CITIZEN SCIENTISTS: THREE GROUNDBREAKING INDEPENDENT RESEARCHERS AND THE ROLE OF RESEARCH UNIVERSITIES

by

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Academic training played a distinctly different role in the careers of Ed Ricketts, Rachel Carson and Dr. Jane Goodall. A study of their three case histories raises fundamental questions about how academic institutions prepare independent researchers to conduct important work. Their stories are instructive because each individual broke away from traditional protocols of research and lacked the credibility that an advanced degree typically provides. Despite these challenges, these three researchers achieved groundbreaking success that forever changed the fields they explored. I make the case that their lack of traditional training was in fact an asset rather than a liability because it freed them to pursue their own interests in their own unique way – and to seek funding sources that would support this intellectual freedom for many years. A significant conclusion of this paper is that institutions of higher learning should encourage future researchers to think outside the box as they explore those areas that they are mostly passionately interested in. Extraordinary results – in research, as elsewhere – require extraordinary ways of thinking, which academic institutions must strive to encourage.

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Table of Contents

Introduction

A college education appears more desirable than ever these days, even while its purpose is increasingly questioned. Institutions of higher learning offer formal training, copious research opportunities and a lifelong boost to the student's professional value. While the pages of business history are filled with college-dropout success stories like Bill Gates, Steve Jobs and Mark Zuckerberg — each of whom made a break to pursue their own passionate interests — little has been written about their counterparts in scientific research. If one does not need a college degree to achieve great success in business, can the same be said of those who follow their passions to explore the sciences? Some have accomplished precisely this, without the resources or safety net of academia — or even a college education. Three influential thinkers in the natural sciences — Edward Ricketts, Rachel Carson and Dr. Jane Goodall — illustrate the differing roles that formal education can play in the professional career of an independent researcher.

Ed Ricketts, a University of Chicago dropout and largely self-taught marine biologist, went on to establish the field of intertidal ecology with his seminal work, *Between Pacific Tides,*[1] which was published in 1939. Dr. Jane Goodall, with no formal education, set out on what eventually became a 55-year definitive study of chimpanzees in Tanzania. Years after making her groundbreaking discoveries, Goodall completed a doctoral degree at Cambridge University (one of only eight in school history to do so without a bachelor's degree) so that her research would be treated seriously by other

[1] Edward Flanders Ricketts and Jack Calvin, *Between Pacific Tides* (Stanford, California: Stanford University Press, 1968).

scholars. Rachel Carson completed her undergraduate studies at the Pennsylvania College for Women before earning a master's degree from Johns Hopkins in marine biology. She was hired by the U. S. Fish and Wildlife Service as a junior aquatic biologist to write reports and radio plays based for the public. Late in her career, Carson conducted independent research on DDT — a pesticide used for insect control — for her book *Silent Spring,*[2] which upended the agricultural chemical industry and earned the author a Presidential Medal of Freedom. It is also worth noting that while Carson, Ricketts and Goodall were undisputed experts in their respective fields, each wrote and thought in ways that were accessible to laypeople.

A Better Model for Research

One may argue that these three remarkable individuals were blessed with such drive, intellect and imagination that they would have succeeded with or without formal academic training. Still, their accomplishments raise important questions about the role of formal education in preparing scientific researchers as well as the systems by which their work is funded. Is academic training perhaps more valuable after researchers, like Goodall, have made important discoveries and demonstrated their talent and passion for the field? Does formal training, with its emphasis on conformity, dull the imagination of those otherwise destined to make great discoveries? Similar questions arise about the funding and publication of scientific research. The importance of publication in academia tends to favor short-term work with more immediate findings, rather than

[2] Rachel Carson, *Silent Spring*, (Boston: Houghton Mifflin Company, 1962).

studies with a longer life cycle, like those conducted by Ricketts, Carson and Goodall. Each of these three effectively self-funded their research in order to conduct it in the way they saw fit. With that freedom, they could pursue their intellectual interests without the pressures of grant writing or academic journal deadlines.

One of the closest institutional models to this today is the MacArthur Fellows Program, which awards 20-30 grants of $625,000 to individuals who have shown "extraordinary originality and dedication in their creative pursuits and a marked capacity for self-direction" in both the arts, sciences and social sciences. The program, which started in 1981, views its fellowship not as “a reward for past accomplishment, but rather an investment in a person's originality, insight and potential.”[3] As a result, many of the recipients become fellows with their best years still before them. In a sense, Ricketts, Carson and Goodall awarded themselves their own private MacArthur grants to accomplish their great work. Is that perhaps a better model to encourage ground-breaking research?

In the book *The Principles of Scientific Research*,[4] published in 1949, Paul Freedman states that “In scientific work clarity of mind is dependent, to a high degree, on the ability to free one’s observations and interpretations from emotional bias.”[5] While this seems sensible, and certainly reflects traditional thinking at the time about scientific research, it fails to account for the great work by these three legendary scientists. Goodall, for example, openly admits her emotional attachment to the

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[3] “About MacArthur Fellows Program.” *MacArthur Foundation,* John D. and Catherine T., 2019, https://www.macfound.org/programs/fellows/strategy/.
[4] Paul Freedman, *The Principles of Scientific Research* (Pergamon Press Ltd: London, 1949), viii.
[5] *The Principles of Scientific Research* edit later, 66-7.

chimpanzees in her study, eventually giving each a personal name. Like Goodall, both Carson and Ricketts were consumed by a deep-seated passion for their respective subjects that cannot be understood in purely rational terms, free from any "emotional bias." On the contrary, had any of these three researchers listened to reason alone, they would have abandoned their pursuits early on since there was almost no evidence to suggest they would be successful. Great accomplishments often entail great risks. One wonders whether institutional academic training and the grant-funding process encourages researchers to take such risks or instead makes them intellectually risk-averse. What we do know, by considering the works of Ricketts, Carson and Goodall, is that some of the most important scientific discoveries of the past hundred-years were made without the pressure to publish or apply for grants and in some cases without any formal academic training. Moreover, these discoveries were made by what Anne Innis Dagg called a "citizen scientist," someone who "has been academically trained in science or who understands scientific principles and carries out research and other enterprises in an accepted scientific fashion. They are "citizens" because their work is not backed by a university or government."[6]

[6] Anne Innis Dagg, *Smitten by Giraffe* (London: McGill-Queen's University Press, 2016), x.

Ed Ricketts: The Visionary of Cannery Row

Early Influences

Ed Ricketts's fascination with "little animals,"[7] began at the "age of six...when an uncle...gave [him]... an old zoology textbook. Here [he] saw for the first time those...incorrect words 'coral insects'" (August 31, 1942)[8] which started his interest with marine animals. In high school, Ricketts excelled in the sciences and the humanities, naturally drawing connections between multiple disciplines which made his approach to biology "as much philosophical as it was scientific."[9] Upon graduating, he enrolled at Illinois State Normal University, where Ricketts was a student from 1915-16 — dropping out to enlist as a U.S. soldier in World War I. Ricketts enrolled at the University of Chicago in the summer of 1919, staying a student only six months and then re-enrolled in 1921. It was at the University of Chicago that Ricketts met Professor Warder Clyde Allee, an ecologist, who was to have an influential role on his intellectual development.

Allee "investigate[d] the relationships existing among the more loosely integrated collections of animals...with regard to their ecological and behavioristic physiology…"[10] Based at Woods Hole in Cape Cod, Massachusetts, where Rachel Carson would later work, Allee analyzed the grouping tendencies of various marine animals. In his work *Animal Aggregations,*[11] he summarized that "all animals, including

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[7] Jackson Benson, *The True Adventures of John Steinbeck, Writer* (New York: Viking, 1984), 187.
[8] Ibid., xv.
[9] Ibid., xvii.
[10] Ibid., xix.
[11] W.C. Allee "Animal Aggregations," *The Quarterly Review of Biology*, vol. 2, no. 3, 1927. *JSTOR*, www.jstor.org/stable/2808323.380

man, tend to cooperate in nature, instinctually moving toward aggregation or a communal life."[12] When observing brittle stars, he noted that if "isolated into glass dishes of sea water [they] will undergo fragmentation of the arms much more rapidly than occurs when a group of ten or so are placed under wholly similar conditions."[13] Allee's work set a precedent in ecological research. Observations and data were gathered systematically on a yearly basis until patterns in animal behaviors and groupings were discerned.

Ricketts was influenced by Allee's theories and approaches, which he later incorporated into his own work. In his most important book, *Between Pacific Tides,* Ricketts cites Allee's study on brittle stars in the Atlantic Ocean as a comparison to his own research in the Monterey Bay. Ricketts eventually applied Allee's concepts on group behaviors to humans, believing that "everything is inherently related to everything else [...] and that to understand nature means to discern the relationship of its constituent parts."[14] Ricketts's belief in the importance of individuals "integrating personal and social experiences in order to achieve a holistic awareness of the world...stems directly from Allee's teachings."[15]

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[12] Ibid., xix.
[13] W.C. Allee "Animal Aggregations" 380.
[14] Richard Astro, *John Steinbeck and Edward F. Ricketts: The Shaping of a Novelist.* (Minneapolis: The University of Minnesota Press, 1973), 29.
[15] Edward F. Ricketts and Katharine A. Rodger, *Renaissance Man of Cannery Row: The Life and Letters of Edward F. Ricketts* (Tuscaloosa: University of Alabama Press, 2002), xx.

Research Opportunities Lacking

Allee's influence on Ricketts was limited entirely to the classroom, since at the time, the University of Chicago lacked research opportunities for undergraduate and graduate students. During Ricketts's time there, for example, the campus newspaper ("The Maroon") does not contain a single news item or announcement about research opportunities for students, who were expected to wait for that rare invitation from a professor. *The University Record* was published quarterly by the school, focusing on the "Developments and Needs of the University." In the October 1919 issue, a section on Research Institutes states: "For special work in the encouragement of research, plans have been adopted for the organization of certain institutions for which funds have been provided and for which it is expected that funds will be provided."[16] At the time, the university encouraged research activities in archaeology, physics and chemistry for "the most advanced graduate work."[17] There were no research fellowships offered in either ecology or zoology.

The university explained that while it wished "to encourage research in all departments," financial circumstances prevented it: "The continued increase in the number of undergraduate students necessarily dr[ew] income from the endowment funds for imperative undergraduate instruction. Thus, the inevitable tendency is to increase the funds spent on undergraduates, thereby lessening the funds available for

[16] President Harry Pratt Judson "University Record (New Series)." *The University of Chicago University Record Publications,* vol. 5, no. 4, October 1919, 328. *The University of Chicago Campus Publications* *http://campub.lib.uchicago.edu/view/?docId=mvol-0445-0005-0004#page/1/mode/1up*.
[17] Ibid., 329.

advanced graduate work and for research."[18] In other words, the school had the intention, but not the means, to provide research opportunities for undergraduates like Ricketts.

Opening Pacific Biological Laboratories

After three years of classroom education at the University of Chicago, Ricketts departed without a degree and moved to Monterey, California in 1923 to pursue his passion for marine biology. He opened the Pacific Biological Laboratories with his former Chicago roommate Albert Galigher, where they "collect[ed] specimens to sell to schools and laboratories across the country. Ricketts's fascination and diligence in observing and collecting was inexhaustible."[19] Ricketts was probably influenced by accounts of Libbie Hyman, a faculty member at the University of Chicago, who had studied at the Hopkins Marine Station in Monterey and detailed her findings of rich seashore life.

In his own poorly-equipped lab, Ricketts conducted research on seashore life and fisheries from an ecological perspective. Realizing there were too many unknown specimens, Ricketts resolved to create a catalogue, which he ultimately published in 1929 through affiliation with the University Apparatus Company of Berkeley. It listed "only sponges, coelenterates, and ctenophores, and included descriptive paragraphs about the zoology of each, with scientific references."[20] Ricketts viewed his projects

[18] Ibid., 330.
[19] Ricketts and Rodger, *Renaissance Man of Cannery Row,* xxi.
[20] Michael J. Lannoo, *Leopold's Shack and Ricketts's Lab: The Emergence of Environmentalism*. (Berkeley: University of California Press, 2010), 24.

philosophically and considered the idea that the primal rhythms of tides govern all life on Earth. Researchers from the nearby Hopkins Marine Station, which was affiliated with Stanford University, soon took an interest in Ricketts's manuscripts and published them, though he had no academic reputation or even a degree.

In 1928, Ricketts become the sole owner of Pacific Biological Laboratories and moved it to a less expensive location. A fire in the lab in 1936 caused over $12,000 in damage. Local resident John Steinbeck, a close friend of Ricketts, bought half the company's stock and became a silent partner. Steinbeck, who found in Ricketts inspiration for the Doc character in his novel *Cannery Row,*[21] provided Pacific Laboratories with the financial and intellectual freedom to follow its own research interests.

Publication of *Between Pacific Tides*

Ricketts's most important work, *Between Pacific Tides*, which he co-authored with Jack Calvin, is based on years of research on the habitats and characteristics of intertidal sea life. These creatures — which survive both underwater when the tide is high and beneath the hot sun when it is low — were hardly studied before Ricketts. In his typically thorough fashion, Ricketts categorized each creature according to its most common characteristic habitat and analyzed the impact of shifting tide levels.

Like Goodall and Carson, Ricketts made the book both understandable to the general public and valuable for scientists. He avoided the scientific names of sea life organisms, preferring "starfish" to "asteroidea." Habitats were described with basic

[21] John Steinbeck, *Cannery Row* (New York: Viking Press, 1945).

terminology, such as “protected outer coast” and “open coast” and with separate categories for rocky shores and sandy beaches. A “bay and estuary” habitat might be divided into rocky shores, sand flats, eelgrass and mud flats, with “wharf piling” either exposed or protected.[22] Without the pressure to publish in academic journals, Ricketts could share his discoveries “so that [they] can be used by the sea coast wanderer who finds interest in the little bugs and would like to know what they are and how they live.”[23] Though his terms were not scientific, the methodology was — moving from observation, to speculation and hypothesis.

Ricketts felt no pressure to report results immediately, so he took his time — and often removed creatures from the tide pools when he feared their numbers might be depleted. He made most of his income from gathering and selling the specimens, which may have influenced which organisms he chose to study. He was particularly interested in studying “the relation of tides to life on the seashore, and analyzing tidal levels.”[24] This broad, ecological perspective was unheard of in the 1930s. His early notes stressed the importance of considering the environment as a whole. Ricketts believed people should observe sea animals by making their own measurements. The first catalog for Pacific Biological Laboratories, published on September 1, 1925, less thorough than the 1929 edition, reflected Ricketts’s concern with conservation. He cautioned: “It should be borne in mind (and this applies especially to local marine forms) that we must, above all else, avoid depleting the region by over-collecting. One or more formerly rich

[22] Lannoo, *Leopold’s Shack and Ricketts’s Lab*, 37.
[23] Eric Enno Tamm, *Beyond the Outer Shores: The Untold Odyssey of Ed Ricketts, The Pioneering Ecologist Who Inspired John Steinbeck and Joseph Campbell* (New York: Four Walls Eight Windows, 2004), 92.
[24] Ibid., 24.

regions, according to reliable authorities, already afford instances of the ease with which depletion is brought about."[25] Since this catalog was targeted towards high schools and colleges, Ricketts saw it as an opportunity to raise awareness on environmental issues.

This created complications when Ricketts attempted to publish *Between Pacific Tides* through Stanford University Press, which was aware he lacked a university degree. University-affiliated professors castigated Ricketts for his writing style, while admitting his findings appeared authentic. Dr. W. K. Fisher, a well-known marine biologist at the Hopkins Marine Station, wrote that "it must be remembered that neither of the authors can be classified in this category, although Mr. Ricketts is a collector of considerable experience."[26] As we will see with Goodall, Ricketts was not taken seriously by the academic community because he did not complete formal training and employed non-scientific language. Ricketts redrafted the book, in an attempt to write "an account interesting to the lay reader, and useful alike to the zoologist."[27]

In the end, Ricketts changed his writing style, adding a short zoological introduction in which he applied Cabrera's Law of ecological incompatibility to the seashore. Quoting the March 1935 *Biological Abstracts*, Ricketts says, "In the same locality...directly related animal forms always occupy different habitats or ecological stations...Related animal forms are ecologically incompatible."[28] Ricketts had made a

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[25] Edward Flanders Ricketts, and Katharine A. Rodger, *Breaking Through: Essays, Journals, and Travelogues of Edward F. Ricketts* (Berkeley: University of California Press, 2006), 83.
[26] Eric Enno Tamm, *Beyond the Outer Shores*, 28-29.
[27] Ibid., 29.
[28] Edward F. Ricketts and Jack Calvin, *Between Pacific Tides*, 87.

startling assertion, as this concept had yet to be applied to marine biology. He had most likely reached this conclusion by analyzing and viewing different tide pools on a regular basis, employing methods outside the norm of academic research. The book was published in 1939. When reviewing it, oceanographer James C. Kelley noted it "contained all the primary elements of 'New Age' writers, [who] think they have found something new and revolutionary, call[ed] 'deep ecology.'"[29]

Between March 11-April 20, 1940, Ricketts, Steinbeck and a four-man crew embarked on a marine specimen-collecting expedition in the Sea of Cortés. Living near Monterey Bay, Ricketts was able to easily vary his research locations. During the expedition, Ricketts completed a scientific log, collected notes, preserved and stored the specimens and eventually identified all the species collected. He took his detailed notes in a green legal-size pad. After the trip, Ricketts proudly wrote to Steinbeck on August 22, 1941 that:

> It seems ungratifying to reflect on the fact that we, unsupported and unaided, seem to have taken more species, in greater number, and better preserved, than expeditions more pretentious and endowed, as we were not, with prestige, personnel, equipment and financial backing...It appears that our unpretentious trip may have achieved results comparable to those of far more elaborate expeditions...It may well prove to be, considering its limitations, one of the most important expeditions of these times.[29]

The Log from the Sea of Cortez,[30] which Ricketts and Steinbeck co-authored, allows readers to review their notes and narrative style in hope of making them more insightful

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[29] Ricketts and Rodger, *Renaissance Man of Cannery Row,* 118.
[30] John, Steinbeck and Edward F. Ricketts, *The Log from the Sea of Cortez: The Narrative Portion of the Book, Sea of Cortez* (New York: Viking Press, 1951).

observers. Yet in reality, it was just good reading and did not add anything new to science.

Ricketts's Approach

Ricketts defined ecology in holistic terms, as "the acceptance of relationships, of living relationships. He wrote…[about]...thinking about the ecological method, the value of building, of trying to build…An ecologist has to consider the parts each in its place and as related to rather than as subsidiary to the whole."[31] Ricketts used ecology to understand the totality of things and defined the philosophy of ecology as "breaking through." He wanted to achieve the integrative moment of living in which one understands things that are not transient by means of things that are — and viewed science as a process of enlightenment.

On his own, Ricketts figured he could predict fish stock fluctuations based on the environmental conditions in the ocean, along with the sea surface temperature. He argued that in warm-water years, sardine catches ought to be curtailed since the stock was not productive, which was the same conclusion a team of scientists came across eight years later, who were all involved in the California Cooperative Oceanic Fisheries Investigation.[32]

Through his research, Ricketts introduced ecology into fisheries science, an academic field dominated by biologists and statisticians. Professor Arthur McEvoy,

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[31] Lannoo, *Leopold's Shack and Ricketts's Lab*, 126.
[32] Eric Enno Tamm, "Ed Ricketts's death, 50 years ago last week, preceded that of Cannery Row by only a few months." montereycountyweekly.com. October 13, 2005. http://www.montereycountyweekly.com/news/local_news/ed-ricketts-death-years-ago-last-week-preceded-that-of/article_83297823-b98d-54b5-b9a8-b99f711118df.html

who is an expert in the fields of legal history and environmental and water law, states that fisheries are a good case study for discussing our problems of sustaining our natural resources and conservation, "because they present in a body every major scientific and political problem that besets resource conservation generally."[33] McEvoy describes fisheries as areas difficult to confine within coherent boundaries of property or legal jurisdiction because individual fisherman and fleets of competing nations all fought for access.[34] He characterizes them as ecologically sensitive to random fluctuations in climate and water conditions, along with being vulnerable to impacts generated by any industry. Ricketts would have been happy to learn that fisheries were the first example that economists worked with when beginning to write about conservation problems in the 1950s.[35] McEvoy conducted research on how the living resources of California's rivers and coastal waters offer an example of the interactions among resource ecology, economic enterprise and law in the history of California's fishing industry.

At the time, academic publications would not publish Ricketts's sardine research, thus limiting the possibilities for other scientists to collaborate and learn from it. He was one of the few marine biologists of his time who studied intertidal organisms in an ecological context.

Professor Keith Benson of Biomedical Ethics wrote about the history of intertidal fisheries ecology. The first international laboratory dedicated to the study of

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[33] Arthur F. McEvoy, "Science, Culture, and Politics in U.S. Natural Resources Management," *Journal of the History of Biology*, vol. 25, no. 3, 1992. *JSTOR*, https://www.jstor.org/stable/pdf/4331234.pdf?refreqid=excelsior%3A794f24188e093b6fddc1d8fcf0f1b964, 471.
[34] Ibid., 472
[35] Ibid., 472.

marine biology was in Naples in 1873 – called the Stazione Zoologica – located adjacent to the Gulf of Naples. At this laboratory, there was a staff or workmen "who obtained the specimens and brought them to the laboratory...researchers were encouraged to study these specimens, often new to science, once they were delivered to the laboratory."[36] This work was important for new specimens and was brought back to the United States by investigators such as "Charles O. Whitman, Edmund B. Wilson, and Thomas Hunt Morgan and soon became a part of the marine biology offerings at Woods Hole, the first permanent marine laboratory in the US in 1888."[37] In America, it was important that the new laboratories were built close to the field research location. The majority of terrestrial animals were too mobile and transitory to allow an investigation of their physical response to specific environmental factor(s), as intertidal faunal forms are practically fixed to their physical location. This characteristic, along with the appreciation of the abundance of invertebrate forms on the West coast and the appearance of intertidal communities on this coast, helped create the interest in marine biology.[38]

Ecologists and marine biologists struggled to deal with the lack of clear and casual connection between the physical space and the space occupied by intertidal animals. Victor Shelford, a zoologist and animal ecologist who helped establish ecology as a distinct field, studied faunal features "first in the Midwest...and then, following the suggestion of his mentor Henry Chandler Cowles, to the mostly-sessile marine animals

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[36] Keith R. Benson, "Marine biology, intertidal ecology, and a new place for biology," *History and Philosophy of the Life Sciences*, vol. 36, no. 3, 2015. *JSTOR*, https://www.jstor.org/stable/pdf/44471822.pdf, 313.
[37] Ibid., 314.
[38] Ibid., 314.

of the Pacific coast intertidal area...[He ended his] almost two-decade program in 1928 when he claimed that the time was not right for an experimental description of the community structure along the entire Pacific coast,"[39] defining Ricketts as one of the few marine biologists of his time who studied intertidal organisms. In general, Benson refers to the "intertidal community structure on the West coast"[40] as complicated due to environmental factors that characterized the coastline.

Ricketts's independent research efforts yielded important results despite minimal interaction with his academic contemporaries, suggesting that participation in that community would have added little to his achievements, or even diminished them.

[39] Ibid., 314.
[40] Ibid., 315.

Rachel Carson: Understanding the Sea and its Destroyers

Academic Beginnings

After graduating magna cum laude from Pennsylvania College for Women in 1929 as a biology major, Rachel Carson spent the summer at the Marine Biological Laboratory at Woods Hole, Massachusetts as part of the master's program at Johns Hopkins. At Woods Hole, Carson spent her time reading scientific literature in the library, dissecting specimens on the research table and exploring the shore and tide pools. Once receiving her master's degree, Carson spent three weeks in Woods Hole working on embryological studies of bony fish. She intended to continue as a Ph.D. student at Johns Hopkins thriving in the academic environment but had to drop out in 1934 due to financial difficulties.

When searching for a job, professors from Johns Hopkins wrote letters of recommendation highlighting her teaching ability, as she was a student teacher while a doctoral candidate and expressed uncertainty for her future in scientific research. Elmer Higgins, head of the Division of Scientific Inquiry at the Bureau of Fisheries, had warned her about the lack of scientific positions and openings for women and suggested that she consider government work. In 1935, Carson started writing radio scripts on marine life on a part-time basis for the Bureau of Fisheries and in 1936, she became a junior aquatic biologist, a position she held through 1952. She was principally responsible for interpreting Bureau reports and making them accessible to the public through pamphlets on conservation and natural resources. Carson's career working in the government allowed her to write independently and to share her thoughts directly with an audience.

Although she worked for the government, Carson had a personal mission. She wanted listeners to understand the sea and its ancient and enduring ecology, so that they would respect even the smallest organism. Some of her writing, such as "Undersea," the basis for her book *Under the Sea Wind* (1941), was viewed by the Bureau of Fisheries as too lyric for a government report — so she began submitting her writing to the *Atlantic Monthly.* In "Undersea," Carson introduces tide pools as "seas in miniature,"[41] containing "living things so small that your two hands might scoop up as many of them as there are stars in the Milky Way."[42] Carson presumed the difficult task of visualizing the sea, since maps of it were rare at the time and some readers may not have ever visited. She also understood the threat that humans posed to the ecological balance of the seas, often portraying them as predators and destroyers.

Carson longed to leave her government job because she was not making much money and the magazine articles did not help much. In the mid-1940s, Carson sought work at the New York Zoological Society after an eminent marine biologist, William Beebe, recommended her for a position. Despite her background and a successful book, Carson's application was rejected.

[41] Rachel Carson and Linda J. Lear, *Lost Woods: The Discovered Writing of Rachel Carson* (Boston: Beacon Press, 1998), 5.
[42] Ibid., 6.

Praise for *The Sea Around Us*

As Carson wrote and researched more about the sea, her awareness of the integral connections of every aspect of the environment grew, which eventually led to her interest in conservation. Beebe "encouraged Carson to dive underwater to get a feel for the research she was doing for *The Sea Around Us* (1951). No one could write genuinely about the sea, he believed, without going in it."[43] *New Yorker* editor William Shawn profiled several chapters and "was so taken with Carson's book that he offered her what amounted to more than a year's salary at her government job for excerpts from *The Sea Around Us.* But even before the *New Yorker* serial, the *Yale Review* had published the chapter "The Birth of an Island" ... [which]...won Carson the $1,000 George Westinghouse Science Writing Award."[44] The book went on to win numerous other awards. The central question of *The Sea Around Us* is how it came to be. How did land rise from it and how does humanity fit in? Carson was not satisfied with the theological notion that it was God's work. In 1951, Carson was awarded a Guggenheim Fellowship in the field of organismic biology and ecology. The success of *The Sea Around Us* allowed Carson to finally retire from her government position.

[43] Mary A. McCay, *Rachel Carson* (New York City: Twayne Publishers, 1993), 20.
[44] Paul Brooks, *The House of Life: Rachel Carson at Work* (Boston: Houghton Mifflin, 1989), 123.

Independent Researcher

In December 1953, Carson attended her only scientific conference, the American Association for the Advancement of Science, in Boston, Massachusetts. She spoke about how the metabolic products of marine organisms excreted into the water might influence the development and reproduction of other organisms. She also acknowledged the emotional aspect of her scientific writing, for which she was often criticized. Carson stated that she is "not afraid of being a sentimentalist where she believe[s] natural beauty has a necessary place in the spiritual development of any individual or any society."[45] Carson wrote with emotion because she viewed nature as too important to be described merely by scientific data.

Carson's next book, *The Edge of the Sea,*[46] published in 1955, was based on her research about tidal areas. In general, intertidal habitats are interesting to ecologists because they illustrate two environments: the land and the sea. Carson and Ricketts may have developed a focus on intertidal habitats because these life forms are probably more sensitive to ecological change than others, since they live in a delicate balance between the two habitats, making them fascinating and easily accessible to anyone. Carson wrote about her research about tidal areas as a sort of field guide to the flora and fauna of the shore in her acceptance speech for the American Association of University Women Achievement Award on June 22, 1956, stating "I [she] am [was] telling something of the story of how marvelous, tough, vital, and adaptable something we know as LIFE has come to occupy one part of the sea world and how it has adjusted itself and survived"

[45]Rachel Carson and Linda J. Lear, *Lost Woods*, 60.
[46] Rachel Carson, *The Edge of the Sea* (Boston: Houghton Mifflin Company, 1955).

(capitalization is hers).[47] At this point, Carson was financially independent from her book sales and moved to Maine, where she could spend all her time studying the sea. She was also free to express her heartfelt opinions about science and nature. In the preface to *The Edge of the Sea,* she writes: "To understand the shore, it is not enough to catalog its life. Understanding comes only when, standing on a beach, we can sense the long rhythms of earth and sea that sculptured its landforms and produced the rock of which it is composed."[48] This was as much a statement of belief as a declaration of independence from the former Fisheries Bureau writer who was once stuck in an office.

Illustrator Bob Hines writes about Carson in awe of her complete immersion in her study, stating:

> Maine coastal waters are never warm, and the tide pools were often frigid, yet Rachel never hesitated to enter. Clad only in lightweight clothing and tennis shoes, she waded into the hip-deep water and became so engrossed in her research...One cloudy day even her determination failed, and when she started to climb out of a pool, she was so numb she nearly fell back in.[49]

The Edge of The Sea helps readers understand the vast sea and its connection with the land. In describing this complex relationship, Carson writes "the shore has a dual nature, changing with the swing of the tides, belonging now to the land, now to the sea."[50] Carson wrote about three different coastlines in her study: "the rocky shores off the coast of Maine, the sandy shores of the Atlantic states, and the coral reefs off the coast of southern Florida."[51] Carson's notes indicate she was looking for examples of interrelations to physics, geology, biochemistry and ecology, since she knew she could

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[47] Paul Brooks, *The House of Life,* 151.
[48] Rachel Carson, *The Edge of the Sea*, vii.
[49] Bob Hines, "Remembering Rachel," *Yankee Magazine,* June 1991, 65.
[50]Rachel Carson, *The Edge of the Sea*, 1.
[51] Mary A. McCay, *Rachel Carson*, 55.

not merely study a single animal as an isolated species. She was committed to exploring the mysterious webs that connect all life forms.

In Maine, Carson observed that "the sea and the land lie here in a relation established gradually, over millions of years"[52] since the contours of the land were more broken in, demonstrating the unhurried process of erosion. When walking along the beaches of North and South Carolina, Carson became acutely aware of how life adapts. When seeing a bridge or long-lasting structure, she asked herself how a specific animal was ready to colonize it. She concluded that there was a "ceaseless migration, for the most part doomed to futility, yet ensuring that always, when opportunity arises, life shall be waiting, ready to take advantage."[53] Finally, there was Florida, the only coral coast in the United States, which Carson chose to study because it "offered a contrast to the rocky coast of New England and the sandy beaches of the mid-Atlantic states."[54] She stated the coast was "not formed of lifeless rock or sand, but created by the activities of living things…"[55] The interrelations of the creatures in different environments and locations led Carson to conclude that just as several small islands have coalesced to form one, "the sea is becoming land before our eyes."[56]

[52] Rachel Carson, *The Edge of the Sea,* 125.
[53] Ibid., 189.
[54] Ibid., 58.
[55] Ibid., 191.
[56] Ibid., 246.

Building a Case Against DDT

In the late 1950's, Carson's interest shifted from the sea to the interrelation between the physical world and the living one. She now had enough money to focus solely on what interested her most, namely the disastrous ecological impact of DDT and other pesticides.

At the time, DDT was the most powerful pesticide on earth, capable of killing hundreds of types of insects at once. The complex chemical compound was first synthesized in 1874 but its effectiveness as an insecticide was discovered only in 1939 by Swiss chemist Paul Hermann Mueller. The chemical was used immediately and with great success to control outbreaks of malaria and typhus amongst troops in World War II and Mueller was later awarded a Nobel Prize for his discovery.[57]

In Europe, where agriculture was still reeling from the destruction of World War II, farmers sprayed DDT liberally as did their American counterparts. DDT first became available for civilian use in 1945 and soon after evoked Carson's interest and concern. Carson and a former Fishery Bureaus colleague, Clarence Cottam, were concerned by the Department of Agriculture's unreserved support for DDT. The powerful pesticide contained chlorinated hydrocarbons that caused horrific collateral damage to other living things. Carson proposed an article to *Reader's Digest* about the effects of DDT in 1945 and was turned down. Undeterred, Carson continued to track DDT usage and in 1957 was prepared to start making a case against it.

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[57] Cristobal S. Berry-Caban, "DDT and Silent Spring: Fifty years after," *Journal of Military and Veterans' Health*, vol. 19, no. 4, 2011. *JMVH*, https://jmvh.org/article/ddt-and-silent-spring-fifty-years-after/.

At some point, Carson shifted from observer to activist. One trigger was a letter to the editor in a Boston newspaper from bird watcher Olga Owens Huckins of Duxbury, Massachusetts who described how spraying DDT to eliminate mosquitoes resulted in the so-called "harmless" spray "killing seven of our lovely song-birds outright." The letter went on to say that "All the birds died horribly and in the same way. Their bills gaping open, and their splayed claws were drawn up to their breasts in agony."[58] Huckins said that she was attacked by the most voracious mosquitoes, yet "the grasshoppers, visiting bees, and other harmless insects, were all gone."[59] She sent a direct copy of this letter to Carson, who was now preparing to write a book based on research conducted and material assembled over the past thirteen years. Financially independent and aware that almost nothing had been written on the subject, Carson was determined to expose the disastrous environmental effects of DDT.

Carson applied the same thorough process in assembling evidence — from arcane academic journals and crop statistics to popular newspaper clippings — that she did when writing about the sea. Huckins and others, including ornithologist Robert Cushman Murphy at the American Museum of Natural History and Archibald Roosevelt from Long Island, New York whom Carson knew, banded together to form the Committee Against Mass Poisoning. The Committee attempted to end the aerial spraying of pesticides by filing lawsuits and organizing protests.[60] One of their lawsuits was brought to court "to stop the spraying of DDT to kill gypsy moths in their area.

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[58]Olga Owens Huckins, "Evidence of Havoc by Air Spraying" *The Boston Herald*, January 29, 1958. Beinecke Rare Book & Manuscript: Rachel Carson papers, 1. https://brbl-dl.library.yale.edu/vufind/Record/3535730

[59] Ibid., 1.

[60] Rachel Carson, *Silent Spring*, xxviii.

Their lawsuit had some [initial] success, but...the Supreme Court...refused to hear it...feeling the alarms that had been raised by experts warranted the court's taking the case."[61] It was these lawsuits, successful or not, that provided key research materials for Carson. Marjorie Spock, a plaintiff in the Long Island lawsuit — condemning aerial spraying of pesticides on the grounds that it was "inhumane, undemocratic, and probably unconstitutional,"[62] — sent Carson a goldmine of case-related information including reports, studies, trial transcripts and names of experts she could contact for her own research.

For *Silent Spring*, Carson gathered her evidence through hundreds of scientific studies, ranging from pharmacology to wildlife ecology. She understood that a thorough and complex picture would be needed to demonstrate the far-reaching effects of DDT. Carson knew which researchers to contact for evidence, after many years spent "keeping an eye on the pesticide debate raging within government agencies."[63] Carson's research explored a wide array of topics, including: radiation and atomic pollution, causes of cancer, food additives and air pollution. In a speech that Lyndon Johnson delivered at the University of Michigan on May 22, 1964 to emphasize how pesticides affect everyone, the President succinctly stated that pesticides "affect the food we eat, the air we breathe and the water we drink."[64]

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[61] Ibid., 140.
[62] Ibid., xxix.
[63] Ibid., xxix.
[64] Lyndon Baines Johnson, "The Great Society," AmericanRhetoric.com, May 22, 1964. https://pages.uoregon.edu/eherman/teaching/texts/Lyndon%20Baines%20Johnson%20-%20The%20Great%20Society.pdf

Writing *Silent Spring*

Silent Spring describes how DDT enters the food chain and leaves a broad wake of destruction in the plant and animal worlds for years to come, including genetic damage and cancer. As a largely self-taught ecologist and writer of popular stories about the sea, Carson was uniquely qualified to make sense of mountains of evidence and present her findings in a way that would be relatable to the general public.

To illustrate the extent of its effect, Carson describes the specific case of salmon in the Miramichi River in New Brunswick, Canada, that were wiped out following a vast DDT spraying program. Prior to the spraying, salmon had been returning to the river from the coast and depositing their eggs each autumn "in beds of gravel over which the stream water flowed swift and cold."[65] During fall and winter, the salmon eggs grew and hatched and would immediately seek out small insects to feed on.

Yet by the time the eggs hatched in the spring of 1954, the Canadian government had essentially ruined the river for salmon by eliminating those insects. The previous year, the government had embarked upon "a program designed to save the forests from the spruce budworm,"[66] which had been abundant every thirty-five years, and particularly since the early 1950s. This program sprayed the budworm populations "with DDT...first in a small way, then at a suddenly accelerated rate in 1953. Millions of acres of forests were sprayed instead of thousands as before,"[67] leading to the DDT oil to filter into some of the flowing streams in the area. Within two days of spraying, "dead and dying fish, including many young salmon, were found among the banks of

[65] Rachel Carson, *Silent Spring*, 115.
[66] Ibid., 116.
[67] Ibid., 116.

the stream. Brook trout also appeared among the dead fish and along the roads and in the woods, birds were dying. All the life of the stream was stilled."[68] With the stream insects' dead, the young salmon had nothing to eat.

Carson accessed this information through the Fisheries Research Board of Canada, which had been "conducting a salmon research study on the northwest Miramichi River since 1950. Each year it had made a census of the fish living in this stream."[69] She also relied on information provided to her as a plaintiff in a suit against a manufacturer of DDT, including a study conducted by the U.S. Food and Drug Administration (FDA) in Texas in 1960 which found evidence of DDT in approximately one third of all manufactured dairy products sampled over several months.[70] Carson feared that the concentration of toxins would increase as they ascended the food chain, eventually affecting humans.

Carson corresponded and met with many members of the Committee Against Mass Poisoning to gather and use their documents on the effects of pesticides in their communities. Meanwhile, she continued to dig for more information via federal agencies and the national research libraries, including the Library of Medicine of the National Institutes of Health. Carson "read across the scientific disciplines and could trace the connections between findings published in widely divergent reports...and sought out the authors of these studies — visiting labs, or calling, or writing — both to seek out more data and to fact-check her conclusions."[71] The more Carson read, the

[68] Ibid., 117.
[69] Ibid., 117.
[70] Mary A. McCay, *Rachel Carson*, 69.
[71] Rachel Carson, *Silent Spring,* xxiii.

more she became aware there was material for an entire book. Once she "discovered that everything which meant the most to [her] as a naturalist was being threatened...nothing [she] could do would be more important."[72]

Response to *Silent Spring*

After the book was released in 1962, Pincus Rothberg, the president of Montrose Chemical Corporation, the nation's largest producer of DDT, told the *New York Times* that Carson wrote her book not "as a scientist but rather as a fanatic defender of the cult of the balance of nature."[73] This was only the beginning of fierce attacks on her book, even though it included extensive documentation and over fifty pages of citations, mostly of scientific research.

After publication, Carson repeatedly stated that "it [was] not [her] contention that chemical insecticides may never be used. [She did] contend that we have put poisonous and biologically potent chemicals indiscriminately into the hands of persons largely or wholly ignorant of their potentials for harm."[74] Carson made the book easy to understand by combining the scientific facts against DDT with specific, real-world examples to illustrate how food-chains and ecological systems were impacted.

Newspapers and media channels attacked Carson's evidence. Eventually in June of 1963, she testified twice in support of President Kennedy's Science Advisory

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[72]Carson, Rachel, Dorothy Freeman, and Martha E. Freeman, *Always, Rachel: The Letters of Rachel Carson and Dorothy Freeman, 1952-1964*. (Boston: Beacon Press, 1995), xxvii.
[73] John M. Lee, '*Silent Spring* is Now Noisy Summer' *New York Times*, July 22, 1962, 2. https://eebookclub.files.wordpress.com/2013/11/proquest_silentspring.pdf
[74]Clarence Cottam and Thomas G. Scott, "A Commentary on *Silent Spring" The Journal of Wildlife Management*, vol. 27, no. 1, January 1963, 153.

Committee before the U.S. Senate Subcommittee of Government Operations and the U.S. Senate Committee on Commerce, arguing for an independent regulatory agency to protect people and the environment from chemical hazards. With *Silent Spring* as an important catalyst, this idea would later materialize as the Environmental Protection Agency, established in 1970. Prior to Carson's testimony, she was interviewed on CBS for a program entitled "The Silent Spring of Rachel Carson." Rather than defend her scientific evidence or attack the pesticide manufacturers, Carson used the opportunity to encourage viewers to help protect the environment. She asked "the public...to assume the risks that the insect controllers calculate. [She brought up the influence of human beings saying] ...we still talk in terms of conquest. We still haven't become mature enough to think of ourselves as only a tiny part of a vast and incredible universe."[75]

Carson's primary concern was the future of the environment and the living things that inhabit it. Aware that her case was solid, she paid little heed to her critics or how her book was received in the scientific community. Her convictions were perhaps galvanized by a diagnosis of cancer, which claimed her life less than a year after the Senate hearings.

[75] Rachel Carson, "CBS Reports," *The Silent Spring of Rachel Carson*. Interview by Eric Sevareid. CBS. April 3, 1963. Television.

Birth of a Movement

Whether Carson intended it or not, *Silent Spring* unleashed an era of political ecology as citizens spoke up against large corporations and others that polluted the environment. A formidable political lobby emerged, in the form of new organizations like Greenpeace and the World Wildlife Fund, as well as established conservation organizations like The Sierra Club who joined the fight to protect the environment. Today there are more than a hundred such organizations active on behalf of environmental causes in the U.S. alone and hundreds more throughout the world. Prior to the publication of *Silent Spring* there were virtually none.

One important point made by *Silent Spring* is that scientists must take responsibility for their discoveries. Having the capability to create a chemical does not mean it can be used irresponsibly. Public outrage about environmental damage reached a crescendo during the Vietnam war when television viewers witnessed the use of napalm, which can cause severe and permanent burns. Carson and other like-minded concerned scientists urged people to reevaluate their ethical framework and consider the long-term impact of their actions. *Silent Spring,* Carson's most widely-known work, was written independently of academia and the grant-application system, though she was dependent on the good will and collaboration of other scientists who were part of that system.

While Carson's academic training gave her a solid foundation for research, given her talent and passion for the subject matter she may have reached the same conclusions without it. As a naturalist, Carson took her writing seriously, chiding other naturalist writers for failing to educate the public about the importance of natural

science through their work. She believed nature writers had an obligation to make the public aware of the wonders of the living world. When accepting the John Burroughs Medal for excellence in nature writing for *The Sea Around Us* in a gala ceremony in New York in April 1952, she castigated nature writers for not standing up to publishers and magazine editors who express a "deprecating attitude which assumes in advance that a nature book will not have a wide audience…[finding] this attitude [as] not only psychologically unsound; it is a mistaken and ill-founded."[76]

In the letters she received from the public, Carson found that "there is an immense and unsatisfied thirst for understanding the world about us and every drop of information, every bit of fact that serves to free the reader's mind to roam the great spaces of the universe."[77] Carson wanted to educate and empower these readers to take positive action to protect the world we all live in.

[76]Rachel Carson and Linda J. Lear, *Lost Woods*, 95.
[77]Ibid., 96.

Dr. Jane Goodall: Independent Scholar in the Jungle

The Path to Africa

Even as a child in England, Dr. Jane Goodall dreamed of living in Africa. In 1957, when she was 23, Goodall used her personal savings for her first visit — to a school friend — and soon looked for a reason to stay. Her friend recommended that Goodall call Dr. Louis Leakey, a paleoanthropologist and archaeologist who at the time was running the Coryndon Museum in Kenya. Leakey answered the phone himself and was impressed by Goodall's enthusiasm for the outdoors and her knowledge of Africa. He invited her to meet up and soon found small jobs for Goodall at the museum. A few years later, after observing Goodall's field work, Leakey offered her an assignment that would prove momentous. He believed that careful observations of chimpanzee behavior "might shed light on the behavior of our stone age ancestors."[78] It was a bold theory and his choice of Goodall as researcher was surprising. She had no education past high school and a secretary's degree. Yet Leakey saw clear advantages with Goodall. Tremendous patience was required to win the confidence of the chimpanzees and observe them up close. He wanted someone with a "...mind uncluttered and unbiased by theory who would make the study for no other reason than a real desire for knowledge; and in addition, someone with a sympathetic understanding of animals."[79] For this type of work, he believed, a university degree was unnecessary — and might even be a hindrance. He also felt that a woman would pay more attention to crucial details than a man. For Goodall, it was a childhood dream come true: living in the African jungle

[78] Jane Goodall*, In the Shadow of Man* (Boston: Houghton Mifflin Company, 1971), 6.
[79] Ibid., 6.

close to the animals. Leakey, who was about to launch one of the most important and controversial studies in the field of animal behavior, spent several months raising funds for Goodall to study chimpanzees in Gombe, Africa.

Goodall consistently challenged expectations and stereotypes about scientists and women. Achieving status in academia was never a goal for her but rather a means to an end. Her passion was for the animals. How did Jane Goodall's formal academic training — which she acquired mid-career — influence the development of her field work, research methods, writing style, career, fame and reputation? By focusing on Goodall's work before, during and after her training at Cambridge and examining her memoirs and letters as primary sources, one can better understand her changing relationship with academia.

Primate Field Research Before Goodall

Prior to Goodall, others had researched wild primate behavior. Psychobiologist Dr. Robert Yerkes was beginning to extend the series of naturalistic studies of primate behavior he had initiated in 1929. Yerkes worked at the Yale Laboratories of Primate Biology and his research focused on laboratory studies of primate behavior. His first project was a study conducted by psychologist Dr. Harold Bingham, who was attempting to observe gorilla behavior in the wild in the Belgian Congo in 1929. Bingham was unsuccessful due to insufficient field methods, a lack of field experience and the shy demeanor of gorillas, therefore resulting in few observations of gorilla behavior. "He did find that gorillas sleep only one night in a given nest and that they

wander about constantly in search of food."[80] That same year, Yerkes organized psychologist Dr. Henry Nissen's field study of chimpanzees at the Pasteur Institute of Kindia in Western Africa. The trip's primary objective was for Nissen to "return with chimpanzees for captive colonies at both the New Haven and Orange Park Laboratories...Nissen spent two and a half months in the field with a total of sixty-four days spent doing 'active field work.'" [81] The chimpanzees were observed for forty-nine days during this trip. Nissen and Bingham both turned toward naturalist observation techniques, including trailing the primates, but their techniques failed. Yerkes agreed with Nissen that one goal of the expedition was to test 'the feasibility of field studies' and to make 'a start of discovering workable methodology and techniques for naturalistic observation of the chimpanzee."'[82] Starting in 1931, Yerkes had Dr. Clarence Ray Carpenter, who is considered as the first individual to conduct scientific primate field studies within the primatological community, began a study of the behavior and social relations of howling monkeys at Barro Colorado, an island in Puerto Rico, who was evidently the most successful.

Carpenter studied the howling monkeys for a total of eight months between 1931-1933 and expanded the methodological arsenal for field primatology. He spent most of his time breaking down the howling monkeys' social behaviors into observable and replicable parts. "His census and recording techniques allowed for the first accurate

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[80] "Dr. Harold Bingham, 76, Dies; Psychologist and V.A. Adviser," *The New York Times*, August 27, 1964. *Nytimes.com*, https://www.nytimes.com/1964/08/27/archives/dr-harold-bingham-76-dies-psychologist-and-va-adviser.html

[81] Georgina M. Montgomery, *Primates in the Real World: Escaping Primate Folklore and Creating Primate Science.* (Charlottesville: University of Virginia Press, 2015), 50.

[82] Ibid., 50.

counts of wild primate populations and for repeated observation of their forms of locomotion, social behavior, and vocalization."[83] He made prolonged observations of natural howling monkeys' behavior, including their communication, territoriality and social interactions. Carpenter used the dyadic method, a new field technique that involved breaking down a social situation into its component parts in order to explore complex social relationships. In 1937, Carpenter went to Thailand to begin studying wild gibbons and recorded their vocalizations and behavior. Influenced by Carpenter, Japanese primatologists, including Masao Kawai, began studying the Japanese macaque, also known as the snow monkey, in 1958, just two years before Goodall started her research in Gombe.[84] While some significant research was conducted prior to Goodall's arrival in Gombe, it lacked both the time commitment and originality of methods that characterized her work.

[83] Ibid., 53.
[84] Karen B. Strier "Primate Behavioral Ecology: From Ethnography to Ethology and Back," *American Anthropologist*, vol. 105, no. 1, 2003. *JSTOR*, https://www.jstor.org/stable/pdf/3567310.pdf?refreqid=excelsior%3A94c231b54e81ba6761b4ff0116d147ac, 16.

First Field Work

Within a year in Gombe, Goodall had made two discoveries that upended conventional scholarship. First, that chimpanzees used tools. Until then, scientists believed this was a behavior unique to humans. Second, that chimpanzees ate meat. This was made possible when Leakey secured a commitment from a Chicago friend, Leighton Wilkie, to fund Goodall's research with a $3000 check from the Wilkie Foundation.[85]

On her first morning in the field, six Africans arrived with the local chief's son to accompany her. However, after Goodall pointed out that she planned to spend the day in "...the steep thickly forested slopes of the valley,"[86] the chief's son and his men decided not to accompany Goodall. The Africans had expected Goodall to merely "...ride up and down the lakeshore in a boat, counting any chimpanzees [she] saw. The idea of clambering about in the mountains did not appeal to him at all and [she] never saw him again."[87] The natives were unprepared for a woman committed to such physical, thorough work.

In her first day, Goodall was led through a valley in which she and her chaperones viewed chimpanzees in Gombe for the first time, counting sixteen overall. Some of Goodall's different male chaperones helped her learn how to navigate the mountain, but she found their presence a nuisance and eventually made the trips without accompaniment. Goodall rose early each morning to study the chimpanzees and

[85] Erika Lorraine Milam, *Creatures of Cain: The Hunt for Human Nature in Cold War America* (Princeton: Princeton University Press, 2019), 55.
[86] Ibid., 17.
[87] Ibid., 17.

remained until late in the day. Equipped with only a notebook and pencil, she observed all the actions of the chimpanzees, trailing them for hours and recording their habits and lifestyle. Goodall was at first frustrated by her inability to get close to the chimpanzees. No matter how quiet and patient she was, whenever a chimpanzee noticed her, it would quickly scamper away.

Three months into her work, Goodall fell ill with malaria for two weeks and she feared she would have little to show before her funds ran out. She decided to travel into the mountain above the camp alone for the first time, unable to bear the thought of any of her African companions seeing her in a weakened state. After reaching an open peak, within fifteen minutes, Goodall "looked around and saw three chimps standing there staring at [her]. [She] expected them to flee...but after a moment they moved on again, quite calmly, [making Goodall realize] the chimps had undoubtedly been fully aware of what was going on.[88]

After this experience, Goodall frequently returned to the same location, and "When the chimpanzees slept near the Peak [she] often stayed up there too."[89] Around a month after Goodall began observing the chimpanzees from the Peak, she began to notice significant differences amongst them. That led to her giving them names, a practice that scientists considered anthropomorphic, sentimental and therefore unacceptable. This was not a trivial administrative matter. In fact, it cut to the core of Goodall's groundbreaking approach. From the start, she had always been interested in "the *differences* between individuals, and a name is not only more individual than a

[88] Ibid., 25.
[89] Ibid., 27.

number but also far easier to remember. Most names were simply those which, for some reason or other, seemed to suit the individuals to whom [she] attached them. A few chimps were named because some facial expression or mannerism reminded [Goodall] of human acquaintances.[90]

Two chimps that stood out were David (Graybeard) and Goliath, a biblical reference because they were often spotted together. Goodall was well-aware that her naming practice was unconventional. Moreover, it represented a shift in thinking about etiology in general and the study of chimpanzees in particular. What Leakey meant by an uncluttered mind proved prophetic. Unfettered by traditional academic practices and biases, even after her brief term at Cambridge, Goodall fundamentally changed the study of chimpanzees and other wildlife animals. Without direct supervision, and with Leakey's general support and encouragement, Goodall was free to work in her own natural, unique way — which is precisely what Leakey wanted.

However, there was a price to pay. Many academics felt Goodall became too close to her subjects and questioned the validity of her work. No one had ever studied chimpanzees for such a long period of time in the wild, nor with such burning passion for the subject matter, which explains why Goodall was able to record so many details and mannerisms previous researchers missed.

Goodall's mother, Vanne, who had initially come as a chaperone, left after five months. Goodall had never been bothered by loneliness, yet feared that if she were alone longer than a year, she may have "...become a rather strange person, for inanimate objects began to develop their own identities: [Goodall] found [herself] saying "Good

[90] Ibid., 32.

morning" to [her] little hut on the Peak, "Hello" to the stream where [she] collected her water."[91] Goodall continued her field work with the same passion with or without company at night, diligently taking notes throughout the day in her notebook and writing summaries at night.

During the last few months of Goodall's trial period, near the summertime, she made two important discoveries. First, she noticed a female, "pick[ing] up a piece of the pink thing and put[ting] it to her mouth: it was at th[at] moment that [Goodall] realized the chimps were eating meat.[92] Goodall determined that they were eating three small piglets and knew it was a major discovery. Two weeks later, she met an even more significant encounter. On a rainy October day through her binoculars, Goodall spotted Graybeard, "...squatting beside the red earth mound of a termite nest, and [watched] him carefully push a long grass stem down into a hole in the mound. After a moment, he withdrew it and picked something from the end with his mouth."[93] From where Goodall was located, she could not tell what Graybeard was eating, but it was obvious he was using a grass stem as a tool. On only two other occasions had casual observers in West Africa seen chimpanzees using tools, so this was a profound discovery.

Previously, humans had been regarded as the sole tool-making species, and that they "made tools to a regular and set pattern. The chimpanzees...had not made tools to any set pattern. Nevertheless, [Goodall's] early observations of their primitive tool-making abilities convinced a number of scientists that it was necessary to redefine man in a more complex manner than before, or...as Louis Leakey put it, we should by

[91] Ibid., 50.
[92] Ibid., 34.
[93] Ibid., 35.

definition have to accept the chimpanzee as Man. Goodall sent telegrams to Leakey about both of [her] new observations...and he was...wildly enthusiastic. Goodall believe[d] that the news was helpful to him in his efforts to find further financial support for [her] work."[94]

In November of 1961, Goodall watched young chimpanzees enjoying the rain by "...charging down the slope toward the trees...break[ing] off...low branche[es] from trees...and when they reached the ridge, they started charging down all over again, one after the other, with equal vigor."[95] Goodall describes the chimpanzees' movements as a "rain dance," with the larger males swaying on their feet to a rhythm, charging not too aggressively at one another. She only witnessed this celebration in the rain a total of three times in Gombe. Goodall admitted that she observed this in a very unscientific manner, as the rain made it difficult to use her notebook or binoculars. Yet, the observation was significant. This is another example of Goodall straying from scientific norms while completing important field work. Goodall focused on enjoying her experiences and time with the chimpanzees, while still conducting important research. Comfortable and relaxed in that environment, Goodall was allowed unprecedented access to her subjects.

After Goodall's discovery that chimpanzees used tools, Leakey was anxious to share her findings with academia. More broadly, Leakey believed that Goodall's work would be taken seriously once she completed academic training and encouraged her to enroll in a Ph.D. program at Cambridge. By then, he was well-acquainted with her

[94] Ibid., 37.
[95] Ibid., 53.

informal, bubbly writing style. In one letter to Leakey she writes: "As for the details of social behaviour — to be able to follow the interrelationships from DAY TO DAY, instead of simply seeing the same animals together once a week or even once a month — well, I can really say, now, that I know chimps. Louis — I beg you will try to come and see things for yourself… DO try and come. You would fall head over heels in love with all my darlings..." (capitalization is hers)[96]

Goodall spent many years in Gombe throughout her career and during that time, *National Geographic* became interested in publishing stories on Goodall, as she was both physically attractive and an expert in her field. Throughout her career, Goodall continued to think of herself as a naturalist, even after her time at Cambridge.

Cambridge Years

While delighted with her discoveries, Leakey knew that without a university degree, Goodall's findings would be largely ignored by academia. With Leakey's help, Goodall enrolled in a Ph.D. program in ethology at Cambridge, where Leakey had received his degree. Although at first daunted by the Cambridge idea, Goodall knew Leakey was right and enrolled in 1962.

In 1965, she became just the eighth person in history ever to receive a Ph.D. from Cambridge without an undergraduate degree. Leakey had dedicated a significant amount of time convincing "...the authorities at Cambridge that her work was important enough to be written up as a thesis, without having to get an ordinary degree first…"[97]

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[96] Goodall, *Africa my Blood*, 265.
[97] Sonia Cole, *Leakey's Luck: The life of Louis Seymour Bazett Leakey* (Great Britain: 1975), 337.

She spent roughly three years working on her Ph.D., including a few additional months of field research in Gombe. To be taken seriously as a scientist, Goodall needed to learn the proper way to take notes and write in a scientific voice. Beforehand, Goodall spent her days writing various observations about the chimpanzees into a notebook with her pencil, summarizing her findings in the evenings. She started recording her observation on a tape while working on her Ph.D. in 1963. One of the first tasks facing Goodall as a field worker was, "...the defining and cataloging of the chimpanzee's gestural, vocal, and facial expressions for intraspecific communication. Her rhetoric...was scientific prose, not the adventure travelogue style…"[98]

Zoology professor Robert Hinde, her advisor at Cambridge, was initially critical of Goodall for what he considered an anthropomorphic approach. Hinde taught Goodall how to think and act like a scientist. He was straightforward and "pointed out the flawed reasoning behind some attempt to describe and quantify a portion of the data, or explained just why it was that certain words were not acceptable in the scientific circles of the time...On occasion he would tell her that [she'd] better go and do a lot of reading before [she] continued to make a fool of [herself] (not that he put it quite in those terms, but his meaning was clear).[99] Goodall longed for the solitude of the forests, but forced herself to follow his guidance. The main problem was that Goodall had to convert "...day-by-day, minute-by-minute narration recorded in her handwritten field journal over a year and a half in the forests of Gombe, into scientifically acceptable form...by

[98] Donna Haraway, *Primate Visions* (London: Routledge, 1989), 139.
[99] Dale Peterson, *The Woman Who Redefined Man* (New York: Houghton Mifflin Company, 2006), 274.

creating an index, then, piece by piece, by summarizing her information as quantitatively and objectively as possible.[100]

Goodall had made a vow when she enrolled at Cambridge, which she considered the start of her scientific career, that she would strive for simplicity and comprehensibility. Therefore,

> ...instead of describing the hair-raised state of excited, fearful, or enraged chimps as *piloerection,* for instance, [she decided] why not call it *hair erection* or *bristling?* Using a fancy word when a simpler one would do always seemed pompous to [Goodall], and, worse, it excluded many people, created small barriers against ordinary understanding. In that regard, she made a second vow. If she has to read anyone else's sentence three times, she would put the book away…Goodall...considered herself reasonably intelligent...and if [she] had to read something three times to understand what it means, why should [she] waste [her] time?[101]

The term Citizen Scientist is an apt one for Goodall, since she focused on her own interests rather than those of an institutional enterprise such as a university or college. She thoroughly recorded her daily accounts and detailed all of her observations, once again defining Goodall as someone who would not have been able to conduct her research if she was associated with a university, as citizen scientists use research methods that do not conform to university researchers as they often seem too labor-intensive.

Hinde did mention that Goodall's original journaling "narrative" style was flexible and made it easy to continue recording observations but left open the possibility of redundant entries. Hinde taught Goodall to utilize "...a check sheet in which for every consecutive time interval you enter what the chimpanzee had been doing. It was that

[100] Ibid., 275.
[101] Ibid., 593.

sort of check sheet [he] introduced her to...Over the next few years, Hinde introduced his standardized check-sheet data collection to Gombe, traveling to the research camp three times…"[102] In his first visit, Hinde brought design check sheets for Goodall and her field staff to use. These sheets allowed data collection to be more reliable. While there, Hinde emphasized the importance of time sampling, yet after spending time in Gombe, realized that methods of data recording which worked for captive studies did not always work in the wild. The biggest impact of his visit was that observations were now recorded on a tape recorder then transferred into customized check sheets. A major advantage of Hinde's data-recording system was that researchers became interchangeable and did need to constantly look down at their notes. Hinde turned Goodall into a person who "...not only wrote like a scientist and acquired data like a scientist but who thought like a scientist."[103] Goodall was very content with her first scientific writing at Cambridge focusing on the typical behaviors of chimpanzees, as knowing these characteristics was essential to understanding chimpanzees. Goodall's naming of the chimpanzees became a discussion topic at Cambridge, as it implied a humanlike individuality, which shocked Hinde and other Cambridge professors.

Goodall was reprimanded for "...ascribing personalities to the different chimpanzees — as though I had made up the vivid and unique characteristics of the various members of the Kasekela community! Only humans have personalities, [she] was told...To assume that some animals behaved in certain ways as the result of personalities, or because of emotions or minds, was in the early 1960s considered

[102] Ibid., 275.
[103] Ibid., 277-76.

unscientific.[104] Though Goodall was learning to write, research and complete field work with a scientific mind, she still held on to her core beliefs. She "...had had a marvelous teacher in animal behavior throughout my [her] childhood – [her] dog, Rusty. Thus, she simply "ignored the admonitions of Science" — until the day her own peculiar ideas became accepted as part of that same Science,"[105] proving that while she may have changed her work style, so it would be accepted by other scientists, her overall approach towards the animals showed little variation.

In 1961, after a year at Cambridge, Goodall returned for a brief visit to Gombe. She was worried that the chimpanzees may no longer accept her presence and would need to start work from scratch. However, Goodall found the chimps "...if anything, *more* tolerant of [her] presence than before. One evening [she] returned to camp and found [her assistants] Dominic and Hassan very excited. A large male chimpanzee, [she was told], had walked right into camp and spent an hour feeding from the palm tree that shaded [her] tent."[106] In May of 1961, while Goodall was recording her previous day's notes on a typewriter that she had brought from England, "...at about ten o'clock David Graybeard strolled calmly past the front of [her] tent and climbed the palm tree. An hour later he climbed down, paused to look, quite deliberately, into the tent, and wandered away. David Graybeard paid [Goodall] regular visits until the palm tree's fruits w[ere] finished.[107]

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[104] Ibid., 277.
[105] Ibid., 277.
[106] Goodall, *In the Shadow of Man*, 65.
[107] Ibid., 65.

Goodall decided to have Dominic leave out bananas whenever Graybeard was spotted, to encourage the chimps to wander into her camp. One day, Goliath wandered into camp for bananas. After observing how Goliath and Graybeard interacted, Goodall concluded that Goliath was the highest-ranking male chimpanzee in the area. Goodall strove to make the chimpanzees comfortable enough to move freely amongst her team. Soon afterwards, Goodall "...initiated a banana feeding station, where more systematic records were begun on infant development and social interactions, interested in terms of status hierarchies."[108] While the banana feeding station was a blemish on her research because it significantly altered the chimpanzees' "normal" behavior, a formally trained research might have made the same mistake. Goodall always viewed animals as individuals, despite the conventional thinking. As her career progressed, her convictions solidified. Unlike most of her contemporaries, Goodall had no doubt that these animals had unique characters, emotions and brain power.

Soon after Goodall's return to Gombe, *National Geographic* photographed her at work with the chimps. Goodall initially resisted the idea, fearing that a large camera would scare the animals. Leakey persuaded her that the photographer, Hugo van Lawick, loved animals and would do a great job.[109] By the time van Lawick left in November, he had captured the chimpanzees using and making tools. Christmastime of 1961, Goodall, all alone, decided to purchase a large supply of bananas and placed them, "...around a small tree [she] had decorated with silver paper and absorbent cotton. Goliath and William [another chimpanzee], arrived together on Christmas morning and

[108] Haraway, *Primate Visions*, 166.
[109] Goodall, *In the Shadow of Man*, 70.

gave loud screams of excitement when they saw the huge pile of fruit.[110] Goodall treating the chimpanzees as though they were friends or family by wrapping up the bananas suggests that perhaps Goodall was simply doing something kind and amusing because she was alone, since she truly cared for all animals — something unusual amongst contemporary scientists.

In March of 1962, Goodall had been asked to write a paper on nesting and reached out to the zoologist Desmond Morris for advice. Even after Cambridge, she still thought more like a naturalist than a scientist. In the letter to Morris, she struggles to understand why chimpanzees changed nests every night. She wondered whether, "...it was simply habit, like a dog turning round and round before he lies down…"[111] These seem more the musings of a hobbyist than a Cambridge Ph.D. student. Goodall still preferred colloquial terms to scientific ones, which says a lot about the impact, or lack of impact, that of her Ph.D. training. She does not seem to have suddenly developed a "scientific mind." That she considers her family dog Rusty to be "...a marvelous teacher in animal behavior throughout [her] childhood"[112] is worth noting. A family dog is not something a conventional scientist would cite as an influential source.

On April 12, 1962, Goodall spoke at the "Primates" symposium held at the Zoological Society of London about her discovery that chimpanzees ate meat. It was her first professional conference and she practiced for hours to avoid stuttering on stage. During her talk, Goodall revealed, "...her discovery that chimpanzees make and use

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[110] Ibid., 75.
[111] Goodall, *Africa my Blood*, 213.
[112] Elizabeth Abbott, "Jane Goodall, Rusty and Me" Huffington Post, May 14, 2016, https://www.huffingtonpost.com/elizabeth-abbott/jane-goodall-rusty-and-me_b_7275668.html

tools, but her first scientific presentation focused on a related subject that was more general, less provocative — chimpanzee feeding behavior, [as] over a period of fifteen months, she had directly watched wild chimpanzees for approximately eight-hundred hours, some three-hundreds of which involved feeding activity...Those who knew Jane...were in awe of the risk she was taking... [they] were learning things from her about chimpanzees which couldn't have [been] learned any other way. This was the point. Her study was unique."[113]

While most other scientists were impressed with her findings, Sir Solly Zuckerman, an anatomist who had studied monkeys in Africa and gone on to become Secretary and Chief Science Adviser to the Ministry of Defense, questioned Goodall's credibility. Zuckerman took the opportunity to ask multiple questions. He told the audience "there are those who are here and who prefer anecdote—and what I must confess I regard as sometimes unbounded speculation. In scientific work, it is far safer to base one's major conclusions and generalizations on a concordant and large body of data than on a few contradictory and isolated observations, the explanation of which sometimes leaves a little to be desired."[114] Zuckerman was known for thinking about primates in a brief field study, which he took as license to bully Goodall. Women scientists who focused on primatology were a novelty and some old-fashioned researchers like Zuckerman did not receive them kindly.

The more Goodall spoke at conferences, the more evident it was that her passion for animals was inseparable from her field work. Goodall portrayed herself "...as

[113] Peterson, *The Woman Who Redefined Man*, 288-90.
[114] Ibid., 291-92.

ambitious at science, intellectually engaged in serious research, rationally determined to advance her own career and our understanding of humanity's closest relatives, and so on." In reality, Goodall's passion for the animals is what kept her going. Even as she adopted certain best practices of scientific research, she continued naming the chimpanzees.

In the summer of 1964, Edna Koning arrived in Gombe with Goodall as her first research assistant. By now, Goodall had fallen in love with and married the National Geographic photographer, van Lawick, who helped with paperwork during the evenings. Koning made typewritten transcriptions of Goodall's notes on tape. This allowed Goodall to keep her eyes on the animals. As Koning "...started making an extra copy of [Goodall's] notes, three copies in all, and [Goodall] marked her copy into categories of behavior-grooming, submission, aggression and so forth. Koning, van Lawick and Goodall cut these up and pasted them in their relevant sections into a large notebook,"[115] which helped Goodall's analysis, as she sent the third copy monthly to Leakey for safe keeping. Evidently, Goodall picked up these tactics at Cambridge. In 1965, as funding opportunities grew, more researchers arrived in Gombe to help. Female assistants who arrived in Gombe "...were the ones primarily assigned to watch and later follow mother-infant pairs in Goodall's study of infant development,"[116] perhaps reflecting traditional notions of a woman's role.

Goodall's personal approach with the animals sometimes had potentially dangerous implications and in 1965, she realized she had made a terrible mistake. She

[115] Goodall, *In the Shadow of Man*, 131-132.
[116] Haraway, *Primate Visions*, 173.

and van Lawick had encouraged Flint, the son of the chimpanzee Flo, to "...touch [them] and [they] had tickled him gently. It had been a delighting experience, and [they] had marveled that a chimpanzee mother could lose her fear of humans to the extent of allowing her infant to play with [them]...When [they] left, they realized the foolishness of [their] behavior. The adult male chimpanzee is at least three times stronger than a man...if [chimpanzees] grew up and realized how much weaker humans were, [they] would become dangerous…[They] made a rule that in the future no student should purposefully contact any of the chimpanzees.[117] In this respect, the conventional wisdom may have been right about maintaining distance from an animal subject.

Life after Cambridge

Part of Goodall's success derives from her personal beliefs, which remained intact after Cambridge. She continued to study what interested her most. Starting in 1963, Goodall began focusing on social behavior and infant development of chimpanzees. Being friendly around the chimpanzees arguably aided her research methods and discoveries. The post-Cambridge habit of talking into a tape during the day meant spending hours each night at the typewriter transcribing the daily notes. This organizational method was one benefit of Cambridge and improved the overall quality of her record-keeping. "Daily charts were kept on 1) group structure and activities 2) individual activities and gestures and 3) contents of feces (giving information about chimp foraging). Population data, photographic archives and lists of gestures were

[117] Goodall, *In the Shadow of Man*, 139.

assembled. The feeding station permitted standardized records of attendance, behavioral interactions, and estrus state of females."[118]

By the time Goodall earned her Ph.D. in 1965, she was utilizing research methods that Hinde had drilled into her. She had learned to think like a scientist at Cambridge, even if she often returned to her former naturalist habits. Goodall was well respected in the scientific community, and the "...chairman of the National Geographic Society's Committee for Research and Exploration declared in a committee meeting of early 1966 [she was] probably the most qualified person in the world today to speak on the subject of chimpanzee behavior in the wild."[119] Professionally she had come of age.

End of Goodall's Research

From her fieldwork in 1960 to the present, Goodall has consistently challenged expectations and stereotypes about scientists and women while pursuing her intellectual passions. Thus, even when Goodall achieved respected status in academia, she declined lucrative opportunities, so she could continue working in Africa. In the 1960s and 1970s, she did accept the National Geographic Society's offer to support her research and in exchange produced a series of articles and documentaries expounding a universal human nature to which chimpanzees were the key.[120] Goodall's formal academic training made her work intelligible and acceptable to academics.

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[118]Ibid., 170.
[119] Goodall, *Africa my Blood*, 334.
[120]Rachel E. Gross, "21st Century Fox Just Bought a Majority Stake in *National Geographic.* Should Science-Lovers Be Worried?" slate.com. September 10, 2015. https://slate.com/business/2015/09/national-geographic-merges-with-fox-is-the-future-of-this-national-treasure-at-stake.html

Still, her methodology and research interests changed little after Cambridge. She clung to her convictions that animals possessed unique characters, emotions and intellect. She followed academic protocol to the extent that it improved her research and made it accessible to her peers, but no more than that. Cambridge empowered her in certain respects but could not undo what was most unique about her thinking.

Goodall's success raises the question: what is the role of academic training? If Goodall had followed a conventional path of study, beginning with an undergraduate degree in zoology and then a master's degree and Ph.D., she might not have developed the same unique approach in the field and would have never been considered by Dr. Leakey. Clearly, there was value in her Cambridge education — especially after her important work in the field.

Conclusion

The 19th century German philosopher Arthur Schopenhauer famously observed: "All truth passes through three stages: First, it is ridiculed. Second, it is violently opposed. Third, it is accepted as self-evident."[121] To a large extent, the important truths uncovered by Ed Ricketts, Rachel Carson and Dr. Jane Goodall passed through each of these stages before finding wide general acceptance in the public and in academia. Each was an independent thinker and researcher, who followed their instincts and broke with traditional protocols of academic research to reach groundbreaking discoveries. Each was motivated by a profound commitment to their respective fields and enduring desire to make their findings accessible to their fellow citizens of the planet.

Academic training played a very different role for each. In the case of Ricketts, who dropped out of the University of Chicago largely because of limited research opportunities, formal training played a minimal role. Carson, though trained as a marine biologist, could see it would be a rough road for a woman to advance in academia at that time and so turned to popular writing about the seas. Goodall made her most important discoveries about chimpanzees alone in Africa, then completed a Ph.D. at Cambridge so that her work would be accepted by the academia world. Each of these three fill zoologist Anne Innis Dagg's definition of a Citizen Scientist. Nowhere is that clearer than in the language and writing style they chose. Ricketts, Carson, and Goodall each avoided arcane, academic jargon in favor of terms and phrases that the average

[121] Jeffrey Shallit, "Science, Pseudoscience, and The Three Stages of Truth" (Waterloo: University of Waterloo, 2005), 5.

reader could understand. While their work had popular appeal, it also had far-reaching significance in scientific circles.

Their success raises important questions about the role of higher education, especially graduate research training and the process by which scientific research is funded. Goodall and Ricketts benefitted from the patronage of well-connected figures, Leakey and Steinbeck, respectively, which allowed them the financial security to follow their interests. When Carson found that security with the success of *The Sea Around Us*, she retired from her government job and assembled material for her most important work, *Silent Spring.* In other words, independence was a cornerstone of success in each case. With that in mind, is the grant-writing process — which often pigeon-holes researchers into narrow areas of interest for a limited amount of time — the best way to encourage great scholarship? Perhaps the MacArthur Fellowship is a better model, in that it provides those with a proven talent and commitment to a particular field the freedom to pursue their interests as they see fit.

These three stories also raise questions about the function of higher education in training researchers. If one needs to break away from traditional ways of thinking — as each of these researchers did — then what is the function of those institutions who train them? Where should the balance be between teaching traditional methods and encouraging curiosity and out-of-the-box thinking? Goodall's case is in some ways the most interesting. She was the only one of the three with absolutely no formal training before she made her most important discoveries and the only one to earn a Ph.D. Her doctoral degree from Cambridge provided the credibility she needed — but why did she need it at all? She herself would say the training proved helpful in the field, in terms of

organizing her research methods, but she picked and chose which methods to employ — and never stopped naming the chimpanzees. Is Goodall's story perhaps a better model for academic training: First go into the field and demonstrate your commitment and talent, then come to the classroom to gain the tools you might find helpful. Many MBA programs use this model, requiring applicants to work several years before pursuing the degree.

One theme that recurs in each of these three stories is connection. Ricketts and Carson, pioneers in ecological thinking, sought to show how all life forms are interrelated and the activities of any one can impact many others. While we take this as "self-evident" today, they wrote it well before it was. Goodall, in her own way, established the evolutionary link we have to other primates. It was through patiently establishing a connection with them that she was able to make her important discoveries. Ricketts, Carson and Goodall all predated the general acceptance of ecosystems as a unifying factor. It was not until after Carson that it became "accepted as self-evident" that all these ecosystems are connected. All three were able to grasp this connection because they worked largely outside the conventional ways of thinking. Furthermore, researchers are often encouraged to focus on narrow segments of the world and it takes a truly free thinker to make connections with other disciplines and research areas. With connection, comes compassion — which figured into the life and work of each of these three Citizen Scientists in profound ways.

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