like him, but rather from the creators of those theories (7).

The issue of “fire” and how a field could burn to nothing and then sprout trees unexpectedly served as one of the final bastions of creationistic argument that Thoreau addressed. After having walked through barren fields and noting the distance that the rum cherry tree grew – from its customary place of growth – Thoreau provided founded reasons as to how trees, in general, so soon after a fire, could spring up so suddenly:

There is no mystery about new trees coming up where there has been a fire, because either the young and feeble plants, whose roots escape the fire but which would die if the wood was left, can now grow there, or else, the ground being thus cleared, the seeds can catch there (Thoreau, Faith...72).

Contending with the historical parade of creationist arguments both frustrated and focused the origin research of Henry David Thoreau and Charles Robert Darwin. Each of these probing men of science hypothesized that the evolution of flora did not happen suddenly; if anything, the vast expanse of life had come about slowly and less randomly for which the theory of spontaneous generation could accurately account.

Darwin demonstrated patient forethought by particularizing his experiments to address the claims set forth by the long-standing, socio-scientific and religious community. Ultimately, his preparedness paid off because, in spite of the controversy that still surrounds twenty-first century discussions concerning life's origin, evolution has still evolved from being considered a theory to now being recognized as a full-fledged scientific fact. Ernst Mayr points out that evolution cannot undergo the same criteria for trying to prove its existence as former origin theories experienced because "...evolutionary events must be inferred from observations. ... most inferences made by evolutionists have by now been tested successfully so often that they are accepted as certainties" (Mayr, What Evolution Is 13). Darwin shared a similar insight when he defended the fact that the theory of evolution does not have to be substantiated by fossil links. He indicated that one does not have to have discovered the remains of a species – to understand and recognize that a plant or animal resembling a variation of

that closely aligned group actually originated from that corresponding parent species (Darwin, The Origin...63).

Prior to each of Thoreau's excursions, he selectively read about the area flora or fauna that would affect his observations. He carried gazetteers and guidebooks whether on foot or in a canoe (Harding xxii). He preferred a microscope and an "alcohol-receiver" in his effort to better investigate any new curiosity that befell him in Concord or among the Flora in the state of Massachusetts (Emerson 12). Thoreau addressed the foibles of spontaneous generation like a scientist and could look his fear of God in the face—if such confrontation meant finding a greater truth. In the eyes of some, Thoreau may have seemingly traveled to irreverent territory when he proclaimed, "Nothing is so much to be feared as fear. Atheism may comparatively be popular with God himself" (22). Thoreau suggests here that those that claim to know and understand God should not fear discovering more about the world of which God either created, allowed or bore/bears dominion over. "Fear," Thoreau implies, prevents or contorts the truth. Just because one's interpretation of God has altered in light of a new discovery [like the origin of the earth explained now through evolution] does not make one's perception of God any less valid. Further, Thoreau indicates that even an atheist—as one who denies the existence of God—may be closer to understanding the truth in relation to understanding God—because the atheist is rejecting a version of God that has been misrepresented in the first place by certain supposed Godly authorities.

Early in his career Charles Darwin faithfully and literally believed in each word of the Bible – as piously proffered through an Anglican church perspective. Toward the end of his life, however, he reversed his former conviction that God had created the world – opting instead for the belief that through natural selection and variation all organic life came into, and successfully sustained, existence (Darwin, The Autobiography 90-1). Darwin’s beliefs were not shattered by his lifetime of observing a planet that had maintained for hundreds of thousands of years without the intervention or biologic interest of man. His beliefs altered slowly with each new unfolding of the earth’s origin – expressing itself through the natural renderings of natural selection, gradualization and adaptation. Ironically, when Darwin first defended his early propositions corroborating his overall theory of evolution, his own gradual move to theism remained intact. However, as he destructed each pillar that upheld the ancient belief of spontaneous generation, his previous, personal conceptions about the creation of the world and mankind dropped away.

Henry David Thoreau, on the other hand, gradually moved from an idealistic view of how the world began and continued running – to offering even greater praise for the intricacies of a naturalizing design that allowed for such. These men, although separated by the second largest body of water in the world, nevertheless, independently evolved toward the understanding that the earth’s flora and fauna could not have come about in either a quick or ubiquitous manner. Each of these natural historians prefaced his own field results against the backdrop of an outdated theory that did not demand the sanctioned auspices of a posteriori knowledge to affirm its truth. Ironically, a

theory by any name other than spontaneous generation would have had to suffer years of scientific scrutiny before being accepted into any cannon of sacred belief.

How society unquestionably accepted a theory of the earth that did not offer reasonable explanations – in spite of Mother Nature’s faithful daily rending for all to see – did not deter the inquisitive minds of Henry David Thoreau and Charles Robert Darwin.

Darwin’s comments concerning America often ran to topics about America’s adaptive flora that originally generated from Europe. He knew not of a common surveyor and pencil maker who simultaneously started an attack on the believers of a four thousand year old origin theory. Henry David Thoreau, however, grew to honor the early works of Charles Darwin because his own experiences while walking the forests of Concord, Massachusetts corroborated Darwin’s discoveries while sailing the world. Darwin enjoyed the respect generated from having his ideas successfully demonstrate the impossibility inherent in select special creation theories, while Henry David Thoreau influenced some of the most profound and conservative editorial minds in America. Darwin referred to the southern American forests and asserted that they did not occur by chance. He confidently related that these slowly struggling survivors eventually return to display a copious variety of vegetation and stately trees (Darwin, The Origin 84). Equally, the subject of how forests originate and process availed Thoreau the opportunity to argue that these gradually occurring woods were not mandated by the sudden actuations of God – but rather these resilient woodlands represent how life evolves from a seed and strives to live in spite of man’s desire to

over-utilize her resources. Henry David Thoreau and Charles Darwin upheld the theory of evolution by demonstrating how forests and organic life naturally occurred. Each of these men reasoned their ideas before biologic critics who insisted on the auspices of ordained creation. Both men admirably identified how life evolves from a seed to grow, struggle and survive among a host of seemingly hostile forces.

Gradualism: Slow and Steady Wins the Race

How Darwin and Thoreau methodically combated the proclamations of special creation generated through Darwin's gradualization theory formerly dubbed "uniformitarianism" by Darwin's close friend and associate Charles Lyell (1797-1875). This Scottish-born geologist believed that the earth and "all changes of nature" had altered gradually rather than through "saltations (gaps) or jumps." The idea that organic life took millions of years to form and reform seemed preposterous to the patrons of spontaneously generated creation, in that the thought of life uniformly and slowly progressing directly opposed the belief that various life forms were created consecutively and within a span of seven days. This imperceptible progression of the earth presented itself as a particular point of contention because the entire theory of abiogenesis hinged on the idea that the earth had begun as recently ago as 4004 B.C.

Darwin repeatedly emphasized that the greatest evolutionary changes take place in the smallest of increments. Even though by the 20th century it was known that "chromosomal phenomena" could cause drastic evolutionary alterations within the course of a single step (Mayr, What Evolution Is 80-1).

Not only had the world evolved slowly and steadily, but Darwin also hypothesized that all of life had generated from a single source. The earth's bio mechanics and natural laws then governed the succession of plant and animal life that ensured continued survival. Also, Darwin's discoveries while commissioned by the British Admiralty on his voyage of the *Beagle* indicated that the earth had often served as her own architect – gradually forming organic life once thought to have abruptly

appeared. Conveniently, for the special theory loyalists, the only proof required to substantiate their theory rested in an earnest desire to maintain blind faith.

The various circumstances under which coral reefs form provided a means through which Darwin could present his gradualization theory. In May of 1837, Darwin explained before the Geological Society the origin of barrier coral reefs north of Keeling Island and their relationship to the identity of (subterranean) mountains. He determined that lamelliform (thin-plated) corals formed a reef as they reproduced to create their limestone skeletons at shallow depths – atop submerged mountains (Darwin, Voyage of the Beagle 343).

Although the grandeur of this elaborate reef of coral inspired great awe in Darwin, he nevertheless provided an observable reason as to why barrier-reef coral occurred at distinct distances from the coast but still grew in shallow enough waters to survive. Darwin also distinguished why other types of coral – lagoon and encircling – grew differently according to effecting environmental influences in the area. By explaining the varied conditions necessary for particular types of coral to grow and prosper, Darwin disproved the concept that coral appeared spontaneously and without reasonable cause. Darwin's arguments with the leading naturalists of the 19th century demonstrated his greater breadth of knowledge concerning life's diverse means of propagation – because he had observed first hand how portions of the earth formed and reformed given the unique characteristics afforded various environments.

Moreover, discussions of *where* life began and reproduced became critical points of argument because according to the theory of special creation, life could appear not

only miraculously, but living organisms could also spring from more than one place at one time. For those that held rigidly to the Biblical account of the creation, Darwin's idea of life beginning at one specific time in a singularly designated place created a disturbing problem if that time and place of origin did not coincide with the religiously perceived Biblical account. Furthermore, Darwin's uniform package of the earth's beginning opened up other equally disturbing possibilities – like perhaps a mating pair of organisms did not necessitate the successful production for the creation of life.

Darwin had suggested that a “single Hermaphrodite” – which would contain both male and female reproductive parts – could have also started the spark of life. Darwin further delineated how a multitude of life forms could still be created from merely one set of parents by explaining how each species “ ... descended from a succession of modified varieties which have [had] supplanted each other, but have [had] never blended with other individuals or varieties of the same species” (Darwin, The Origin...352-3). Darwin deduced that if all life started from a single source, then that source must have originated from a singular geographic location. How that primary source descended and modified into the multitude of resembling but distinct forms would require, according to Darwin, vast years of slow, natural processing.

Estimating or gauging the actual age of the earth, Darwin contended, remained a difficult task for scientists. Because mankind's own brief lifespan had prevented the longevity necessary to measure the hundreds of thousands of years required to produce the earth, Darwin realized that up until the mid 19th century, scientists had not factored

in the significance of the earth's great age when considering her true origin and subsequent processing (Darwin, The Origin...294). For example, the evidence of the "slow rate at which the land is worn away through subaerial and littoral action" and "the masses of rock that have been removed over ... extensive areas" indicated the slow wearing away necessary to produce such grand geologic formations. The volcanic islands, also, with their "perpendicular cliffs of one or two thousand feet in height" further portrayed massive vistas worn and shaped through grandiose durations of time (297).

Not only Darwin realized that man's comparatively brief life inhibited his ability to see the larger picture of how and why life had evolved, but Thoreau, too, had noted that often observers of nature misperceived what they saw, not comprehending the importance of the colossal durations required for the successful ensuring of continued life. In Thoreau's account as recorded in his *Dispersion of Seeds*, he relates his theory of a uniform universe and how the laws of nature have allowed for plant and animal survival. Thoreau indicated that humankind should not be alarmed at the idea that existing processes account for all past and present geologic diversity because "preserving Nature" has had sumptuous time to allow for such change. Having read Charles Lyell's Principles of Geology, Thoreau came to regard the forests of Concord as universal and omnipotent – an eternal place where ageless destruction and renewal pervade in naturally choreographed unison (Walls 89).

Thoreau himself almost missed an identifying moment in nature that revealed an ancient and ongoing geologic rite – inherent to the profitable growth of the stately pitch

pine tree. While sauntering among a pitch-pine forest in Concord, Thoreau mistook a pitch-pine seed for a solitary “sprig of moss.” He noted that the seeming insignificant size of this majestic seed masked the actual extended amount of time that this tree required for full maturity and growth:

By the next year it [the pitch-pine tree] will be a star of greater magnitude, and in a few years ... those seedlings will alter the face of Nature... from pasture, this portion of the earth’s surface becomes forest These which are now mistaken for mosses in the grass will perhaps become lofty trees and endure two hundred years (Thoreau, Faith...27).

Thoreau, like Darwin, realized that although well-meaning observers of nature attempted to study their surroundings, and from their observations make confident claims concerning the age of the earth, many, in reality, misread what they saw. Something as seemingly common as the growth of a pitch-pine tree, for example, may microcosmically serve as a sample of how the earth, in general, processes and ages. Moreover, Thoreau indicated that when agriculturists cut down young pitch-pine trees, they generally left “only the old parent tree to seed the ground again.” Because of the small stature of these fledgling pitch pines, they customarily were missed altogether in a forest until they reached about the age of six years (26). These trees had undergone a half dozen full cycles of seasonal growth unbeknownst to the average farmer or naturalist. The point both Darwin and Thoreau reveal here is that man often miscalculates nature’s processing time – because he either does not possess the adequate lifespan to objectively assess the evolutionary processes of the earth, or he is

too close to his subject of study – and therefore takes for granted the minute, unhurried gradations required for stages of life-sustaining variation and growth.

Thoreau eventually regarded even mutations as part or parcel of the earth's gradual undertaking – deeming obvious incongruities as part of the natural processing necessary to ensure successful variation. Eleven years after Thoreau's passing, in 1871, Darwin would publish his Descent of Man relating how he believed that man had come about as a result of a "mutable species" who "fell into a similar law" (Darwin, The Autobiography 130). Thoreau commented concerning the positive effects of nature's divergence from her norm as he observed the various red and yellow excrescences (external blemishes) on young oaks: "... any anomaly in vegetation makes nature seem more real and present in her workings." Out of chaos Thoreau saw order through identifiably miniscule anatomic changes: Out of "blooming, buzzing confusion," Thoreau also perceived "patterns that reveal a deeper structure" (Walls 185).

Variations for an improved species can occur in the soil or in the plant's structure – enough so that one might be surprised at what seed forms and what types of soil might spur more favorable growth. Darwin realized that botanists tended to classify plants at a more advanced stage if they possessed every perfectly and fully developed organ. But he indicated that a greater truth divines for researchers who classify plants higher whose organs have undergone more extensive modifications (Darwin, Origin... 125).

Thoreau realized too that observers would be amazed by the soil that the pitch pine prefer. He indicated that over time the pitch pine seed modifies to more amenable

shapes and climes. Equally, he understood that “nature ... adopts the simplest modes” indicating his confidence in an organic phenomenon that seems to control or invoke the time and place where her seeds reside (Thoreau, Faith 25). He admired the seed of this ancient tree traveling toward the soil needed at a particular time. When discussing the unusual preferences of the hearty pitch pine, Thoreau indicated that, surprisingly, the rockier the soil, the more the pitch pine bore fruit (Thoreau, Faith...26). To Thoreau, why the environment accepted select seeds or how those seeds managed to gravitate to receptive environs revealed only part of nature’s amazing unifying force and character.

Gradualism or incremental changes in the earth proved the practical means through which Darwin could explain how his theory of geologic time entered into his overall theory of evolution. Sir Charles Lyell had paved the way for Darwin’s extension of this timely concept when Lyell introduced the idea that the earth had slowly altered rather than changed by way of immediate, global upheavals. Henry David Thoreau seasonally charted the development of numerous seeds and vegetation among the barren and fertile fields around Concord, Massachusetts. His copious, detailed notes on the same flower or plant indicated that no two seasons produced a replica of a plant’s former, specific self. When comparing the stark contrast of growth that pitch pine seeds undergo in their transformation from tiny seedlings to their eventual stately heights, Thoreau considered not only the slight structural changes incurred through such growth, but he also understood the perpetual ages consumed both prior to and past (even) his own existence.

The Periodic Table of Geo Time

In the early part of the 19th century, when Henry David Thoreau and Charles Darwin entered the path of naturalistic studies, the slowly waning theory of abiogenesis connoted life forming within the span of one hundred and sixty-eight hours or seven days. One of Darwin's complaints about the misinterpretations of his theory of evolution generated from scientists and interested parties misconstruing the significance that time played in species formation compared to the more critical element of life possessing the proper geographic space to live and reproduce (Darwin, The Origin...108). Additionally, a theory that promoted the idea that the organic mechanizing of the earth proceeded at a snail's pace and yet engulfed seamless, ageless frequencies did not make all facets of Darwin's theory readily digestible – particularly when briefer periods like October 23, 4004 B.C. bore finite numbers more easily comprehensible by the average Victorian.

A point of reference when considering the geologic events that have transpired over vast periods might be better understood through the rocky elevations or depressions in the earth's surface and the significance of what those upheavals and downfalls reveal about historic geologic occurrences. When the earth's crust goes through elevating stages, Darwin explained, then the land and sea shoal also undergo aggrandizement – to the degree that this fresh land mass creates novel opportunities for new species to breed. However, during periods of de-elevation, the organisms that occupied the area prior to subsistence often cannot sustain the terrestrial drop – or

adapt to the newly created environmental conditions. When these organisms die, certain species leave a graveyard of valuable fossils. These fossils or skeletons often provide a measurement for when these organisms lived, or indicate an historical reason as to why they may have died (Darwin, The Origin...304).

Because the earth's age could not be counted in twenty-four hour increments – but rather through cataclysmic occurrences like floods, volcanic eruptions, or earthquakes – those attempting to understand evolutionary time often sought simpler explanations. These geologic demarcations or dramatic occurrences in and of themselves generally required hundreds or thousands of years to process. With such infinitesimal ages looming before them, many of the 19th century Europeans could more easily conceive of the earth's origin as having begun in 4004 B.C. – when the creation of man became immanent. However, for many scientists, a geologic time scale made perfect sense, in fact such sequential elongations answered many of their questions that Biblical chronology could not – like why do humanoid fossils appear to reveal man's emergence on the earth far prior to 4004 B.C.? (Brody & Brody, The Science Class...228). But for the common, skeptical citizen incurring the onslaught of Darwin's ideas during the mid 1800s, geologic time seemed a concept both suspect and befuddling.

Considering the significance of what mountains indicated about the age of the earth, Henry David Thoreau additionally penned his own revelations after assaying the regional Northeastern peaks of America. Although Mt. Washington in New Hampshire (1939) served as the highest ground that Thoreau ever ascended, both from this view of Mount Washington, and later a side view from Mount Monadnock, he discerned the

relevance of these respected cliffs in relation to their time-honored years of existence. Consequently, his deep reverence for these Godly heights led to his refusal to climb *any* mountain to its summit – not wanting to treat these spiritual landscapes as an adversary in a sporting event – to be conquered rather than revered. This nevertheless athletic man of nature completed his inspired ascents as late as 1860 from the saintly rocky lofts of Mt. Monadnock in southern New Hampshire (Thoreau, *Elevating Ourselves...* (2). His final climb took place nine months after Darwin’s first publication of *Origin of Species*. Mt. Monadnock was one of the first mountains to begin Thoreau’s revelatory discovery concerning mankind’s spiritual connection to nature (1844), and this solitary island-like mass resulted in rounding out his scientific observations, as he surveyed the ancient age of life contained within its venerable, isolated peak.

In the early part of the twenty-first century, a conservation plan to preserve the forests and vegetation surrounding Mt. Monadnock is (currently) underway. These 268,800 acres gracing southwest New Hampshire will hopefully be preserved by a plan initiated by The Nature Conservancy and the public. “A Land Conservation Plan for the Ashuelot River Watershed,” will help assure that the Ashuelot River continues to drain through these verdant forests as it runs to the Connecticut River.



Fig. 1: Photo by Eric Aldrich (c TNC) displaying a recent picture of Mt. Monadnock in New Hampshire. The Nature Conservancy of New Hampshire. (22 Bridge St, Concord, New Hampshire 2008).

Below: Thoreau’s twenty ascents accomplished in a span of twenty-one years:

Reputedly, Thoreau favored Mt. Monadnock – a summit he ascended more frequently and over an extended period of time--suggesting his personal and professional growth from transcendental symbolist to a man of conscionable science.

Table 1

Thoreau’s Mountain Climbs from September 1839 to August 1860

1. 10 September 1839 Washington, New Hampshire	6288’
2. 20 July 1842 Wachusett, Massachusetts	2006’
3. July 1844 Monadnock, New Hampshire	3165’
4 July 1844 Hoosac Range, Whitcomb Summit, Massachusetts	2173’
5 July 1844 Greylock, Massachusetts	3491’
6. July 1844 Catskills, New York	2200’
7. 7-8 September 1846 Katahdin, Maine	5267’
8. 5 September 1848 Uneconomic, New Hampshire	1329’
9. 6 September 1852 Temple Mountain, Whitcomb Peak, New Hampshire	1710
10. 6 September 1852 Pack Monadnock, New Hampshire	2286’
11. 7 September 1852 Monadnock, New Hampshire	3165’
12. 19-20 October 1854 Wachusett, Massachusetts	2006’
13. 9 September 1856 Wantastiquet, New Hampshire	1351’
14. 10 Septmeber 1856 Fall, New Hampshire	1115’
15. 24 July 1857 Kineo, Maine	1806’

16. 2-4 June 1858	Monadnock, New Hampshire	3165'
17. 5 July 1858	Red Hill, New Hampshire	2029'
18. 7-8 July 1858	Washington, New Hampshire	6288'
19. 14-15 July 1858	Lafayette, New Hampshire	5260'
20. 4-9 August 1860	Monadnock, New Hampshire	3165'

Source from Table 1 above: *Thoreau's Mountain Climbs: The Thoreau Society from Elevating Ourselves: Henry David Thoreau on Mountains: Introduction 3.*

Climbing mountains over a period of two decades gave Thoreau a geologic sense of the earth's ancientness. Ironically, Thoreau considered the pleasantries of scaling these peaks as part of his "job" on earth. He commented that "My profession is to always ... view God in nature" (Thoreau, Elevating Ourselves 2). Part of his aspiring journey allowed him the opportunity to place another piece of the earth's development into perspective. Whether Thoreau thoughtfully walked the woods of Walden or towered heights that invoked poetic praise, his purpose rested in his intellectual desire to understand how Mother Nature conducted herself: "The landscape lies far and fair within," Thoreau mused, "and the deepest thinker is the farthest traveled" (10).

More specifically, while climbing Mt. Manadnock, Thoreau gained the objective distance necessary to perceive the grand scheme of things – from observing just one side of the mountain. From this focalized viewpoint, he noticed a boulder tilting oddly from the ground which suggested that in some former age the Titans must have been in the process of moving it and were suddenly interrupted (68). Just by gazing at this unusually placed mammoth stone, Thoreau surmised its origin from some classic age

whose mythology spoke of superhuman men who grazed the natural resources of the mountain.

Thoreau and Darwin looked upon the mountains and realized from their composition, placement and shape that their presence most likely spoke of a time substantially farther into our past than man had formerly imagined. While Darwin concerned himself with describing the various ways that coral originated, clarifying to the Geological Society that reef coral grew on top of sub-aquatic mountains whose elevated heights permitted shallow enough conditions for coral to grow, Thoreau's thoughts descended to the sacrilege committed by sporting men who chose to top sacred terrestrial peaks. Thoreau explained that for the Indians the highest vistas of the mountains served as the abodes for their gods. To Thoreau, the mountains were as sacred as the Indians and former civilizations who had inhabited them. He perceived a mountain as an emblem of the past—judging its megalithic wonder in light of its ancient beauty.

Additionally, in late July of 1842, Thoreau traveled to the Wachusett Mountains by way of Wataquadock Hill. As he gazed from this comparatively small but nevertheless generous mound of earth, he viewed not only Nashua Valley but also the broad expanse of Mt. Wachusett—relating that from such heights he could view “the form and structure of the globe” (10). While camping 3,000 feet above sea level and overlooking the village of Princeton, Thoreau cast additional projections about how the hill that he momentarily stood upon might likely in the future become, “... a Helvellyn, or even a Parnassus,” a place where one day “... other Homers [might] frequent the

neighboring plains?" (12). The movement of mountainous stones, or the idea of a similar space occupied by various civilizations in different eras, for Thoreau, appeared juxtaposed with the passage of time – but such transference surged both forward and back – cyclically engaging and merging in a geological expanse of time that in retrospect *had* transpired – and through hopeful prospect would one day divine to occur again.

For Darwin, however, clocking time's continuum in an effort to make his revolutionary ideas sound, appeared less important than focusing on the available, specialized perimeter of earth needed for speciation to occur (Darwin, The Origin...108). Nevertheless, scientists and Darwin's reading public focused on the area of evolution that they thought they had always understood – time. Although Darwin and Thoreau did not possess the opportunity to see the age of strata assessed by radiometric dating methods, these men understood that ancient megaliths of rock and soil tell a tale of the earth's origin far older than can be conceived by man (Mayr, What Evolution Is 18).

By September 17, 1839, twenty years before Darwin's publication of The Origin of Species, Thoreau had already realized that man's supposed means of progress and civilization incongruously corresponded with how the earth had profitably organized and managed herself. Further, Thoreau indicated an inherent perception of evolutionary unveiling in that he recognized the folly of man's attempts to measure nature in concentric time. Henry David Thoreau also understood that for man to truly comprehend nature's timetable, he would have to demonstrate the patience to observe

Mother Nature at her slowest – which for this grand and earthy dame could be evaluated only through her eternal, epochal cycles. Thoreau recognized the interminable expanse of time necessary for the earth’s processing twenty years prior to Darwin’s having published the supporting concepts that ultimately offered evidence proving branching links and evolutionary descent:

Nature never makes haste; ... The bud swells imperceptibly... as though the short spring days were an eternity. All her operations seem separately, for the time, the single object for which all things tarry (Thoreau, The Heart...12).

Although Thoreau was unaware of the high degree of definition that now accompanies modern geologic time charts, he nevertheless had a sense that not only mountainous terrain but also the paths worn by venerated rivers accurately portend lifelines of ancient history. On March 24, 1855, while writing about how erosion provides the life source for the earth’s soil, Thoreau commented about how the rivers earned their serpentine and individualized shapes – and how time leisurely engendered the construct for such riverine designs:

“... rivers appear to have traveled back and worn into the meadows of their creatingthus in the course of ages the rivers wriggle in their beds, till it feels comfortable under them. Time is cheap and rather insignificant.... (Thoreau, The Heart 214-15)

Thoreau indicates that the duration for rivers to form and reform matters little because nature will move at a speed conducive to her survival and structure her design as it profits her existence.

The quintessential evolutionists of the 19th century, Charles Darwin, advised his reader to “...examine for himself the great piles of superimposed strata, and watch the rivulets bringing down mud ... in order to comprehend ... the monuments of which we see all around us (Darwin, The Origin 295-6).

At the age of thirty-seven, Henry David Thoreau essayed the structural, notable alterations incurred in a river bed and seemed to unknowingly fulfill the prescription of what Darwin deemed necessary for one to truly appreciate the immense durations required to observe major geologic change. Darwin agreed with Croll who indicated that geologists in general mistakenly parcel time into man-made years when assessing the ages of rocks, mountains or solidified lava (Darwin, Origin...298).

Moreover, in the 21st century, computer satellite calculations have confirmed Darwin’s projections concerning the gradual movement of mountains. These computer computations measure the slight receding and escalating motions generated through these grand mounts – technology that became available for such use only as recently ago as 1997 (4) – a little over one hundred years after the death of Charles Darwin.

The following page displays an early 21st century evolutionary time chart – a far cry from counting generations of families and peoples attempting to establish time periods. William “Strata” Smith’s six divisions of sedimentary rock layers (1799) started the dating process and those divisions still function today as the basic format for the geologic time scale (O’Neil, Dennis 1).

Twenty-First Century Geologic Time Table

Table 2

Eon	Era	Period	Epoch	Age Ma	Life Forms	
Phanerozoic	Cenozoic	Quaternary	Holocene			
			Pleistocene			
		Tertiary	Neogene	Pliocene	1.8	Earliest Homo
				Miocene	5.2	
			Paleogene	Oligocene	23.8	First apes
				Eocene	33.5	First whales First horses
				Paleocene	55.6	
					65	Extinction of dinosaurs First placental mammals
		Mesozoic	Cretaceous	Late	96.9	
				Early	144	
	Jurassic		Late	160	First birds	
			Middle	180		
			Early	206	First mammals First dinosaurs	
	Triassic		Late	228		
			Middle			
			Scythian	251		
	Paleozoic		Permian			
			Carboniferous	Pennsylvanian	290	First mammal-like reptiles
		Mississippian		353.7	First reptiles First amphibians	
		Devonian			408.5	First insects First land plants
		Silurian			439	First fish with jaws
		Ordovician			495	
		Cambrian			543	First shelled organisms First multicellular organisms
		Proterozoic			2500	
		Archaean			3600	First bacteria Origin of life?
Hadean				4600	Oldest rocks Formation of the Earth	

As of 2001, the above timescale shows the Precambrian era ranging from the origin of life (ca. 3,800 million years ago) to the beginning of the Cambrian (ca. 543 million years ago)." ...As new fossils are discovered, adjustments occur as higher taxon are created. Source: Mayr, Ernst. *What Evolution Is 20: from Evolutionary Analysis 2nd ed.* Feeman/Herron 1997.

Like Thoreau, Darwin, too, believed rocks contained secrets to the earth's early origin. At a young age, Darwin was challenged by a Shropshire, geologic local called Mr. Cotton. This respected man asked Darwin to explain just how a mammoth Bellstone (rock) had come to rest in Shrewsbury. Seeing a boulder resting where no

others of its kind ever had, Darwin recognized for the first time the reality of a pre-existing age – incredibly far before his own.

On March 24, 1855, at the age of thirty-seven, while canoeing down the Assabet River, Thoreau, too, conjectured that the residing rocks that had come to slide into the middle of this river had been moved by the water as the river often “eats into the hill” with its rushing and channel changing – causing the underlying rocks to dislodge” (Thoreau, The Heart...214). Both men understood that the events that caused these rocks to rest in conspicuous places most likely resulted from prolonged natural forces that occurred over time. Not only rocks but other organic forms of life have appeared far from where one would think their natural habitat lay.

Darwin explained the relationship between where special species arose and their tendency to desire a particular environment through his theory of natural selection. This selecting mechanism portrays just how various species have appeared only to become extinct and also demonstrates how less capable species fail to exist as part of a thriving population.

Natural Selection: Mother Nature's Choice

The process known as “natural selection” centrally focuses Darwin’s entire biological evolutionary theory. This popular but too narrowly conceived “only the strong survive” interpretation appears rather simple in concept but in practice must engage and be engaged by a host of intricate environmental and elemental forces. Simply put, natural selection impels the means by which species successfully survive. Literally stated, natural selection is a “complex process in which the total environment determines which members of a species survive to reproduce and so [*sic*] pass on their genes to the generation” (Allaby 265).

At first, unfortunate social implications obstructed Darwin’s explanations when he attempted to explain key elements of his theory – like natural selection. This miscommunication stemmed from Darwin’s willingness to allow a popular but inaccurate term to penetrate the public psyche. In 1864, at the bidding of Alfred Russel Wallace (1823-1913), and two years after Thoreau lay buried at the end of Bedford Street in Concord, Massachusetts, Darwin resigned himself to Herbert Spencer’s sweeping description of natural selection dubbed “the survival of the fittest.” Darwin woefully contended that he should have redefined his natural selection theory earlier and called it (more precisely) “natural preservation” (Browne 59).

Lost among this misidentified theory was the significance that variation plays in the process of selection. More specifically, Darwin clarified natural selection as “...the preservation of favorable individual differences and variations, and the destruction of those which are injurious” (The Origin of Species 88-9). Thoreau also understood the

value that variety offered an organism and how change in the overall environment – the soil or climate – would enhance the prospect of a seed’s healthy survival:

Consider how the apple tree has spread over the country, through the agency of cows and other quadrupeds, making almost impenetrable thickets in many places and yielding many new and superior varieties for the orchard. (Faith in a Seed 79)

The observant Thoreau noted too how modifications in color effectively aided the success of a species – as well as naturally enriching soil or producing a more favorable climate. He acknowledged how a flower or fruit’s ability to either blend in with the environment or contrast its surroundings may produce either favorable or disastrous results. On October 8, 1858, Thoreau remarks about how all of nature to her advantage colorizes and alters according to the seasons, the sun and the weather:

The brilliant autumnal colors are red and yellow and the various tints, hues, and shades....Blue is reserved to be the color of the sky, but yellow and red are the colors of the earth flowers. Color stands for all ripeness and success.... Now we shall see what kind of fruit will succeed. (Thoreau, The Heart...308).

Thoreau’s vibrant fruits and seasons wear the colors of health and life. The contrast of reds and yellows – against a sky-blue backdrop offers the flowers both a blend and a dissimilarity to the heavens – an incongruity of hues that will assure the balance necessary for the preservation of life.

The idea of variation and its contribution to natural selection equally crept into those faithful to the idea of specially created life. In The Origin of Species, Darwin

discusses how Chevalier De Lamarck's (1744-1829) interpretation of Spontaneous Generation states that in the creation and destruction processing of life, organisms perpetually evolve toward perfection. Darwin challenged the concept of continual betterment of the species by asking if natural selection only ensured improvement of a species, then "...why have not the more highly developed forms everywhere supplanted and exterminated the lower?" Nevertheless, Lamarck's idea contained his own unique version of variation – one that did not need to undergo natural changes or logical earthly influences to alter a species (125).

Lamarckian ideals held fast against the up-and-coming Darwinian beliefs because this French biologist and botanist – Jean Baptiste Pierre Antoine De Monet Chevalier De Lamarck – had already fully provided a theory of evolution as early as 1809, and up until 1859, a literal interpretation of the Bible's version of creation remained an impenetrable belief for most (Mayr 5).

Darwin anticipated, however, his opponents arguments and to further counter Lamarck's spontaneous and progression-of-the-species' claims, Darwin cited such basic examples as infusoria (simple, tiny organisms found in decomposing organic matter) and rhizopods (amoeba protozoan or lobate [rootlike] pseudopodia) as organisms that have not improved – because no biological, structural or environmental advantage necessitated a reason for these primary organisms to progress (Darwin, The Origin...126).

Darwin not only countered certain Biblical interpretations, but he also utilized their historical truths to make his point concerning artificial selection versus natural.

Darwin admitted that the theory of natural selection had not originated with him – or even Lamarck. He cited early examples of natural selection – as portrayed in the Bible in the Book of Genesis when breeding cattle attained desired color traits. Additionally, he noted how the Chinese had selected their animals for certain preferred characteristics. Even the Roman classical writers, particularly Pliny the Elder (A.D. 23-79), spoke of how the early Romans improved their domestic dog stock by breeding them with feral canines. The English, too, contributed to forms of artificial selection through centuries of altering to improve their racehorses. According to Darwin, any larger, stronger or faster horse falls into the category of “selection” albeit consciously contrived by man (Darwin, The Origin of Species 50). Sometimes even the unconscious selection by man compares with the natural selection by nature when, for example, man destroys or minimizes unfavorable traits in an effort to inhibit repulsive, destructive or non-productive species’ characteristics. Nature manages her own sifting of undesirable traits as Darwin indicates: “... monstrosities in nature are rare and when they occur they often do not survive” (97).

So what causal factors did both Thoreau and Darwin deem critical to selection and the successful continuance of life? Darwin asserts that climate, food and favorable conditions play into the prolific production of a species. Through a series of profitable variations, natural selection runs its course. For example, Nature might increase the species of a particular tree by spreading the tree’s seed by way of the wind – just as such method can also be actuated by a horticulturist selecting the seeds from cotton pods that only produce the finest texture of cotton (Origin of Species 93).

Charles Darwin's grandfather Erasmus Darwin (1731-1802) equally had an influence on Darwin's theorizing and bent for natural history. Their sharing included a foundation of ideas that eventually under girded many of the grandson's resulting theories. Erasmus Darwin, however, did not share in his grandson's ideas concerning natural selection, but this intellectual grandsire possessed a diverse catalogue of interests and knowledge including poetry (a talent for which he was well-known), philosophy and botany. His career as a physician and naturalist led him to biological questions and discussions concerned with species transmutation ("Erasmus Darwin"1).

Ernst Mayr (1905-2005), one of the 20th century's groundbreaking evolutionary biologists and former Harvard Zoology professor of Alexander Agassiz explained the concept of transmutation as conveniently offering another means by which to insert a variation of the Spontaneous Generation theory. By belief-wise complying with the philosophy of essentialism and conceding to the idea that the world is contrived of immutable types, one might seemingly conclude that since these types cannot alter, then a new version of life must appear "through an instantaneous 'mutation' or saltation of an existing type." Strong proponents of this theory have published arguments in support of saltation as late as the mid 1900s (Mayr 78). Because intermediate fossil remains largely went undiscovered until the twentieth century, along with precise genetic advances and taxon or species classification, transmutation died a slow death (79).

Many of Darwin's evolutionary ideas generated from previous origin concepts emanating from men like Charles Lyell, and James Hutton; but, the overriding concept

of natural selection inherent to Darwin's theory of evolution appears to be unique to Charles Darwin. He decried the misguided public critique of The Origin of Species when appraised as successful simply because "the subject was in the air" or "men's minds were prepared for it." In Darwin's autobiography (first published in 1887), he explains that when he would peremptorily discuss his ideas on natural selection, he could not find a single naturalist who seemed to agree with him: Even his close friends and scientific counterparts – Sir Charles Lyell and Joseph Hooker – appeared to listened to him only out of politeness (The Autobiography of Charles Darwin 124).

To not understand variation's roll in natural selection served to cloud the essence of his theory – and such misunderstandings paved the way for the arcane door of spontaneous generation to stay open in spite of Charles Darwin's confirmation to the contrary. Insinuating or linking his evolutionary ideas with seeming underlying corollaries to spontaneous generation provoked Darwin to definitions of a simpler nature. Overall Darwin would not concede to the popular assessment that he viewed nature and natural selection as forces basically compelled by God. Because of these and other inaccurate assertions about Darwin's ideas, he clearly defined what he meant by the word "nature": Darwin signified nature as "the aggregate action and product of many natural laws, and by laws the sequence of events as ascertained by us" (Darwin, The Origin...89).

It appears that Thoreau too understood a connection between variation and natural selection because one of his personal journal recordings reveal on May 23, 1854, that he anticipated improvement of fauna and flora in due time:

I expected a fauna more infinite and various, birds of more dazzling colors and more celestial song. How many springs shall I continue to see the common sucker (*catostomus Bostoniensis*) floating dead on our river! Will not Nature select her types from a new fount? (Thoreau, The Heart ...198)

Thoreau suggests that even a floating shoot possesses the potential for nature to create a novel species from one so commonly found “dead” and floating. Nature affects both her dazzling fauna and the lowly sucker equally – in her march forward to improve her charge.

Even after his own morphing into a man of science, Henry David Thoreau continued to personify nature in his writings to embody a moral, social or spiritual point –. On August 19, 1851, he recorded, “I fear the character of my knowledge is from year to year becoming more distinct and scientific” (Thoreau, Material Faith 25).

During the period that Thoreau worked on his manuscript Wild Fruits – off and on from 1850 to 1861 – his interest in science and botany increased. He began consulting a botanical guidebook on his daily walks and started collecting specimens. In an effort to keep his records completely accurate, by 1850, he had begun recording each botanical entry and no longer included his scientific data with his personal journals (Thoreau, Wild Fruits ix-x).

Although this Transcendentalists symbolized nature as a matter of philosophic and literary course, Charles Darwin, on the other hand, realized and resisted the temptation to speak of nature in religiously inspired terms – choosing rather to define

the biological means of natural selection through natural laws. To adopt the Romantic's and Transcendentalist's tendency to personify Mother Nature' in an effort to explain his theory of natural selection would complicate a concept that demanded clear and concise definitions (Darwin, The Origin of Species 89).

Wild Fruits became Henry David Thoreau's final tribute to nature: His collection of thoughts, hypotheses, observations and recordings did not get published until 2000—but this collection demonstrated his detailed botanical efforts referenced throughout a brief lifetime of perceptive observation. The formal recording of this manuscript, however, began in the autumn of 1859, several months prior to Charles Darwin's publishing of The Origin of Species. Thoreau's latent manuscript served as a segment of a more pronounced project that Thoreau had begun in Concord in the summer of 1850. The year after his publication of A Week on the Concord and Merrimack Rivers and "Resistance to Civil Government" (1849), Thoreau wrote in his November 16, 1850 journal, "I feel ripe for something, yet do nothing, can't discover what that thing is," (Wild Fruits ix). His detailed records on New England flora produced a manuscript that corroborated the sentiments of Charles Darwin—who regarded Nature as an ultimate surviving, hopeful entity (The Origin of Species 77).

Both Darwin and Thoreau commented on the efforts of natural selection compared to man's artificial means of culling preferred flora and fauna. In Wild Fruits, Thoreau wrote that he watched an apple picker as he, one by one, discarded apples that had specks on them and therefore would not sell as well at market. The farmer's mechanical attempt to do what Darwin calls "artificially" select choice apples, in

actuality, Thoreau notes, missed the very point of what made the production of these apples possible in the first place (76). This farmer's attempt to choose "choice barrels," seems somewhat mystifying to Thoreau in that the very apples that the farmer casts out, bear the mark of the recently dropped flower usually poised at the base of the apple. What Thoreau does not reveal to the farmer – but shares with his readers – is that the farmer uses flawed criteria to disqualify certain apples. The farmer looks at the specks remaining on each apple as if their appearance will make these pomes less desirable – forgetting that the seeming marring flecks in actuality tell of "the magic of the fruit [once] represented by the floral parts" (Schmalstig). The farmer disregards the importance of the flowers which generally form pollen as the flower buds grow – forgetting that from this pollen and potential fertilization come the precious seeds of the apple tree.

In Thoreau's journal accounts from The Concord and Merrimack Rivers (1839), he recorded his diverse nature experiences with his brother, John, while detailing how the willow tree bonds and harmonizes with the streams. Prior to history ever crediting Thoreau as a botanist, he wrote the following:

The dead limbs of the willow were rounded and adorned by the climbing mikania (*Mikania scandens*) [climbing hempvine], which filled every crevice in the leafy bank... The water willow (*Salix Purshiana*), ... masses of light-green foliage, ... seemed to float on the surface No tree is so wedded to the water, and harmonizes so well with still streams. (The Concord and The Merrimack 51-2)

For the *Salix Purshiana* favorable comparisons abound when later in the passage Thoreau relates how this graceful tree gainfully incurs a “buoying up” by the stream rather than the drooping of its branches into water like the weeping willow. Further, Thoreau seems to suggest a symbiotic connection between the stream and the tree – the tree lending enough of a root system to bolster the stream’s structural basin while the willow simultaneously absorbs enough water to quench a thirsty root system – further providing turgid strength to leaves that will not drape into saturating, destructive waters.

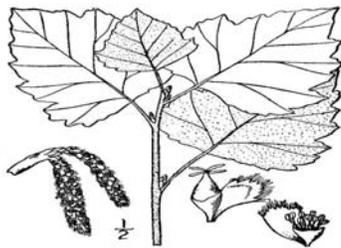
Over ten years later, in his journals, Thoreau speaks of how “man has learned to protect his causeways against flood by setting willows of the largest species there” (Faith in a Seed 59). This perception of how the willow tree selects a watery host as if it were a natural partner appeared in writing twenty-one years prior to the acknowledged date of Henry David Thoreau’s having read Charles Darwin’s The Origin of Species (1859). Thoreau understood the self-serving mechanics of natural selection – as he perceived that the willow chose the water for its natural, hydrating advantage, and the roots of the tree offered strength to the soil – which in turn bolstered the base of the tree enough so that the lacy leaves did not dip and decay in the water.



Salix Purshiana

Synonym: *Salix Nigra Marsh*
Courtesy of Kentucky Native Plant Society
Britton, N., and A Brown

The willow tree and her propagation methods have long enjoyed historical attention and study. The willow has gained attention for its attraction to water as recorded in aged literature. Thoreau recounts venerated writers and botanists who have passed on the geographical preferences of the willow. He cites Sir Alexander Pope's translation of the description of the Infernal Region that Circe describes to Ulysses to acquaint him with his destination: "...The Barren trees of Proserpine's black woods/Poplars and willows trembling o'er the floods." Additionally, the explorers Hind and Sir Alexander Mackenzie (1755?-1820) [the first white man credited with crossing the full north American frontier from the Peace River to the Pacific Ocean in 1792-3] wrote of the plains river valleys in the northwest as predominately strewn with willows and aspens (Faith in a Seed 58).



Populus alba L.: White Poplar
Britton, N.L., and A. Brown, 1913
Courtesy of Kentucky Native Plant Society

Natural selection, however, could not provide an evolutionary panacea for all questions concerned with human and animal origin and processing—or extinction. That inevitable anomaly called “sterility” often reared its random head at seemingly inexplicable times—defying natural selection’s regularity of genotype reproduction that ensures beneficial variations. The twenty-first century concept of sterility describes a biological/reproductive process that reached a non-productive point—or more

specifically, “...the inability to produce viable propagules or to reproduce sexually” (Lincoln, R.J., G.A. Boxshall, and P.F. Clark 235). Both Darwin and Thoreau concluded that sterility in plants could not be the result of natural selection because sterility is not to the advantage of a species – but rather prevents the plants ability to germinate.

The prime candidates for sterility, as Darwin pointed out, entailed the relevance of first crosses between like forms (species) – along with their hybrids. Because the degree of sterility varies within an organism, many times those trying to classify an organism as either sterile or not, customarily missed the finer point that the plants/animals tendency to no longer reproduce was often, in actuality, just a matter of degree – rather than outright resistance to any continued selection (Darwin, Origin of Species 290).

Creationist ideas have crept into explanations of why species become sterile, too; Darwin, however, would not entertain the idea that select species “have been specially endowed with various degrees of sterility to prevent their crossing and blending in nature...” because he considered such foundational reasons as untimely embryonic death, or as oft prevails in the case with hybrids, their individual, primary forms which undergo an attempt to compound characteristics that manufacture “new and unnatural conditions.” Additionally, Darwin points out that when attempting to determine the causes of sterility, one equally needs to take into consideration the variance of degree of trait dissimilarity between the two original species providing the attempted cross (The Origin of Species 290-1).

For Darwin to believe that God had caused a human or an animal to become intentionally barren was difficult when he could determine a variety of biological factors that contributed non-productivity in the plant. In summary, Darwin determined that sterility might have several causal factors: unfavorable conditions; critical trait differences between the original propagators (those being crossed); first crosses being too similar in form; first crosses conducted between hybrids; or that the non-productivity may have been one of degree rather than one of a totally permanent condition.

Thoreau addresses the complexity involving sterility versus fertility in his 354-page manuscript, Faith in a Seed (1993). This late publication has resurrected Thoreau's reputation as a Transcendental poet, while pronouncedly revealing the analytical side of a sentient man of science. In that this manuscript touts his "...first new book...to appear in one hundred and twenty-five years," the similarity and contrast between poet and naturalist has resulted in a spiritual-scientific perspective made clearer by the distance of time (Faith in a Seed 3).

In his final manuscript, Thoreau records that the willow's and poplar's "downy seeds" produce both sterile and fertile flowers--noting that these barren and fertile flowers also invariably inhabit different plants. He pens the following impressions when distinguishing the fecundity of his beloved seeds:

It chances that most of the foreign white willows set out on our causeways are sterile. You can easily distinguish the fertile ones at a distance, when the pods are ripe and bursting, by their hoariness. It is said that no sterile weeping

willows have been introduced into this country, that we have but one-half the tree and accordingly no perfect seeds are formed there. Also, I have detected but one sex of two of the indigenous willows common on the brink of our river

(55)

Thoreau, like Darwin, indicates that sterility is a natural happenstance – but not an intentionally favorable occurrence because nature selects that which favorably ensures her own existence. Thoreau mentions that the sterile weeping willows have *not* been purposely introduced into the country and yet it is the “foreign” white willows that are sterile – indicating that these barren seeds occur without the preferred selection of either man or nature. Although Thoreau (unlike Darwin) does not categorically list the various possible causes of sterility, Thoreau, nevertheless, recognized that infertile willow seeds can be the result of only one sex of a tree being available for propagation, or because, in the case of the foreign white willow, the environmental conditions for the tree are not being met.

Darwin divulges that overall sterility is not an act or punishment meted out by Providence. Nature, he implies, selects what lies in her best interest and is suited – or at least is not incompatible with the surrounding biotic community (Siry 119). Darwin indicates specific, known provocations for sterility or fertility like embryonic death or a receptive environment. Additionally, Thoreau suggests that the intrusion of civilization proves another hostile condition that the white willow must suffer, as these seeds often come to rest on causeways which have been cleared and graded – reducing the foreign willow seeds’ chances even more for prospective fertilization due to lack of available

space – the geographic area necessary (as Darwin continually points out) for the successful production of natural selection to occur.

The flexibility of the local willow seed did not escape Thoreau and in an effort to purvey what other mechanisms ensure its survival, Thoreau meticulously measures the seed to see how size and weight might have lent to the prospect of the seeds fruitfulness. His records revealed that his treasured willow seed measured “almost one-sixteenth of an inch in length by one quarter as much in width” – affirming his suspicions that this seed with its lithe weight and cotton-like base hairs has the ability to float to more diverse environs than the heavier and increasingly rarer birch (Faith in a Seed 55-6).

Charles Darwin deliberately and methodically dispelled myths about the crux of his evolution theory by explaining what natural selection did not mean. “Sterility of first crosses and their hybrid progeny has *not* been acquired through natural selection” (The Origin of Species 275-6). Henry David Thoreau considered that unlikely participant in nature – sterility – as adverse to the profitable succession of species. These men followed their hypotheses concerning their belief in nature’s probability to provide for herself – under changing conditions that could spur even stronger variations – whether those conditions blew a willow seed to vast lands and climes or by creating a more colorful, adaptable type.

As previously discussed, the gradualizing process through which natural selection engages a host of activities and environmental experiences occurs through incredibly slow time – enough time to allow for just the right composition of elements

to afford amenable, overall acceptance. Additionally, for profitable structural changes to succeed, Darwin explained, optimal situational conditions must “long endure in order that any marked effect should thus be produced.” Scientists may be looking for a physical alteration prior to the time conditions allow for such change to take place—precluding the ability to “view the results” of the structural transition (Darwin, Origin... 208). Further, Darwin states that variation occurs so subtly and steadily to a species that man usually does not even recognize the slight structural or functional changes (90-1).

On December 16, 1837, in one of Thoreau’s earliest extant journal recordings, he spoke of the characteristics that embody “a true man of science”:

How indispensable to a correct study of nature is a perception of her true meaning—The fact will one day flower out into a truth. The season will mature and fructify what the understanding had cultivated. Mere accumulators of facts—collectors of material for the master workmen, are, like those plants growing in dark forests, which “put forth only leaves instead of blossoms.”

(Thoreau, Material Faith 1)

Thoreau realized that merely collecting data did not serve a scientist well. Assembling facts about nature—based on detached, theoretical hypotheses—without trying to understand Nature’s “true meaning” or reason for her design presented only a partial and therefore incorrect study. For example, when Thoreau spoke of natural selection, he did not write merely that a willow seed often accompanies watery environs, he—in reverent tone and terms—indicated that the wedding between these

two (the water and the willow seed) were a match made by nature. This holy union might be interrupted by civilization in light of their effect on a “causeway” perhaps; but without people understanding how their own lives mirror the health of their biotic environment, then sciences approach to studying nature, Thoreau clarifies, with their charts and endless Latin names, means little.

Charles Darwin lived out the words of Henry David Thoreau – as Darwin, too, only a few years after Thoreau’s journal entry, indicated that his natural selection theory would one day meet full evidentiary approval. Such glowing confidence was customary for this persuasive gentleman scientist (Browne 5) who predicted that one day this theory would meet social and scientific acceptance. He understood that once scientists had the time to more thoroughly and readily study his natural selection phenomenon, then his prime-moving theory for life’s origin would factually counter any of their objections. Charles Darwin, in an almost poetic tone assured his reading public that the present-day arguments against his natural selection theory would one day most assuredly “pass away” (Darwin, The Origin 89).

Transport: Natural Disbursement

In the early 19th century, one of the reasons that special creation went uncontested as a theory was because scientists and botanists had not considered the link between seed dispersion and non-indigenous plant growth. Darwin reported that other than Charles Lyell and himself, no one had seriously considered the significance and means by which seeds could be transported and eventually adapted from one vastly different milieu to another. Even though Darwin commented that Lyell had already “admirably” addressed the subject of seed dispersal, Darwin felt compelled to explain the circumstances under which many plants appeared and adapted to otherwise “unlikely” locals (Darwin, The Origin of Species 353). He realized that the seed’s structure, too, often made this miniscule source of life alluring or accommodating to other animals. Darwin delineated how a seed’s encasing could even transform into a “balloon-like envelope” – whose structure would then become amenable to wind carriage. Additionally, he related that the seed grain is not only nutritious for diverse animals, but that specific colors serve as lures for select birds. Even a seed’s “hooks,” “grapnels” (prongs), Darwin discovered, offer the seed transport when stuck to the fur of quadrupeds (Darwin, The Origin 182).

Further, Darwin provided an unusual example of how birds brought seeds to other lands. He reported that the means of seed propagation were often so “common” that this form of planting was often missed by the average observer. Darwin conducted an experiment where he collected three tablespoons of pond mud from under the water;

the mud also came from three different locations. He mixed the mud and covered the sticky substance for six months – only lifting the cover to count and pull up each new plant that appeared. He discovered that within the span of six months a total of 537 plants had grown in the small breakfast cup that he had used as a container for the mud. Also many different types of plants sprang from the “viscid” mud. From this experiment he deduced that water birds must be bringing this variety of seed from their various habitats (Darwin, The Origin 376). Prior to Darwin and Thoreau having investigated the myriad of specialized but simple means through which seeds transport, this major contributor to world-wide plant propagation had been missed. Special creation seemed a logical choice for many when considering how life began since a preponderance of provable data had not been produced in an effort to argue the point.

Among other reasons, Darwin asserted that climate and land level alterations instigated the need for vegetation and animals to migrate. By the mid 1800s, geologists generally agreed that most islands and land masses – even those presently under the ocean – at one time, undeniably connected. Darwin quotes Edward Forbes (1815-1854) as having “insisted” that the Atlantic islands once joined Africa and Europe – in geologic time – not that long ago.

Edward Forbes led initiatives in biogeography, paleontology and oceanography. Not unlike Darwin, he served on the HMS Beacon as a naturalist studying the Grecian Archipelago and Asia Minor in 1838 and 1841. Darwin admired Forbes’ “polish and intellect” among his other notable achievements (Darwin, “Letters of Charles Darwin” 51). Forbes’ prominent essay, *On the Connection Between the Distribution of the Existing*

Fauna and Flora of the British Isles and the Changes Which Have Affected their Area (1846), influenced Darwin's own ideas concerning concepts dealing with the distribution and adaptation of flora and fauna in distinct, distant locals. For example, Darwin concurred with Forbes who had documented that he discovered the same type of massive rocks in the Cordillera [South America] that he had seen in Norway. Forbes' discoveries affirmed Darwin's own findings that former glacial activity must have occurred to cause these larger boulders (that both men were finding throughout the world) to appear in otherwise vastly distant places (Darwin, The Origin 363-4).

America and Europe, too, bore enough topical similarities, earthly components, and similar varieties of flora and fauna to indicate signs of previous, mutual geographic enjoyment. Like Forbes, Darwin came to "freely admit" that many of the islands presently submerged beneath the oceans at one time served as rest areas or homes to migrating plants and animals. Although the idea of seed dispersal answered the primary question of how flora and fauna appeared in otherwise atypical terrain, Darwin realized that little affirmable data existed to prove the generally agreed upon hypothesis; therefore, Darwin initiated diverse experiments to determine how sea water affected geologic seed dissemination— sizably contributing to the once scarce information existing on the subject (Darwin, The Origin of Species 354).

Darwin and Thoreau both studied the transport of seeds and how those seeds adapted to their new and sometimes non-native environments. Water and its contribution to organic life had become a curiosity among scientists and the reading public. Darwin devised a number of experiments in an effort to observe just how seed

transported both in and over a body of water. Scientific explanations for man's biologic birth origin and succession started influencing the generally traditional Victorians. The idea of water – as an essential element underlying man's potential to exist – also made its way into the scenarios of popular fiction writers of the early 19th century. In the mid 1800s, throughout Europe and America, literary artists such as Fritz-James O'Brien and Edgar Alan Poe introduced and stretched the perimeters of speculative non-fiction. The significance that water played in the origin of life steadily seeped into the mind's of the reading public through this projecting and hypothesizing genre of new non-fiction. The Irish born Obrien (1828-1862) published "The Diamond Lens" a year prior to the publication of Darwin's, The Origin of Species. This popular, science-based fantasy portrayed a lovely female living within a water droplet. Seeing life in microcosm and containable within the survivable confines of an H₂O molecule further spurred noted latter writers like Ray Cummings (1919) to produce innovative short stories such as, "The Girl in the Golden Atom." Darwin's concrete experiments to determine the workability of life's transference to other terrains – and through oceanic, or other water-related means – inversely appeared in the writings of novel science fiction minds exploring concepts concerned with life's progression made possible within the minute boundaries of atoms, molecules and that uncanny mix of one of the oldest and most common compounds known to man – the one part hydrogen and two-part oxygen mix ("Timeline 19th Century" 11). While Darwin configured seed and water experiments (his laboratory often set up in his own home), Thoreau compiled notes as he observed how water bolstered the stamina of trees, its ability to transport seeds and even the

means through which water worked with other environmental factors – like the wind and air temperature.

Water, Darwin discovered, even served as a catalyst for bees that unintentionally carried pollen to various flowers. For example, Darwin reported how Dr. Crüger's experiments with the *Coryanthes* revealed that this orchid collected "almost pure water" in its bucket-shaped base that almost appeared hollowed out. This flower secreted water from two projections located above the labellum or "lower lip" which eventually filled up the base's pocket and overflowed like a spout. He explained how the lower part of the labellum projected past the bucket and also possessed what looked like a type of "chamber" with two horizontal openings or entrances which contained "fleshy ridges." As large humble bees gnawed off the ridges, the crowd of bees caused some others to fall into the well of water below. As the bees attempted to crawl out of the flower (because their wet wings would not allow for flight) – through narrow grooves created by the overflow of water – the bees would then "rub their backs against the viscid [sticky] stigma and viscid glands" causing the pollen to adhere to their backs. Once the pollen-backed bees flew away, they inadvertently pollinated other flowers. Darwin was fascinated by the ingenious ways that water served not only as a means of transport for seeds – but this versatile organic liquid also demonstrated a creative means through which bees carried seed microspores to other flowers.



To the left: *Coryanthes verrucolineata* from Perú From the Peruvian specimen of *Coryanthes*, one can identify the bucket-like shape that holds the water secreted from two “horns” (within the flower and so not identifiable) that sit above the labellum or lower lip of the orchid.

To the right: Traditional bee pollinator of *Coryanthes mastersiana* Host: Columbia Department Chocó: This bee traditionally pollinates *Coryanthes*. Darwin, however, spoke of Dr. Crüger’s observation of the “humble bee” or large bumble bee falling in and rubbing pollen from both the sticky stigma and pollen masses in their desperate effort to escape their watery well. Darwin was amazed that these humble bees (not pictured) did not visit the orchids to pollinate them, but rather to eat the fleshy ridges housed in the chamber of the base of the labellum.



Working within the realistic perimeters of the scientific realm, however, Darwin had determined to discover how water transport contributed to seed dispersal. Through a series of thorough “floating” experiments, Darwin’s plant seed transfer tests substantiated the fact that vegetation did not just unaccountably grow in non-indigenous milieu. To Darwin’s delight, out of the 87 varying types of seeds immersed in salt water for a period of 28 days, 64 of these persevering seeds still germinated. After conducting floating trials with small light seeds that did not contain their fruit or capsules [i.e. weight], he realized that because these seeds sank so readily, then they could not have sustained the long journey required to cross the sea and subsequently

grow. Darwin devised numerous means and situational variables to ascertain the survivability of select seeds in ocean water. Additionally, these revelatory seed experiments were substantiated by another botanist, M. Martens, who had conducted even more exacting experimentation methods than those of Darwin's (The Origin of Species 355). An advantage to Martens' efforts rested in the fact that he used not only larger seeds but also seeds that invariably grew in the geographic areas in question. He even put the seeds in actual sea water where they alternated between air and saline water – to more realistically actuate the full environmental exposure to the seed.

From observing the results of a compilation of both Marten' and his own seed-transport data, Darwin discovered that ten out of one hundred pre-dried plants could float for a distance of 900 miles and still remain undamaged enough to germinate. These outcomes also confirmed Alphonse de Candolle's results (1806-1893) who reported that large seeds/fruits most likely traveled by this method of floating inasmuch as their increased weight would have prohibited animals and birds from transporting them. Determining the capacity for weightier fruit/seed transport further explained these heftier seed's tendency to inhabit a more "restricted terrain" (Darwin, The Origin of Species 356).

Although Charles Darwin's reputation as a groundbreaking evolutionist often connotes his work in classifying flora and fauna, in actuality, men like Alphonse Louis-Pierre de Candolle (1806-1893), the noted Swiss botanist/phytogeographer along with his father – the reputed and renowned European botanist of the latter eighteenth century – Augustin Pyrame de Candolle (1778-1841) – provided the basis of

information from which Darwin built his hypotheses and experimentation ideas concerning plant evolution and classification. Augustin Candolle attempted to undertake the mammoth task of typifying *all* plants. His effort, called *Prodromus Systematis Naturalis Regni Vegetabilis* began as early as 1824, and once completed, included a total of seventeen volumes. Darwin's references to Alphonse Louis-Pierre de Candolle indicate his respect for Candolle's meticulous work – and equally provided the foundational information upon which Darwin built his own botanical hypothesis and means of experimentation.

How plants and animals migrated from one geographic location to another concerned both Darwin and Thoreau. Initially, Darwin discussed the perplexity of how various species of plants and animals found themselves in one primary geologic local. He realized the importance of considering all of the logical possibilities of transport before proposing a likely theory. He recounted how a case of mistaken identity (as far as determining the actual geographic origin of select plants and animals) frequently occurred when biologists, archeologists, and geologists tried to claim a particular plant or animal derived from a select location. For example, just because the Mastodon tooth surfaced in the Antilles, Darwin asserted, did not prove that the host animal originally dwelled in the Bahama's. Darwin believed that such finds as the tooth could have floated there in the carcass of an animal – offering the likely possibility that the tooth had become embedded in the stomach of the carcass that had consumed it (Darwin, Voyage...131).

In 1836, the year prior to Thoreau leaving Harvard, Darwin noted on his voyage for England the unusual predominance of coral comprising Direction Island. This island, found 600 miles from Sumatra in the Indian Ocean, had heartily withstood the power of the ocean waves, only to benefit in other ways as the sea brought ashore the seeds that accounted for the (then) surviving vegetation. When assessing the structure and distribution of coral, Darwin additionally considered how the coral endowed the “vigorously” growing “vegetation.” He attributed the healthy, non-indigenous twenty species of flora and two trees to their seeds having floated ashore by way of sea waves (Darwin, The Voyage...334). Darwin cites other observer’s experiences, too, specifying the accounts of A.S. Keating who published in Holman’s Travels, and whose studies indicate how Mr. Keating’s twelve-month stay on the island allowed him the time to discover a variety of seeds washed ashore. Darwin ultimately concluded that geographically disparate seeds arrived in a panoply of ways – not withstanding, the occasions of even fishing-canoes from Java that eventually washed ashore carrying resilient seed varieties like “creepers.” (335).

Darwin did not ignore the influences that climate and geography played in relation to the probability of successful seed dispersion, nor did he eschew how such tiny nuggets of life may have successfully ensured the naturalization of certain aboriginal plants. He hypothesized that the water itself may have preserved rather than destroyed the seeds. Even after all of Darwin’s meticulous experiments and thorough descriptions of the myriad means of water transport for seed dispersal, questions still arose concerning the seeming relentless belief in spontaneous generation. Additionally,

when challenged with the inquiry of how and why certain plants appeared in select domains while others had not, Darwin claimed that often geographic “barriers” prevented successful passage and ultimate seed germination (Darwin, Origin of Species 351).

In fact, as aforementioned, one of Darwin’s first fascinations with the whole idea of evolution came about because of his intrigue with how gargantuan elements of the earth’s crust suddenly appeared in conspicuous, if not seeming illogical places. In his second year of college, the lectures on geology and zoology at Edinburgh rarely interested Darwin. However, one particular person’s know-how intrigued this father of evolution. From Darwin’s challenge by Mr. Cotton to explain how such a notoriously large stone (called the bell-stone) had come to rest in Shrewsbury, Darwin was forced to consider transport and how environmental curvatures and climes and alterations conceivably provoked, permitted or forbade certain natural conveyances. Mr. Cotton asserted that none had ever before been found of this type or size any closer than within the perimeters of Cumberland or Scotland. Darwin’s interest peaked at that critical revelatory moment as he imagined the impressive array of ways that the boulder may have come to rest in Shrewsbury. Ultimately, the idea of how plants and animals traveled to non-indigenous terrains proved the catalyst to his eventual evolutionary theory. He reflected on this early incident that spurred his eventual, continual quest into life’s origin as recorded in his autobiography. Darwin relays his elation when other affirmable data corroborated his own theory concerning how mammoth rocks may have come to reside in unlikely territories: “I felt the keenest delight when I first read of

the action of icebergs in transporting boulders, and I gloried in the progress of Geology” (Darwin, The Autobiography...53).

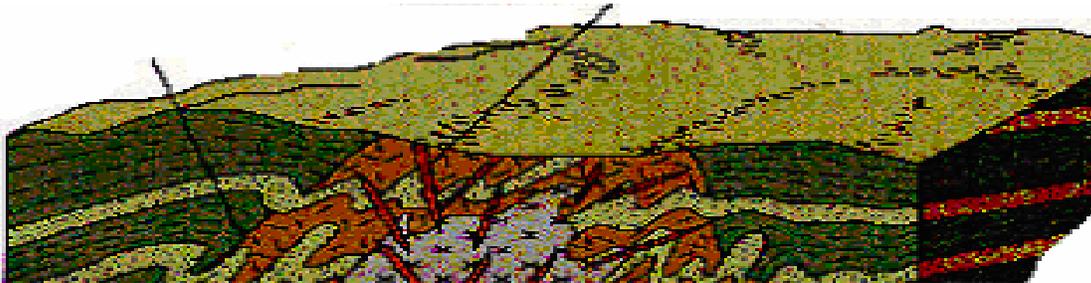


“The Bellstone” (from left) displayed in the town center of Shrewsbury, Shropshire, England is a probable sample of the type of unusual rock Mr. Cotton drew to Darwin’s attention.

Although an interesting granite boulder of impressive size, these rocks are often found along the Wailua River in Hawaii, where volcanic activity and rock is not uncommon. (Pictured to the right), a boulder resting by Halawa Valley Drive in Hawaii. This photograph provides a more rustic portrayal of the rock as it might appear in more natural surroundings. (See “Bellstone” in Works Cited for photography credits).

On April 29, 1834, during his Beagle voyage, Darwin recorded that not all transport of the earthly minerals and elements results from violent force. After having discovered porphyry, basalt, granite and slate rocks along the white summits of the Cordillera in Santa Cruz, Patagonia (Argentina, South America), Darwin determined that these rocks must have floated there via the ice at a time when the country remained submerged beneath the water (Darwin, Voyage of the Beagle 169).

Porphyry: An igneous rock containing identifiably distinct crystals. A sample of a disseminated (permeated) porphyry copper deposit. Top right diagonal line demonstrates how hydrothermal fluids may rise to form fissures and fractures. Top left, diagonal line indicates the outer boundary of mineral alterations caused by granite invasion. West Publishing Company 1994.



Icebergs provided not only the means for conveying boulders, but these glacial fragments accounted for moving and propitiously preserving certain seeds and birds' nests, too. Darwin quotes Lyell as having already noted that during the Glacial period, icebergs served as an efficient means of passage from select sections of the Arctic and Antarctica. Darwin agreed with Lyell's contention that "ice-borne seeds stocked the islands during the Glacial epoch" (Darwin, Origin of Species 358).

On a more select scale, microcosmic, representative samples of icy, snowy seed travel were scientifically observed and recorded from a Concord pitch-pine wood forest, too. Thoreau equally understood the roll that ice played in assuring successful passage for the seeds of particular flora and fauna. From Thoreau's *Dispersion of Seeds* (1860-1), he records how the pitch pine opens its cones throughout the winter, and after having wafted in the wind, such seeds slide "...yet further over the snow and ice."

Thoreau deduced that the crusted snow with its favorable smoothness probably served as the ideal texture for the pine seeds to scale to far-reaching germination spots. His

observations underwent repetitive tests in an effort to actuate the precision and number of times necessary to measure the distance from the nearest observable pine seed to the farthest. Thoreau notes how the snow and ice both expedite and facilitate seed passage:

In the fall it [the seed] would be detained by the grass, weeds, and bushes, but the snow having first come to cover up all and make a level surface, the restless pine seeds go dashing over it Nature has her annual sledding to do, as well as we. In a region of snow and ice like ours, this tree can be gradually spread thus from one side of the continent to the other. (27)



Pitch-pine seeds
Pinus rigida
from Thoreau's
sketches *Faith*
in a Seed 27



Fruit or cone from
which ripe, single
seeds disperse
Mill, P., U.S.
Department of
Agriculture

All of nature, at times, appears to take in and utilize her various parts to maintain the whole. Even the known freezing destruction of winter often dons a unique means of life-sustaining support. Thoreau reported that early in June on the shore of the Assabet River, he espied a black willow lying prostrate – yet amazingly, this noble tree still managed to prosper and flower. Upon pulling the tree out by its roots, this observant botanist realized that it was no more than twig size – measuring sixteen inches in length – with all but one third growing (buried) beneath the moist leaves and sandy wood shavings. He deduced that this isolated twig tree must have snapped off when hit by the ice. The tree then washed down as the ice melted and

rested at the point where he found it rooted. The ice's accidental breaking of the willow branch served only to allow this tree to offer itself to an environment not directly within the vicinity where black willows generally thrive. Seemingly, the ice could have easily destroyed the prospect for the willow to grow, crushing the tree, or decimating the seed's prospect to germinate; but for the resilient black willow, this winter severing brought the opportunity of new life to a typically foreign terrain. Thoreau perceived the relationship that these two normally divergent partakers of nature share as he noted, "The ice that strips it [the willow] and breaks it down only disperses it the more widely" (Thoreau, *The Dispersion of Seeds* 63).

If Thoreau had lived in the first part of the twenty-first century, he might have been surprised to learn that the Assabet River remains a continued presence as an eclectic bed for fertile seed growth. This river presently teems with vegetative life and resides as a favorite canoeing waterway and place where nature enthusiasts and botanists alike enjoy the pleasure and study of diverse flora.



The headwaters in Westborough to the river's end at Egg Rock comprise slightly more than 31 miles in length. At Egg Rock, the waters join the Sudbury River to form the Concord. Today this river possesses portions of non-navigable waters, and yet remains a choice place to canoe and intimately observe the red maple, river grape, arrowwood, alder, pickerelweed, honeysuckle, nannyberry, yellow pond lily, currant, green briar, winterberry, blueberry, skunk cabbage, oak, and traditional beech tree. (Wadsworth 1-5)

Thoreau recognized the relationship between seed dispersal and water and how either might vary according to the climate and environmental conditions. At times, snow and ice signaled the successful agent of transport – at others – torrents, floods, melted snow, or sometimes just the mere presence of water made for receptive seeding ground. Thoreau noted that seeds not infrequently found themselves atop a pond or lake’s surface, and, unless they sank, would continue on to eventually float ashore. He projected that given the right watery conditions, the willow, birch, alder and maple (to name but a few) would undoubtedly spring up in areas formerly unknown to these trees.

As Darwin intently experimented by carefully counting seeds that possessed the availability and ability to float in saline solutions, Thoreau likewise confirmed his hypotheses by closely observing similar seed-transport results. Thoreau reports how through experimentation by floating the alder and pine seeds down “distant shores,” the scales [a modified leaf protecting the seed bud] quickly sank in the water; however, he further recorded that the core seeds still possessed the unique capacity to “float for many days” (Thoreau, Faith in a Seed 44). Thoreau realized that water often supplies not only the creative life-sourcing for various plant varieties, but also the successful means of transport for these minute, potentially flowering trees.

Other types of trees, Thoreau wrote, had also gained passage by floating to the outer reaches of their own accustomed vicinity of growth. For example, the black ash seed, prescriptively housed “knife-shaped seeds” that clung to the leaf through most of

the winter – but ultimately floated off onto streams nearest where they [ultimately] grew (54).



Top middle portion of leaf demonstrates a “knife-shaped” seed.
Britton, N.L., and A. Brown, 1913.
Kentucky Native Plant Society USDA

Both Darwin and Thoreau recognized the ingeniousness with which seeds transport. Minute and fastidious research on seed transport comprised a significant basis for much of their origin of species research. These botanical men of science inherently understood that “To understand a seed, is to understand more than a forest or any plant, it is to understand the world....” (Siry, “Seeds, Soil and Water and the Renewing Circuit of Life” 2). Seeds, Thoreau notes, not only happen to find themselves transported by water, but also in the “midst of river meadows” and growing near or around rocks. Besides a means of conveyance, the creative combining of water and rock can carve a germinating home for a seed. Thoreau indicated that the usually unnoticed stolid rocks could even offer the stature and strength necessary for the trees and seeds to not falter and “waste away.” He also observed the protecting capacity of these water-based rocks, as they first stopped and held the seeds in place – and later protected the frail young trees as they matured – by continually preserving “the very soil in which they grow” (Thoreau, *The Dispersion of Seeds* 54-5).

Darwin attested to the validity of Alphonse De Candolle’s experiments with seed sizes and weights and the effects such had on their corresponding ability to transport;

and Thoreau, too, relied on this venerated botanist's claims – as Thoreau cited Candolle's quoting of M. Dureau's statement relating that mustard and birch seeds' ability to “preserve their vitality after twenty years' immersion in fresh water” (Thoreau, Faith in a Seed 45). But where Candolle rejected the idea of a particular seed's ability to travel because of their size and weight, Thoreau deduced that even heavy seeds, like acorns and nuts, given enough water or wind force, could still travel respectable distances. Because Thoreau had frequently discovered chestnuts in sizable mounds awash in hollows caused by “small torrents of melted snow or rain,” this belatedly discovered botanist realized that these sizable seeds could still surprisingly travel short distances (114).

Both Thoreau and Darwin researched similar transport ideas which ultimately offered plausible evidence to corroborate their disbelief in the basic premise of spontaneously generated vegetation. Both, too, verifiably respected the same men in the biologic field who served as their former and closely related contemporaries. Each man of science knew the role that water played in a seed's life – whether water served to convey a seed to germinating grounds by way of stream, or river, or merely by transforming itself into a frozen solid. Each of these emerging men of original thought recognized the various means for seed dispersion – other than that of the more customary water, waves, and water-based solids; these giants of natural study understood that Nature hosts a largess of conveyance to assure her life-sustaining seed.

Both men understood the significance of how wind and air current often determined the life of a seed. They perceived how blustery, mild or watery wind forces

facilitated a seed's journey – in sometimes surprisingly ingenious ways. The value of seeds “profiting” by the wind underscored Charles Darwin's natural selection theory as it related to the importance of wind transport. In his The Origin of Species, Darwin recounted how variations of species were made possible partly through nature literally having more availability or abundance from which to choose – in her effort to recombine and recreate new species. Through the prolific scattering of seeds by the wind, oftentimes seed shape, size and even flavor could favorably alter and diversify a species. Because of the improved numeric selection and availability of types – Darwin noted how combinations of seed necessarily abound:

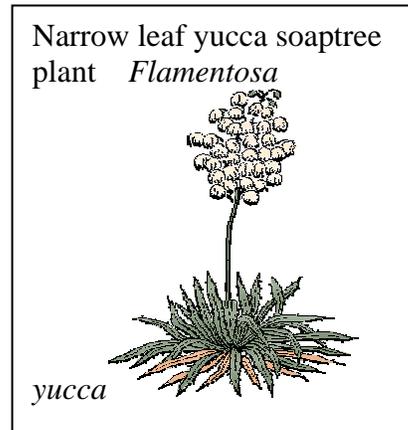
If it profit a plant to have its seeds more and more widely disseminated by the wind, I can see no greater difficulty in this being effected through natural selection, than in the cotton-planter increasing and improving by selection the down in the pods on his cotton-trees. (93)

In April of 1836, Darwin discussed generally disparate seed varieties common to Direction Island – and how those anomalies underwent successful transport by way of torrential winds and rains:

Right: *Ricinus communis*. Castor Oil Plant seeds: three seeds to a pod.

Illustration: “Castor Oil Plant: Antique Botanical Stephenson and Churchill,” 1836. Visual Language





Yucca seeds, U.S. Department of Agriculture, 2005

Darwin recorded soap tree yucca and castor oil seeds as non-indigenous to Keeling or the Cocos Islands. Darwin stated that these seeds most likely “have been driven on shore by the NW monsoon to the coast of New Holland and then to the coral islands by the SE tradewind” (Darwin, The Voyage...335).

The great number of seeds that managed to travel such vast distances to Direction Island continued to impress Darwin. He even went so far as to disagree with his noted mentor, Professor Henslow, who contended that all of the seeds transported to the island came from the East Indian archipelago. Henslow insisted that the usual wind and current stream could not afford a straight path from the archipelago to Direction Island. However, Darwin concurred with the findings of the well-reputed Adelbert Von Chamisso (1781-1836) – the French-born botanist revered (ironically) more in the twenty-first century for his legacy of poetry than for his contribution to science (“Chamisso” 1). Darwin noted that these resistant seeds traveled from 1,800 to 2,400 miles before resting to ultimately plant themselves. Chamisso wrote that the

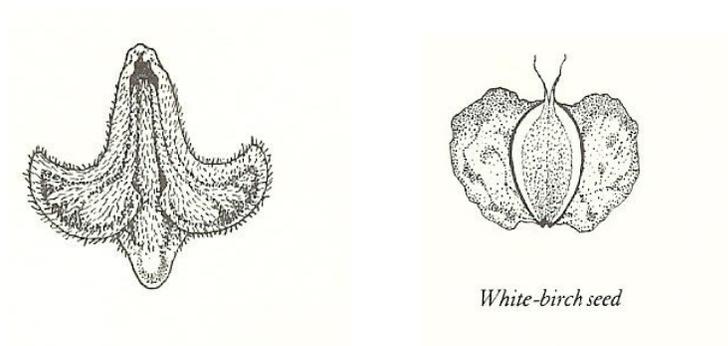
seeds which landed on the Radack Archipelago (central West Pacific) did not originate there. Darwin not only recorded but he also highly respected and regarded Chamisso's following comment: "'the sea brings to these islands the seeds and fruits of many trees, most of which have yet not grown here,'" and he added that most of the seeds "'... are washed ashore'" (Darwin, *Voyage*...335).

By April of 1836, twenty-three years prior to the publication of *The Origin of Species*, Charles Darwin had collected enough verifiable information on seed transport to corroborate the findings of Adelbert Chamisso and to argue the geographic impossibilities set forth by his former mentor and botany professor, the Reverend John Henslow. A significant aspect of Darwin's research led him to confirm nature's tendency to provide for herself within the confines of her own elemental circumspection. In natural harmony, the wind and water brought forth resplendent seed. Air current and surf served as joint seed conveyers – not only as carriers for these earthy nuggets of nascent life – but also as guides in their journey to their ultimately receptive, but distinguishably non-native, homes.

To adequately understand the significance of Henry David Thoreau's achievements as a man of science, one must delve into the influences on, and accomplishments of, Charles Robert Darwin. Thoreau certainly must have understood the importance of Darwin's research because Thoreau quoted Darwin's background knowledge in relation to seed transport by air. More specifically, Thoreau related in his *Dispersion of Seeds* that Charles Darwin quoted Alphonse De Candolle as having said, "winged seeds are never found in fruits which do not open. They were designed for

flight” (25). Darwin discussed seed dispersal by wind and wave current at least twenty years prior to his aforementioned *HMS Beagle* journaling of 1839, but the concept of how certain winged seeds may have attained flight appears to have been published later – securing the time period through which Thoreau had already read Darwin’s, The Origin of Species by Natural Selection or, The Preservation of Favored Races in the Struggle for Life in 1860.

Thoreau studied the various seeds that Candolle had deemed for flight – in particular, the birch tree seed. By studying and appreciating the significance of the structure of a seed, both Thoreau and Darwin realized the critical connection between the form a seed takes and its corresponding means of transport. Ironically, perhaps, a great abundance of seed does not always ensure a sound crop. Birch tree seeds, Thoreau stated, “...bear an abundance of seed,” but woefully, Thoreau also noted that in spite of their plenitude, the birch was becoming rarer in the Northeast (Thoreau, Faith in a Seed 41).



Sketches of white birch seed above hand-drawn by Thoreau, from his *Dispersion of Seeds* 42-3.

In Bradley P. Dean’s editorial notes from Thoreau’s essay, “The Dispersion of Seeds,” anthologized within Faith in a Seed (1993), Dean inserted Thoreau’s reading publication

date of On the Origin of Species by Means of Natural Selection, or The Preservation of Favored Races in the Struggle for Life at approximately 1860, the 2nd publication date, rather than the first publication date of November 24, 1859. The second edition was published on January 7, 1860 and sold out at 3000 copies. "Editor's Notes," p. 224. A month later, Thoreau is known to have publicly discussed The Origin of Species with friends.

In their pursuit of natural truths, Thoreau and Darwin each perceptively sifted through the studied background knowledge provided by former botanists concerning seed production and habit. Darwin balances his own findings against those of others, as Thoreau somewhat sadly recounts how the average viewer misses Nature's perpetual and reliable "gifting." He credits the wind with scattering northern birch grains hundreds of miles from Boxborough to Cambridge while ruefully musing the inappreciation of others:

... In sudden gusts of wind such seeds as these [birch cone], and even much heavier ones, must be carried over our highest hills, not to say mountains, and it is evidently one of the uses of such winds, which occur especially in the fall and spring, to disseminate plants. Alphonse De Candolle quotes Humboldt as saying that M. Bousringault had seen seeds (*graines*) elevated 5,400 feet (*pieds*) and fall back in the neighborhood ... [of the Alps].

Thoreau further expounds on M. Bousringault's claims suggesting that Bousringault's observation could be tested, and that even Thoreau himself could "arrange a trap" by which he would literally catch and quarantine the plenteous, floating, blustering seeds. Thoreau's description of his affirming experiment, however, rendered poetic as he speaks confidently of these seeds whose "light spray" peppers

even the highest summits of the Alps – as they perpetually mist the air from fall to spring (Thoreau, Faith in a Seed 43).

Additionally, the disposition of the wind and atmosphere often determines successful seed dispersion for particular types of trees. Methodically, Thoreau described a diversity of these trees and the exact dates that they began to seed and show their down. He recorded the behavior of each tree in the spring, relating, for example, how by May 13th, “...the earliest of our willows (*Salix Discolor*), ... show great green wands, a foot or two long consisting of curved worm-like catkins three inches” in length. This nature-enamored scientist explained that by mid-June the down of the aspen (*Populus tremuloides*) and other willow varieties like the *Salix Humilis* and the *Salix tristis* depend on the wind to spread their seeds over both civilized causeways and wild meadows alike. This seeming indiscriminate display of wafting seeds, ever faithful in their annual ripening, relied on the temperament of the wind and the capricious tempo of the air (56).

Thoreau’s formal recognition of the critical contribution that the wind offers to a tree’s expansion and survival occurred at least four to five years before he had read Darwin’s, The Origin of Species. When observing a full and flourishing tree, Thoreau connoted the connection between the tree’s seed of origin and the wind. This poetic man of science waxed worshipfully concerning one particular tree – the Red Maple – noting her trusty Fall display of colors or “autumnal tints” of burnish yellows, deep reds and earthy ambers. He both blessed and eulogized this Red Maple’s existence and cyclical demise unto new life. On September 27, 1857, Thoreau paid high tribute to this

“virtuous” tree when in his journal he shared his precious find with his reader concerning this lone, unnoticed Red Maple – having grown a mile from the nearest causeway. Nevertheless, this maple faithfully “discharges ... (her) duties” ... by steadily growing all summer.” Ultimately, in personifying praise, Thoreau honored this “industrious” tree, his *Acer rubrum*, and gave homage to its loyal contribution to nature – ages hence – when this young, steadfast tree “committed its seeds to the winds ...” Thoreau’s lyrical rendering of the beauty of a Red Maple generates from his deep appreciation of the fact that the wind first honored its own existence by conveying its accommodating seed (Thoreau, The Heart of Thoreau’s Journals, 276-7).

Not unlike Darwin, Thoreau realized that not only forceful winds but also mild air currents ably transported thousands of seeds to welcoming waters. Immediately after a heavy shower, On June 9, 1860, Thoreau recorded that he espied what he thought was lint or feathers floating “roof-high” and landing atop Mill Dam. At one point he even thought that such refined substances were “light-winged” insects. His account of willow seed traveling through a mild current vividly engenders the enterprising nature of the wind:

It [the willow down] was driven by a slight current of air between and over the buildings and went flying in a stream all along the street, and it was very distinct in the moist air, seen against the dark clouds This [flying stream] was white-willow down which the rain had loosened, and the succeeding light breeze set a-going, gearing its minute blackish seed in its midst. The earth having just been moistened, this was the best time to sow it. (Thoreau, Faith...56-7)

Precisely one week after having seen the willow slowly descend like soft bird feathers, Thoreau was fooled a second time by what he again mistook for feathers as he paddled down the Concord River. He noticed an unusually white shore (for at least two or three rods) packed with tiny seeds “collected by the wind, like a dense white foam a foot or two wide along the water’s edge.” He had not considered the white willow down previously because the border of the river was lined with the black-willow; however, because the wind came from the southwest, he realized that the wind had lifted the willows from a causeway after having been blown over land for fifteen rods [i.e. considering one rod [rd] equals 5.50 yards or 16.5 feet] (57).

Other than nature utilizing the properties of water and wind advantage for seed conveyance, Darwin and Thoreau additionally recorded the more overt means of seed carriage enacted by animals. Animal transport pragmatically provided the more predictable means by which to carry seeds because such purposeful transmission did not necessitate deferring to the whims of wind or water. The food preferences, habits and even engendering anatomical design of the various animals made them not only amenable to natural selection, but these customizing characteristics conveniently allowed for consistent transport throughout the year or to a preferred geographic food sourcing local.

On October 8, 1836, while on the *Beagle* voyage, Darwin wrote about his weeks’ discoveries and collections on St. James Island in the Galapagos Archipelago. Although Darwin assessed the stomach contents of what he found in monstrous lizards, he did not make any (recorded) connection between the acacia trees found within the

intestines and the lizards possible dispersing of the acacia seed (Darwin, Voyage...284). Further, Darwin recounted how particular animals came to exist in atypical places; for example, the few quadrupeds that actively roamed the broken islets of the Chrono Archipelago indicated that they escaped from “rapacious” animals – but the mention of their transporting seed along with their desperate migration to survive did not appear in Darwin’s these particular written discoveries. He even recorded how he believed that the alterations in sea level spread the small rodents and other vermin throughout the archipelago – but still no documented assessments appeared that might connect how these rodents may have inadvertently spread vegetation via seed dispersal through their excrement (Darwin, Voyage...227).

In his early recordings, while traveling on his *Beagle* voyage, Darwin concentrated more on the major physical transference of animals and how that transmission explained geographically unexpected animal appearances; but interestingly, by the time Darwin (twenty-four years later) had interpreted his results and had conducted additional research, he had connected and concluded the significance that birds, insects and animals make to the successful spreading of seed (Darwin, The Origin...356-8). Between Darwin’s delineation in his The Origin of Species concerning the “Means of (seed) Dispersion” and how that dispersion played out during the Glacial Period, he devoted a respectable amount of discussion describing the fortuitous ways in which animals scatter seed:

Seeds may be ... transported in another manner [other than by water transport].

... sometimes the carcasses of birds, when floating on the sea, ... escape ...

and many kinds of seeds in the crops of floating birds long retain their vitality: peas and vetches, for instance, are killed by even a few days' immersion in sea-water; but some are taken out of the crop of a pigeon, which had floated on artificial sea-water for 30 days, to my surprise nearly all germinated. (356)

Darwin evolved from his early exploratory investigations in the mid-1800s—thrilled at having discovered twenty-five new bird species in the Galapagos Archipelago at the St. James Island in October of 1836 (Darwin, The Voyage... 375)—to recognizing that birds, in general, often inadvertently sprinkle seeds to germinate otherwise non-indigenous plants. Darwin now fully realized that their [the bird species] expanded variety correspondingly permitted an increase in variety of vegetation.

Henry David Thoreau, in his final years of life, equally demonstrated a methodical, scientific delving into the in-depth workings of nature—having started from the practice of aesthetically admiring and morally spiritualizing the transcendent relationship between God, man and nature—and growing to the more factually based point of carefully observing and recording the myriad of practicable ways nature sustains.

On March 21, 1840, at the age of twenty-two, when writing about man's materialistic attempts to sequester and protect his goods by way of rail fences and stone walls, Thoreau imparts in his journal how "...the buckeye does not grow in New England; the mockingbird is rarely heard here.... The Pigeon carries an acorn in his crop from the King of Holland's to [the] Mason and Dixon's line" (Thoreau, The Heart...17).

Twelve years following his recognition of seed dispersal by one of nature's more enterprising birds (July 27, 1852), Thoreau wryly bemoans Europe's ancientness and how extended age contributes to sacrificing certain bird species like the thrush in her [Europe's] effort to civilize and populate (146).

The significance of animal transport for Thoreau at the age of thirty-five took on a more melancholy mood and meaning – as he expresses on March 23, 1856 a nostalgic regret for the loss of the primitive (wild) nature in birds that formerly had kept them moving (migrating) and alive. This sorrowful exposé by Thoreau prompted a statement that foreshadows his early inclination to thoroughness when approaching and studying nature's curious, all-encompassing largess:

Primitive Nature is the most interesting to me. I take infinite pains to know all the phenomena of the spring ... thinking that I have here the entire poem. ... I wish to know an entire heaven and an entire earth. All the great trees and beasts, fish and fowl (Thoreau, The Heart of Thoreau's Journals 239).

The commonplace seed dispersal by animals personally met close and consistent observations by Thoreau throughout his life. He recorded how, by virtue of their daily eating, walking and flight preferences, birds spread seeds. He noted how scarlet asparagus seeds appeared before him in abundance, as he recorded and related in *Dispersion of Seeds* that they sprinkled “... at least as acre of the plant, and there must have been many bushels of the seed. This sight [the accumulation of asparagus seed] suggested how extensively the birds must spread it.” He further penned how small tomato plants growing wild resulted from birds annually dropping tomato seeds in the

woods. Thoreau's demonstrates a confidence in this large-scale, efficient production of seed dispersal when he writes, "Nature employs ... a great many birds" (Thoreau, Faith in a Seed 78). Thoreau intimates here that nature uses a plethora of bird species to spread a diversified typology of seeds to equally diverse locales.

Clearly then, the amount and degree to which birds convey this plenitude of life-producing resource did not escape the keen eye of Thoreau. He observed that the birds "shake down ten times the seed to the ground more than what they consume" and the birds' penchant for successful sightings of the select trees (from which they will shake and scatter seed), additionally did not appear by accident – in that these birds espied from great distances the particular trees that they desired (Thoreau, Faith...48).

Nature also spreads her fertile seeds from not only great bird heights, but also from earthy mammalian depths by way of squirrels' that daily scurry and scour for food. Thoreau noted this clever comprehensive covering of seed by the squirrels as he observed the evidence that they left behind. After closely inspecting a pitch-pine floor in the woods, Thoreau stopped to inspect the tell-tale area in an effort to affirm his hypothesis that squirrels were physically stronger than man realized. He asserted that these arboreal rodents reign as the foremost carriers of the seed that ultimately plants the plentiful forests of pitch-pine:

I observed one [a twig] eleven inches long and about half an inch thick, cut off close between two closed cones, the stem of one cone also being partly cut. Also in open land three or four rods from this grove, I saw three twigs which had been dropped near together. One was just two feet long and cut off more than a foot

below three cones.... Thus, my theory was confirmed by observation. The squirrels were carrying off these pine boughs with their fruit to a more convenient place either to eat or to store up.... (Thoreau, Faith in a Seed 29)

The enterprising nature of these survivalist squirrels does much in the way of transporting all types of seeds. And although Thoreau admits that he has not observed squirrels actually planting acorns, he frequently identified squirrels “transporting them.” He found acorns buried beneath the earth, too, but conceded that just because an acorn rests atop an evergreen forest, does not mean that this willing seed will become buried and germinate (131).

The degree of detail and dedication Thoreau exacted in his effort to demonstrate the diversity of animals that transport seeds crystallized meaningfully when he examined fox excrement—feces that ultimately revealed the otherwise hidden huckleberries seeds. In the mid-1800s, many considered the fox strictly a carnivore, but Thoreau quickly corrected that notion by explaining how Nature additionally “employs [even] the restless ranger, the fox, to disperse the huckleberry” (78).

The significance that seeds play (in nature’s role) when creating and reproducing forests and vegetation escaped neither Darwin nor Thoreau. Darwin realized that nature provided for the growth of “almost every full-grown plant” by producing seed. Although the number of seeds produced did not always necessitate the number needed to successfully maintain, Darwin contended that often a larger number of seed production did, indeed, assure survival for select species (Darwin, The Origin...78).

Both men, too, underscored the means by which seeds must have traveled—to the point

that each botanist experimented with seed carriage – albeit Darwin primarily through laboratory-type testing and Thoreau by way of his sauntering field studies.

Thoreau noted that “almost every seed that falls to the earth is picked up by some animal or other,” and his realization of such came from sensitive observations in and of nature that spanned over most of his lifetime (Thoreau, Faith in a Seed 146). Both during the Victoria era and currently, the relevance of seed production and migration reigns as one of the most defensible arguments against spontaneously generated life. Although Darwin touts that most serious-minded scientists of the 19th Century believed in some form of evolution, the concentrated data to dismiss the concept of spontaneous generation had not yet irrefutably presented itself. Not only did the world’s most progressive and controversial evolutionist understand the contribution that seeds made to his origin-of-life theory, but the lesser known poet and botanist Henry David Thoreau simultaneously perceived the significance of his own corroborating evidence that ultimately confirmed Darwin’s revolutionary findings.

Conclusion

Without the well-entrenched belief in organic matter arising from inorganic sources, Henry David Thoreau and Charles Darwin would not have had a basis from which to pursue or argue their theory of evolution. Famous, realistic but unconvincing results from such earnest scientist as Francesco Redi (1626-98?) and Louis Pasteur (1822-95) failed to convince the majority of Americans and Europeans of the certitude of naturally created and evolving life. However, this religiously based concept called abiogenesis did not prove an impossible target for men like Thoreau and Darwin – who consumed their lives exploring the mechanics of Mother Nature. Darwin anticipated the arguments from the leading scientists of the Victorian Age – and equally addressed theories of a spontaneous nature generating from earlier theorists. Darwin's discoveries when commissioned by the British Admiralty led him to experiments that determined larger species had undergone greater changes in structural form. Subsequently, these more diverse alterations proved the flexing forces that allowed for profitable species' selection and survival. Darwin also demonstrated how natural selection did not produce good characteristics for the benefit (or blessing) of other species. He portrayed the natural consequences, however, of certain structural traits that might directly injure subsequent life forms (Darwin, The Origin 190). To battle a theory that had existed long before he came into the world, and would breathe life far after his leaving, Darwin through his immediately popular book The Origin of Species explained how the earth gradually transpired within an imperceptible realm of time.

To help clarify how the earth had evolved by way of natural selection, Darwin detailed what natural selection was *not*. This non-example called “sterility” or the inability of flora to fertilize or reproduce became a topic that both Thoreau and Darwin addressed, although Thoreau focused primarily on plants and vegetation. A superstitious atmosphere pervaded Victorian thought when women discovered they were unable to bear children. Darwin realized that sterility was not necessarily a curse or an admonition from God. He experimented with various barren plant organisms to prove how sterility was not part of the positive processing of natural selection. After observing the reproductive cycles and systems inherent to numerous domestic and exotic floras, Darwin determined that unproductive sexual conditioning resulted from observable, biologic and/or geologic causes. Thoreau, without having had the advantage of Charles Darwin’s years of research on the subject, still addressed sterility as an aberration of nature rather than as part of her successful systemization and growth.

Thoreau categorically refuted the rumors of spontaneously generating forests – by demonstrating through his years of observations, experiments and record-keeping that woodlands did not populate by way of miracles – but rather from seeds that most likely had transported via elemental and natural means. The discussions and written discourse that Darwin and Thoreau wielded concerning the transport of seed are lengthy and serve to disprove how organic life occurs in non-indigenous locals. Darwin and Thoreau’s detailed delineation of the transport of seeds by way of wind,

water, fire, waves, ice, air current, animals and other natural causes proved a substantial body of defense against the abiogenesis idea.

Each man of science believed in the gradualizing process that took ions to accomplish in nature's bid for functioning, sustaining life. Darwin honored a geologic clock called natural selection that pulsed through millions of years of interminable time. Thoreau's transcendental influence of seeing life in destructive and nurturing cycles – overridden by a god who measured man upon the levelly scale of nature – eventually gave way to the more biologic equations of life. Thoreau noted the myriad of varied occasions Mother Earth provided and acted upon in her bid to naturally select seeds for amiable environs. He transcended to a more scientific mind as he considered the reasons and results exhibited by a well-oiled earth grinding with ease and precision at an age-defying geologic pace.

Darwin recognized that plants and animals bonded naturally together in an intricate maze of interdependency. He noted how select bees only visited certain flowers and without those visits the flowers were unable to seed. Thoreau spent hours with a chipmunk and finally domesticated this docile creature to the point that he could rub its stomach. The degree of hospitable relations that could occur between man and his animal environment have never been fully realized. Charles Darwin spent his life amazed by the great wonders a worm could produce for the soil. He praised the earth for her uniform orchestrating of life – self-providing in soil or temperatures otherwise unsuitable for living. He noted that in the southern hemisphere – South America, Australia, and along the Cape of Good Hope – the trees never shed their leaves, and

other than the blue gum, they would never attain great heights. The little rain present made cultivation of crops difficult, but, Darwin noted that the plants remained uniform to their living conditions (Darwin, The Voyage...319).

Thoreau honored the earth as both a “granary and a seminary” – one so self-contained that she plants her seeds in her own soil (Thoreau, Faith in a Seed 151). When Thoreau was twenty-two years of age, he gazed on the meadows and proclaimed that “the poet does not need to see how meadows are something else than earth, grass, and water...” (Thoreau, The Heart...14), but later Thoreau considered how the uniform laws of nature shape all facets of life (227).

Six weeks before Thoreau’s death he commented “... if I were to live, I should have much to report on Natural History generally...” (Thoreau, Faith...5). His natural history recordings ended in May of 1861 – one year to the day before his death (217). Much of Thoreau’s writing after *Walden* rested safely, unpublished, in a wooden chest until they surfaced in the Henry W. and Albert A. Berg collection at the New York Public Library in 1940. It took years to sort through and reconstruct his thousands of pages of writings. Not until 1993 was Faith in a Seed published which contained a book within a book, *The Dispersion of Seeds*. Wild Fruits, his final work, did not appear in print until the year 2000. Regrettably, this acclaimed poet, who loved the earth to the point of examining each miniscule part of her biologic make-up is yet perceived by the public as the transcendental philosopher who fathered the Walden Pond experience.

On the other hand, Charles Robert Darwin’s impact on evolutionary theory was heralded as a success in his own lifetime – and continues to hold deep roots in our

culture and mindset today. The equally profound and sustainable scientific efforts of Henry David Thoreau are only now becoming realized. The eloquent, evolutionary expertise of this recently discovered man of science has finally met the inescapable eye of botanists, conservationists and naturalists. Time, however, will exact the final word – patiently measuring out the truths residing in Henry David Thoreau’s painstaking field studies – a body of work that affirms both Darwin’s and Thoreau’s positive predictions concerning nature’s willing, methodical march toward survival.

Glossary

Abiogenesis The supposed spontaneous origination of living organisms directly from lifeless matter.

Abiotic Devoid of life. Non-living.

Acclimation A response by an animal that enables it to tolerate a change in a single factor (e.g. temperature) in its environment. Term used most commonly to animals used in lab experiments and implies a change in only one factor.

Acclimatization A reversible adaptive response that enables animals to tolerate environmental change (e.g. seasonal climate change involving...factors such as temperature and availability of food). The response is physiological but may affect behavior (e.g. when an animal responds physiologically to falling temperature in ways that make hibernation possible and behaviorally by seeking a nesting site, nesting materials and food).

Accretion 1. The process by which an inorganic body grows in size by the addition of new particles to its exterior. 2. The accumulation of sediments from any cause, representing an excess of decomposition over erosion. 3. The addition of material to the edge of a continent, thus enlarging it.

Accumulation Zone That part of a glacier where the mean annual gain of ice, firn and snow is greater than the mean annual loss. The zone consists of stratified firn and snow together with ice from frozen melted water. The lower boundary is the equilibrium line.

Accumulator In plant succession studies, a pioneer species whose activities are claimed to enrich the abiotic environment with nutrients.

Adaptation 1. The adjustments that occur in animals in respect of their environment. The adjustment may occur by natural selection, an individual with favorable genetic traits breed more prolifically than those lacking these traits (genotypic adaptation), or they may involve non-genetic changes in individuals such (e.g. acclimatization) or behavioral changes (phenotypic adaptation). 2. That which fits an organism both generally and specifically to exploit a given adaptive zone. The word also implies that the feature has survived because it assists its possessor in its existing niche.

Apriori Claim Relating to or derived by reasoning of self-evident propositions; presupposed by experience; being without examination or analysis; formed or conceived beforehand (presumptive).

Archipelago An expanse of water with many scattered islands.

Atoll A coral reef island surrounded by a lagoon. Direction Island spoken of in "Transport."

Axis A plant stem.

Biocoenosis European term for biotic community. Marshes... 100 Siry.

Biodiversity A portmanteau term which gained popularity in the late 1980s used to describe all aspects of biological diversity, especially including species richness, ecosystem complexity, and genetic variation.

Bioecology The study of organisms in relation to the environment; ecology.

Biogeography The study of the geographical distribution of organisms, their habits (ecological biogeography) and the historical and biological factors which produce them.

Biotic Pertaining to life or living organisms.

Bract 1: A leaf from the axil of which a flower or floral axis arises 2: A leaf borne on a floral axis especially one subtending a flower or flower cluster. p. 137 *Origin of Species*.

Cataclysm Flood or deluge; an event that brings great changes.

Catastrophic Evolution (catastrophic speciation) A theory proposing that environmental stress might lead to the sudden rearrangement of chromosomes, which in self-fertilizing organisms may then give rise sympatrically to a new species. Recent research suggests that at best this explanation applies only to some special cases. *See sympatric*.

Catastrophism The doctrine that fossil faunas were the result of catastrophic changes which had periodically exterminated large numbers of species, so that past cataclysmic geological or climatic events have had a major impact on the course of evolution; convulsionism; *cf.* uniformitarianism.

Catkins 1578 from form resembling a cattail; a spicate inflorescence (as of the willow, Birch or oak) – bearing scaly bracts and unisexual usually apetalous flowers – called also *ament* p. 181 *Origin of Species*.

Cladogenesis A branching type of evolutionary progress involving the splitting and subsequent divergence of populations; evolutionary diversification; dendritic evolution; *cf.* phyletic evolution.

Coevolution The parallel evolution of two kinds of organisms that are interdependent, like flowers and their pollinators, or where at least one depends on the other, like predators on prey or parasites on their hosts, and where any change in one will result in an adaptive response in the other. Mayr.

Conservation: The older Pinchot inspired concept of preservation and protection of natural resources, the purpose of which was to save them for use by subsequent generations.

Coppice A forest originating from shoots or root suckers rather than from seed; to sprout freely from the base.

Deme A local population of potentially interbreeding individuals. Mayr.

Dimorphic Relating to a population or taxon having two genetically determined, discontinuous morphological types; ditypic; dimorphism.

Ecology The science which studies the interaction between organisms and their

Environment The broad range of subjects dealing with pollution, technology, economics, and ecology.

Essentialism A belief that the variation of nature can be reduced to a limited number of basic classes, representing constant, sharply delimited types; typographical thinking. Mayr.

Gazetteer A book in which a subject is treated especially in regard to geographic distribution and regional specialization. [Thoreau carried one of these prior to each excursion in which he engaged].

Genetics The branch of biology that studies heredity and variations in living organisms.

Hermaphroditic An animal or plant having both male and female reproductive organs.

Homologous having the same or allelic genes with genetic loci usually arranged in the same order (~chromosomes).

Inflorescence 1: The mode of development and arrangement of flowers on an axis. 2: The floral axis with its appendages also: a. a flower cluster b. a cluster of reproductive organs on a moss usually subtended by a bract: 2. The budding and unfolding of a blossom.

Loci/Locus The position in a chromosome of a particular gene or allele.

Milagro This is the miracle of life found only in suitable areas of our earth, which scientists call the biosphere. Bathed in water, the seed sprouts to find, if fortune prevails, a suitable spot to grow, mature and live to seed again.

Morphology 1: The study of form and structure of organisms. 2: The form and structure of an organism with special emphasis on the external features. 3: The structural features of rocks and sediments.

Mos A community of assemblage of species living together but without mutual interdependence.

Niche A constellation of properties of the environment making it suitable for occupation by a species.

Ontogeny The course of growth and development of an individual to maturity; ontogenesis; ontogenetic.

Paleoanthropologist One who specializes in the study of anthropology dealing with fossil remains.

Palaeoautecology The study of the ecology of individual fossil species or groups; *cf.* palaeosynecology.

Palaeontology The study of or a science dealing with the life of past geological periods as known from fossil remains.

Paripatric Speciation Pertaining to continually living but non-overlapping populations or species. Ernst Mayr's theory which has become widely accepted as one of the standard modes of speciation, and is the basis for punctuated equilibrium.

Paroxysm A sudden or violent emotion or action.

Phenology A branch of science dealing with the relations between climate and periodic biological phenomena (as bird migration or plant flowering).

Phyletic Lineage A branch of the phylogenetic tree; all the linear descendants of an ancestral tree. Mayr.

Phylogeny The inferred lines of descent of a group of organisms, including a reconstruction of the common ancestor and the amount of divergence of the various branches. Mayr.

Phytogeography The biogeography (dealing with the geographic distribution of plants and animals) of plants.

Phytology Botany.

Propagules A structure (as a cutting, a seed, or a spore) that propagates a plant.

Punctuated Equilibrium Alteration of extremely rapid and normal or slow.

evolutionary change in a pyletic lineage as a result of speciation evolution. *See above*
Mayr.

Rod 5.50 yards, 16.5 feet (unit of measure commonly used by Thoreau).

Saltation A sudden event, resulting in a discontinuity (gap), such as the sudden production of a new species or higher taxon. Mayr.

Seed/s A favorable setting conducive of soil, shade, temperature, slop, moisture and seed sprouts giving rise from an original single cell to all of the diverse and huge plants around us that animals depend on to live. Even animals grow from single celled seeds into enormously active multiple celled creatures who enliven our world. To truly understand a "seed" is to comprehend more than a forest or any one plant, it is to understand the world and how one comes into this 'garden' [Aldo Leopold] we are commanded to keep by re-nourishing our commitment to the seeds we seek to plan and nourish. Siry.

Speciation The ability of a species to separate and subdivide into other species. Brody and Brody. Speciation is not just a matter of genes or chromosomes but also the nature and the population in which the genetic changes occur. Mayr.

Species A group of organisms that resemble one another closely: the term derives from the Latin *speculare*, 'to look'. In taxonomy it is applied to one or more groups (populations) of individuals that can interbreed within the group but cannot exchange

genes with other groups (populations), or, in other words an interbreeding group of biological organisms which is isolated reproductively from all other organisms (a species can be made up of groups in which members do not actually exchange genes with members of other groups though in principle they could do so), as, for example, at the extremes of a continuous geographical range. However, if some gene flow occurs along a continuum, the formation of another species is unlikely to occur. Where barriers to gene flow arise (e.g. physical barriers such as sea, or areas of unfavorable habitat) this reproductive isolation may lead by either local selection or random genetic drift or the formation of morphologically distinct forms termed races or subspecies. These could interbreed with other races of the same species if they were introduced to one another. Once this potential is lost, through some further evolutionary divergence, the races may be recognized as species, although this concept is not a rigid one. Most species cannot interbreed with others: a few can, but produce infertile offspring; a smaller number may actually produce fertile offspring. The term cannot be applied precisely to organisms whose breeding behavior is unknown.

Species "If a variety...flourishes then it can be then ranked as a species because when the number out-ranks the parent species, this variety then becomes the dominate species and is viewed by naturalists as the original species when it may not be. Both species, too, could 'co-exist,' and each species rank as independent species." Darwin The Origin of Species 68.

Spicate In the form of a spike.

Sympatric Applied to species or other taxa with ranges that overlap.

Synergy A combined activity where the actions affect each other. Siry.

Tertiary The first sub-era of the Cenozoic Era, which began about 65 Ma ago and lasted approximately 63 Ma. The Tertiary followed the Mesozoic and comprises five epochs; Paleocene; Eocene; Oligocene; Miocene; and Pliocene, Angiosperms superseded the gymnosperms as the dominant plants. Allaby.

Transmutationism The theory that evolutionary change is caused by sudden new mutations or saltations producing instantaneously a new species. Mayr.

Uniformitarianism The principle proposed by James Hutton (1726-97) and paraphrased as 'the present is the key to the past', that the surface of the Earth has been formed and shaped by processes similar to those which can be observed today. This is a considerable oversimplification, since processes that occurred in historical times may not be occurring now, or may not be observable now, and vice versa. Allaby.

Sexual Selection Selection for attributes that enhance reproductive success. Mayr.

Speciation, Sympatric Speciation without geographical isolation; the origin of a new set of isolating mechanisms within a deme. See deme. Mayr.

Transmutation The transformation of one element into another by radioactive decay.

2. The change of one species or type to another. Allaby.

Transmutationism The theory that evolutionary change is caused by sudden new mutations or saltations producing instantaneously a new species. Mayr.

Uniformitarianism The theory of some pre-Darwinian geologists, particularly Charles Lyell, that all changes in the Earth's history are gradual, rather than occurring in

saltations or jumps. Being gradual, these changes cannot be considered acts of special creation. Mayr.

Variation Differences displayed by individuals within a species, and which may be favored or eliminated by natural selection. In sexual reproduction, reshuffling of genes in each generation ensures the maintenance of variation. The ultimate source of variation is mutation, which produces fresh genetic material.

Glossary Resources:

A Dictionary of Ecology, Evolution and Systematics. R.J. Lincoln, G.A. Boxshall, and

P.F. Clark

Marshes of the Ocean Shore: Development of an Ecological Ethic Dr. Joseph V. Siry

Merriam Webster's 10th Collegiate Dictionary

Siry's Ecology Homepage: Basic Concepts

<<http://fox.rollins.edu/jsiry/inddex.html>>.

The Origin of Species Charles Darwin

The Oxford Dictionary of Ecology. Allaby, Michael.

What Evolution Is Mayr, Ernst

Henry David Thoreau

1817 Born 12 July Concord, Massachusetts to John

and Cythia (Dunbar) Thoreau.

1828-33 Attended Concord Academy.

1833-37 Attended Harvard College.

1837 Taught briefly at Concord Center School.

1838-41 Conducted a private school in Concord with his elder brother John.

1839 Boating excursion with Brother John on Concord and Merrimack rivers.

1840 Poems and essays published in *Dial*.

1840-43 *Lived* with Ralph Waldo Emerson and family in Concord.

1842 Brother John died suddenly of lockjaw; "Natural History of Massachusetts" published.

1843 "A Walk to Wachusett" and "A Winter Walk" published; tutored William Emerson's children on Staten Island, New York.

1844 Accidentally set fire to in Concord with Edward Hoar.

1845-47 Lived in small, shore house of Walden Pond.

1846 Traveled to Maine woods; spent one night in jail for refusing to pay poll tax.

1847-48 Lived in Emerson household while Ralph Waldo Emerson lectured in England.

1848 Began career as professional lecturer; "Ktaadn and the Maine Woods" published.

1849 *A Week on the Concord and Merrimack Rivers* and "Resistance to Civil Government" published; traveled to Cape Cod; Sister Helen died apparently of tuberculosis.

1850 Traveled to Cape Cod and Quebec.

1851 Charles Darwin referenced in journal.

1853 Traveled to Maine woods; portions of "A Yankee in Canada" published.

1854 *Walden: or, Life in the Woods* and "Slavery in Massachusetts" published.

1855 Portions of "Cape Cod" published; traveled to Cape Cod.

1856 Surveyed Eagleswood Community near Perth Amboy, New Jersey. *May-June*:

Wrote references succession of forest trees.

1857 Traveled to Cape Cod and Maine woods; "Chesuncook" published.

1858 Traveled to White Mountains in New Hampshire.

1859 Father, John, died: "A Plea for Capt. John Brown" published.

1860

1 January: Discussed Darwin's *Origin of Species* (published London, 24 November 1859) with friends.

February: Read and copied extracts from *On the Origin of Species*.

20 September: Delivered "The Succession of Forest Trees" before Middlesex Agricultural Society.

29 September: Sent "The Succession of Forest Trees" Horace Greeley, editor *New York Weekly Tribune*.

8 October: "The Succession of Forest Trees" published in *New-York Weekly Tribune*.

October-November: Visited local woodlots almost daily; drafted many passages in journal later used in *The Dispersion of Seeds*; began expanding "The Succession of Forest Trees" into *The Dispersion of Seeds*. *December*: Worked on *Wild Fruits* manuscript.

3 December: While researching tree growth, contracted a severe cold, which rapidly worsened into bronchitis and kept him housebound.

11 December: Delivered final lecture "Autumnal".

30 December: Responded to Horace Greeley's letter of 13 December about spontaneous generation of plants.

1861

January-February: Continued work on Wild Fruits manuscript.

2 February: Letter of 30 December 1860 to Greeley denying possibility of spontaneous generation published in *New-York Weekly Tribune*.

March-early May: Worked on *The Dispersion of Seeds*.

12 May-14 July: Traveled to Minnesota with Horace Mann, Jr., in effort to regain health.

1862 6 May

Dies in Concord, MA. "Walking," "Autumnal Tints," and "Wild Apples" published in *The Atlantic Monthly*

Charles Darwin

- 1809 Born at Shrewsbury, Shropshire, England.
- 1817 Spring: Attended Mr. Case's grammar school in Shrewsbury. He was shy imaginative and mischievous.
- 1817 Darwin's mother died.
- 1825 Attends Edinburgh University.
- 1827 27 March contributed two scientific Papers to the radical student Plinian Society.
- 1827-31 Attends Christ's College, Cambridge University.
- 1831 27 December H. M. S. Beagle sails from Davenport.
- 1832 23 September Darwin discovers his first significant fossils.
- 1835 Studies the natural history of the Galapagos Islands.
- 1836 2 October H. M. S Beagle returns to England.
- 1837 31 May Reads his theoretical paper on Coral Reef formation to London Geological Society.
- 1837 Begins notebook on "Transmutation of Species."
- 1838 July Begins notebooks on man and materialism.
- 1838 September First formulates theory of evolution by natural selection.
- 1839 Marries cousin Emma Wedgwood.
- 1842 Published *The Structure and Distribution of Coral Reefs*.
- 1844 Published *Geological Observations on the Volcanic Islands* (visited while on H.M.S. Beagle voyage).

1845 Published *Journal of Researches into the Natural History and Geology of the Countries visited during the Voyage of H. M. S Beagle Round The World.*

1846 Begins eight year study of barnacles. Publishes *Geological Observations on South America.*

1858 20 July Receives Alfred Russel Wallace letter of similar theory of evolution that prompts Darwin to go public with his.

1859 19 March Finished writing *Origin of Species.*

1859 24 November *Origin of Species* published; all 1,250 copies sold first day of release.

1865 Published *The Movements and Habits of Climbing Plants.*

1868 Published *The Variation of Plants and Animals Under Domestication.*

1871 Published *The Descent of Man.*

1872 Published *The Expression of Emotions in Man and Animals.*

1876 Published *The Effects of Cross and Self Fertilization in the Vegetable Kingdom.*

1862 Prepared earlier lecture-essays for publication in anticipation of death. Died 6 May Concord, Massachusetts.

1877 Published "A Biographical Sketch of an Infant" and "The Different Forms of Flowers on Plants of the Same Species."

1881 Published *The Formation of Vegetable Mould Through the Action of Worms, with Observations of their Habits.*

1882 Dies at Down House, Buried in Westminster Cathedral.

Acknowledgments

My friend John Clark called me up one day after months of vying for the attention of various creative writing schools and said, “Forget all that. Now that I know you better, I realize the perfect place for you – the Master of Liberal Studies program at Rollins College.” His timely comment about his Alma Mater proved truer than any fact unearthed by any scientist – from the moment Hoyt Edge inspired us with a preview of what to expect from enlightened philosophic minds, to my final two classes with Dr. Joseph Siry – who brought me to the consciousness of commitment that each of us owes our long-suffering earth.

“Working with” and “worshiping the earth” seemed like opposing endeavors to me; however, I discovered that above all Charles Darwin favored the Romantic poets – who unabashedly idealized nature, and Henry David Thoreau, after years of ogling the earth’s natural processes, sobered to the point of conceding to many of Darwin’s theories. Their common and contrary thread wove a natural sentiment in me.

Two other professors have also encouraged me to understand the deeper nature of man – Dr. Jean West who walks in the spirit of Virginia Woolf – and Dr. Wendy Brandon, whose heart stops short only of judging others.

I also want to thank each of the MLS students who braved his/her soul in an effort to honor the essence of our scholarly discussions – or to dispel the issues of our great divide. To each professor who resisted the temptation to hold me accountable for my oft importunate method of questioning, I give a humble thanks – your self-

confidence has permitted me the freedom to divine far more profound questions. And to John Clark I bestow a most magnanimous love for marrying me in the midst of my studious turmoil.

And most appreciably, I would like to convey my deep gratitude to the staff of the Thoreau Institute at Walden Woods in Lincoln, MA, and to Dr. Jeff Cramer, the painstaking curator, who has made it his life's work to promulgate the science, poetry and environmental considerations of Henry David Thoreau. Without Dr. Cramer's attention to the detailed volumes contributed by and about this philosophic scientist, like too much of the animal and plant populations of today, Thoreau's life and works—along with all of the good that they have brought to the healthy preservation of the Earth—might dwindle dangerously close to conscienceless extinction.