Commentary

Rachel Carson and Mid-Twentieth Century Ecology

With the obvious exception of Charles Darwin, perhaps few biologists match the influence of Rachel Carson on society and on her adopted science. That science was not the marine biology of her popular books, but the previously little-known science of ecology that was transforming itself—and would transform itself in no small part due to Carson's influence—into the science that has today become a household word. A study committee of the Ecological Society of America (ESA) on the direction of ecology in 1964 credited *Silent Spring* with creating "a tide of opinion which will never again allow professional ecologists to remain comfortably aloof from public responsibility."[1]

Although ecological histories have begun to incorporate the history of the environmental movement with that of the science, Carson's work has yet to be fully integrated into the history of ecology. It needs to be part of that history.

Rachel Carson's training in ecology

Questions about Rachel Carson's scientific knowledge base arose not just from those in the chemical industry, as was expected, but also from those in ecology. In an important review in *Scientific American*, Cornell University ecologist LaMont Cole, soon to be President of the Ecological Society of America (ESA), criticized her understanding of the "balance of nature" and of evolutionary processes.[2]

How much of an ecologist was Carson? And in what field of ecology? Neither question can be answered satisfactorily, but there are fascinating hints.

The transitional and polymorphous nature of ecology during Rachel Carson's life makes it difficult to target indicators of expertise on her part. There were no courses with any specifically identified ecological content offered at Johns Hopkins University when she attended classes there. However, without actual lecture notes or reading lists, it is difficult to exclude subject matter from a course. Three of the six-member faculty of 1929 in biology were listed as members in the ESA's first membership directory and would publish in the society's journal, *Ecology*, two doing so just prior to and during Rachel Carson's time there. She therefore had opportunity at Hopkins to be exposed to two venerable parts of ecology: animal and plant physiology.[3]

Raymond Pearl, who developed the logistic growth equation that is so fundamental to ecology, and in whose laboratory Carson finished her education at Hopkins, was not an ecologist at all, but a human biologist who pioneered the science of demography. Pearl's logistic equation, a foundation for environmental thought, never found its way into Carson's works, even by inference. Pearl did, however, exert an important influence on her through his holistic view of biology, in which biological studies served to promote understanding of the human condition. Similarly, Herbert S. Jennings, Carson's graduate examining committee chairman, was not recognizable as an ecologist, yet a 1965 compendium of ecological literature includes a paper on methodology published by him in 1904. Pearl's view—with man a part of, not apart from biology—was shared by Jennings.[4]

Given the density of ecologists—avowed or otherwise—at Hopkins, Carson had to have been exposed to ecology, but it was a different sort from the ecology that was to burst out in America after World War II, and that would be proclaimed the science of the environment essentially simultaneously with the publication of *Silent Spring*. The ideas of Frederick E. Clements, Victor E. Shelford, Charles S. Elton, and Giorgii Gause (and Pearl), which would soon be stirred together with those of others to create a new ecology, left no tracks leading through her graduate experience at Hopkins. That much is evident in examining her works and notes.

First, there is her dissertation, a thorough document of one hundred and one pages of description that strays not a single step away from the physiological development of the fish organ under study. Neither is there a hint of any ecological ideas that had to have been in the air at Hopkins.[5]

Then there is her Woods Hole experience. E. A. Andrews (of her examining committee), Jennings, and Reinhardt P. Cowles, under whom she studied marine biology at Hopkins, were regulars on its summer staff. Carson was twenty-two when she found herself in the setting of a picture-book village by the sea from which fascinatingly equipped research vessels set out. It initiated a lifelong passion in her for the seashore. And until *Silent Spring* caused her to broaden her contacts, the scientific advice she sought was often from people having a Woods Hole background. She relied on Henry Bigelow, for example, until he advised in a letter to her that he was "too ancient to keep up-to-date or even understand all the new language."[6]

As impossible as it is to establish what she might have read or heard in lectures while at Hopkins, Woods Hole presents an even greater mystery. Modern ideas of ecology were at least in the air at Hopkins based on evidence presented; there is less evidence for that quality of air at Woods Hole. Shelford, then pioneering animal ecology in the United States, called "that Woods Hole establishment" anti-ecological. Photographs of Woods Hole scientists of those days almost invariably have them posed with microscopes, and a laboratory emphasis was prominent in the topics for seminars and lectures during Carson's stays there. Shelford's remark, however, could not have described the Woods Hole of the 1920s when his student, Warder Clyde Allee, who would head what would become known as the Chicago "school" of ecology, was there doing research. Allee would go on to co-author the highly influential text, *Principles of Animal Ecology*, which came to be known among ecologists as "great *AEPPS,*" after the authors' initials.[7]

The Woods Hole "mess" provided ample opportunities for informal interactions. A spirited discussion could have had as much impact on Carson's thinking as a lecture. There were also the shelves of the Woods Hole library, which held all of the latest in ecology. Unfortunately, both the nature of her discussions and subjects of her reading are lost to us.[8]

Her early works

Scientists continue their education well beyond their formal school years. After her dissertation, Carson's books stand as the most direct testimony to her knowledge. They hint at a view of ecology that was typical of her times.

The Sea Around Us lists *Ecological Animal Geography* as further reading. This is a 1937 translation (and bowdlerization) of a 1924 work by a German animal geographer. The translators, Allee and Schmidt of *AEPPS*, liberally updated the text with ecological principles and results that were in large part their own. It is not known what Carson absorbed from *Ecological Animal Geography.* "About a fourth of the book is concerned with marine animals," she noted.[9]

The marine environment was, after all, her love. Although there are no notes made by Carson extant from *Ecological Animal Geography*, she probably would have been interested in specific species, their distribution, and their life histories, as is consistent with research notebooks that have come down to us. In preparing *Edge of the Sea*, she made 23 pages of notes on a paper in *Ecological Monographs* having to do with the species present in a tidal inlet and their distribution. In the April 1942 issue of the same journal, purchased by Carson as a single copy, parts of a report on the ecology of sand beaches in Beaufort, North Carolina, have been copiously underlined and bear occasional parenthetical remarks along margins. The section titled "Adaptations of Sand Beach Animals" is heavily annotated. It is a "who is who" and "who does what to whom" of that seashore. Unmarked by Carson is the main data table. Unmarked also is a section entitled "Seasonal Progression on Sand Beaches." Neither did Carson seem to care much for what was written about the plants in the paper. Marine organisms, what they eat and what eats them, appear to have been Carson's overriding interest in the ecology of sand beaches.[10]

Another monograph she requested was on a tidal inlet at Cape Ann, Massachusetts. The dry information in the monograph on the barnacle common in the inlet and its dog whelk predator is impossible to map to Carson's lively prose on the same subject in *The Edge of the Sea*. Its title, "A Study in Bio-ecology," however, has potential links to modern ecology. Bio-ecology was the term used by Shelford and Clements for their attempt to combine animal and plant ecology around the community concept. Recognizing the amorphous nature of ecology as spread through various academic departments, they also saw in the term a way to escape the ambiguous meaning then attached to ecology. Clements had been the champion of the *superorganism* concept of the plant community, seeing the process of succession to climax as a physiological development to a self-regulating, mature entity determined by the regional climate. Within that concept of homeostasis is the balance of nature concept.[11]

Under the Sea Wind is classic nature writing, and Carson's notes for it reflect a concern for writing technique. "What age child do editors prefer to attract?" for example, is no doubt answered in the book by the story of Scomber the mackerel. "Science explains-normal range—When pop. pressure great, many spill into new territory," "Extremes of production" noted by a figure, and the distribution of plankton into zones, however, are items in her notes that reflect the most current ecology of that time. Carson's notes and research materials for *The Sea Around Us* are heavy on physical oceanography and oceanographic research methods.[12]

A paper entitled "The Edge of the Sea," presented at an American Association for the Advancement of Science symposium, was the only purely scientific paper Carson ever gave to a professional academic organization. In it, she pursued questions such as "Why does an animal live where it does?" and "What is the nature of the ties that bind it to its world?" The questions, Carson proposed, showed progress in the science of ecology beyond the mere descriptive and into greater integration with other sciences. Carson almost parenthetically quotes without citation words of W. C. Allee, whom she identified as an animal ecologist at Woods Hole in the early 1930s. Allee was an independent investigator there in 1931, 1934, and 1936, but Carson was there in 1929 and 1932. However, Allee was a member of the corporation in 1932 and might have made a brief appearance. Thomas Park, Allee's student, arrived in Raymond Pearl's laboratory as a post-doc in 1933, but Carson's assistantship in the laboratory had ended in 1931. Whether they met or not, Allee managed somehow to exert an influence on Carson, most likely through her Woods Hole experience.[13]

Silent Spring

It is in researching *Silent Spring* that the name Charles Elton, a founder of modern ecology, first appears in her notes. His work represents one of the paths to the ecosystem concept fervently promoted by Eugene P. Odum. Although this concept was not initially favored by the Chicago school, it shared the organicism that underlay Carson's "ecological concept" in *Silent Spring*. The emphasis on energy and nutrient dynamics in the systems approach of Raymond Lindeman in combination with the radioactive tracer studies of the Odum brothers and others are what allowed an ecological explanation for the decline of raptors due to DDT use.[14]

Yet it is not Elton's classic text, *Animal Ecology*, but his less technical work, *The Ecology of Invasions*, that Carson makes note of. We know that Carson first became aware of Elton's popular—it grew out of three BBC radio broadcasts—book on invading species when she was introduced to it by E. O. Wilson while she was already working on the manuscript that was to become *Silent Spring*. Based on her notes, Carson may not have taken much more from the text than a literary device, although what remained unwritten but in her memory can never be ascertained. "Elton recalls the youth of ecology as a science by saying that only 25 years ago it was in its Neolithic age," Carson carefully typed, going on to conclude: "One has only to look about to see that, in terms of its philosophy, applied entomology is still in its Stone Age."[15]

For advice on *Silent Spring*, Carson relied heavily on Clarence Cottam, F. Raymond Fosburg, and Frank E. Egler. Wildlife biologist Cottam and botanist Fosburg described themselves as Carson's personal friends. They are not likely to have guided her through the science of ecology. In his correspondence with her, the word ecology is not to be found in advice Cottam gave her about wildlife and pesticide issues; some of this advice, such as the relationship between DDT and the decline of Bald Eagles being questionable, is itself questionable.[16]

Fosburg is a problematic figure. Although he became an active member of the ESA who urged ecologists to promote their own interests, judging from reprints he provided Carson, his knowledge of modern ecology was superficial, at best. In one, he identifies himself as preoccupied with "*human ecology.*" In another reprint sent to Carson, he proposes a definition for the term, *community ecologist*. By then community ecology had been well established as an area of ecological investigation that was absolutely not synonymous with human ecology, as Fosburg proposed for it. In still another reprint, he identifies himself as a systematic botanist having "inclinations toward ecology."[17]

Then there is Egler, a scientific maverick with an ax to grind and a decidedly not dispassionate approach to the science of his choice. A prolific letter writer—they were truly missives, in his case—he waged war against herbicide use, enlisting any and all who might help as allies in his cause and writing off as enemies all those who disagreed with him in any way. "I was once an Assoc. Prof. of Physics," he announced in a page of correspondence that could instantly be recognized as his from across the room. (His writing style could only be described as early Tom! Wolfish abetted by a recalcitrant typewriter; it let his cantankerous personality show through.) After that wartime appointment, Egler, born to a New York family of apparent means, lived the life of an independent scholar. His longest appointment was with the American Museum of Natural History in New York from 1949 to 1954. He had his own view of ecology and ecologists. "I would sooner trust an intelligent and self-educated layman, than a Ph.D in ecology who is an 'expert' in one of the fashionable specialties of the day," Egler later announced to the ESA membership. This low opinion of academics he had earlier shared with Carson in their correspondence.[18]

As in her previous books, Carson also obtained assistance by soliciting advice and reprints from appropriate specialists. For *Silent Spring*, ecologists E. O. Wilson, Paul Errington, and C. S. Holling are examples. Robert Rudd urged her to present "'good' ecology" to the public, which he identified as having biological, chemical, and sociological ingredients, but Carson focused instead in their correspondence on the details of Lady Bird Beetle collecting. She may have already known more than enough "good" ecology. William L. Brown, Jr., to whom she had communicated her hope of preparing a book on what she saw was "a serious threat to the basic ecology of the earth," sent her reprints on "general evolutionary–ecological subjects" and cautioned her about what he called the "biome concept." At that time, the biome concept to which Brown referred was that of the Clementsian "superorganism" in which the "balance of nature" could be found in its supposed homeostatic mechanisms. There was no mention of Brown's suggestion of caution in her reply. Again, it may all have been old news to her, and she had issues on her mind that were more pressing at the time—failing health and the need to master both pesticide chemistry and the physiology of carcinogenesis, for example.[19]

Ecology in *Silent Spring*

In the text of *Silent Spring* Rachel Carson's use of "ecology" is spare and more often than not used as "the ecology," or as a synonym for some more specific concept. (At times she showed a lack of comfort in the use of the term. In a letter to Egler, written well into the writing phase of *Silent Spring*, she wondered if "ecological history" was an appropriate term.) She equates ecology with "interrelationships" and "interdependence." The indirect poisoning of robins by insecticides reflects "the web of life—or death—that scientists know as ecology." This poetic but careless use of the term is stretched even more in her next sen-

tence, where she begins a discussion of "an ecology of the world within our bodies." It must be fair to say that the ecologists who reviewed her book were—much like ecologists today—squarely on the side of protecting the environment. Had they not been so, there would have been additional ammunition for pesticide manufacturers to use against Carson's professionalism.[20]

The review of *Silent Spring* written by Ray Fosburg in the journal *Ecology* was, of course, favorable. Strangely, however, he gave the opinion that the book was not intended to be a scientific report. Frank Egler perhaps sought to correct Fosburg's gaffe when he reviewed a symposium edited by Fosburg. On the pages of *Ecology*, he called *Silent Spring* "'original research' in the truest sense of the word." B. N. K. Davis took Carson to task in the pages of the *Journal of Ecology*, a publication of the British Ecological Society, for her treatment of carcinogenesis, finding those sections "hypothetical and unconvincing," but concluded after fact checking that factual errors were relatively unimportant. Davis found that the confidence Carson placed in the "ecological concept" of pest control was "not generally shared," the only remark having to do with ecology in the review. Ian Baldwin, an agricultural scientist, took umbrage in his review in *Science* with what he saw as a lack of balance and the "sarcastic and unjustified attack on the ethics and integrity of many scientific workers." Frits Went, then the Director of the Missouri Botanical Garden, praised the book in the *AIBS Bulletin*, the precursor to *BioScience*, but took little note of Carson's use of ecology in it, simply acquiescing in her having equated "ecological" with "natural."[21]

LaMont Cole's review in *Scientific American* was an important one in a number of ways. Cole was then one of the nation's leading ecologists and one of the first to touch on the practical environmental applications of general ecological principles. In *Scientific American* he was communicating to a very broad scientific audience. (The journal had not yet changed ownership and turned to the popular science format it has today. It was then an outlet for scientists to communicate their latest and most important results to scientists of all disciplines, as well as the public.) Cole's review was important enough to be revisited by Paul Ehrlich 17 years later.[22]

"As an ecologist," Cole wrote, "I am glad that this provocative book was written." He criticized it mainly for its "highly partisan selection of examples and interpretations." He found errors of fact to be "infrequent, trivial and irrelevant." He did, however, criticize her use of the idea of a "balance of nature," an idea his colleague at Cornell, William Brown, had warned her about, calling it "an obsolete concept among ecologists." He especially took Rachel Carson to task for what he saw was her misunderstanding of the evolution of insect resistance to pesticides, claiming "not for a moment" to believe "that the chemicals are producing superinsects."[23]

The basis for Cole's latter criticism was an idea older than the science of ecology: that selection—artificial or natural—must be a compromise of sorts. Once called the "Matthew Kermack principle" by J. B. S. Haldane, it was then renamed the Principle of Allocation and credited to an unpublished paper by Richard Levins and Robert H. MacArthur. MacArthur was by then becoming something of a legend, whom a popular writer has called the "James Dean of ecology." His mathematically oriented evolutionary ecology was then coming into competition for supremacy in ecology with the physico-chemical ecosystem approach of Eugene Odum.[24]

In explanation, Cole used the example of the sickle-cell trait in humans, in which resistance to malaria results in anemia in the trait's possessor, fatally so to those having received the gene from both parents. Ernst Mayr would sum up the idea as "virtually all aspects of the *phenotype are a compromise between opposing selection pressures"* [italics in the original, phenotype in this instance essentially being the expression of an individual's inherited characters]. An insect that developed resistance to an insecticide would, according to the principle, necessarily have an insufficiency in something else, making the evolution of "superinsects" unlikely, if not impossible.[25]

Other than a somewhat bizarre treatment in the *Bulletin of the Torrey Botanical Club,* in which a number of seminar students at Rutgers University examined "Dr. Carson's … ecological knowledge," the reviews above are all that were published in outlets that can be identified as those typically used by professional ecologists. The Rutgers students found her ecology basically sound, but then unintentionally damned the book by calling it "propaganda." Entomologists were notably silent on *Silent Spring* in their professional journals.[26]

Paul Ehrlich's reexamination of *Silent Spring* "in light of 17 years' more experience with pesticides" sheds some light on the posture that Cole was taking "as an ecologist" towards Carson's use of their science. Ehrlich found nothing in Cole's review with which to take issue, agreeing that Carson "presented a picture of the evolution of insect resistance that showed she was not intimately familiar with the details of the evolutionary process." He utterly failed to consider new information on the mechanisms of insect resistance to pesticides that was available to him. There **were** "superinsects" out there, having resistance not only to DDT, but also to other insecticides to which they had not yet been exposed, with no demonstrable loss of fitness in other respects. Insects in Australia were found to have resistance to organochlorine insecticides, such as DDT, persisting 15 years without any selection pressure for resistance. A simple change in cuticle properties was all the trick took for certain insects. Rachel Carson had this information in front of her while writing *Silent Spring*, but the idea never appeared in the final version of the book. Ehlich's suggested revisions to *Silent Spring* were to place less emphasis on the "balance of nature" and to add that "plants and herbivores are in a 'coevolutionary race.'"[27]

Both Cole and Ehrlich must be taken to task, however, for their insistence that Carson represented pyrethrins as simple molecules. The offending passage probably reflected careless writing, rather than careless chemistry. In addition, Cole—and Ehrlich by his silence on it—can be faulted for taking issue with something Rachel Carson never said. This had to do with then current views "of what regulates the size of any population in nature." As far as *Silent Spring* is concerned, the issue is something of a red herring. Cole referred to, but did not adequately explain to the reader an argument about density-dependent mortality that cannot be taken up here without this article becoming book length. Cole was taking a stance on a raging debate that is still under dispute. That Rachel Carson had never heard of an argument that in hindsight turned out to be either untrue or irrelevant (or both) cannot stand as an indictment of her science.[28]

Cole—and then Ehrlich—displayed not errors by Carson, but an ax that had to be ground. Carson's only ecological transgression may have been in crossing into the turf of the professional ecologist.[29]

The impact of *Silent Spring* on ecology

Cole and Ehrlich were not the only ecologists who took a condescending attitude toward Rachel Carson's science in *Silent Spring*. For example, reviews of Robert Rudd's *Pesticides and the Living Landscape* contrasted Carson's "bold" and "dramatically" written popular work with Rudd's "textbook" in which personal judgment is "scrupulously" distinguished from evidence. British ecologist J. M. Cherrett smugly attributed the lack of surprise over Carson's revelations to Rudd having published on the topic since 1955 in the United States.[30]

That smugness was not justified. The 1956 position of the ESA was that "on the whole, great care is being exercised by most federal and state agencies" in the use of chemical controls. "Instances in which beneficial animals and plants have been killed are surprisingly few and usually occurred where the applicators failed to follow instructions," a study committee concluded, a few paragraphs before reporting that Rudd had sent the committee a letter emphasizing the need for more data that could be brought to bear on the issue. Heavy metal pollution was thought to be a greater threat to wildlife than DDT. The following year the conclusion on synthetic pesticides was that "when applied to agricultural crops at the dosages and in the manner prescribed by federal and state authorities, they have caused little or no losses to wildlife,"

even though acknowledging fears of conservationists and "others concerned with the preservation of our wildlife" that "such treatments will destroy nature's balance" and emphasizing the need for thorough ecological studies for large-scale projects. Both reports showed more concern about the losses of natural lands and the damming of rivers, more traditional concerns for the ESA.[31]

In 1961, a brief report by an expanded committee on applied ecology— described as having had "very rough going"—showed concern over adequate water supplies and the fire ant eradication program. In 1964, however, the ESA was sponsoring a well-attended symposium in the hope of allowing ecologists to exchange information on the "increasing problem of pesticide pollution." *Silent Spring* was the acknowledged impetus. The same year, the ESA President charged the committee on applied ecology "to formulate an ecological context for the use and conservation of natural resources." Its findings were not reassuring. Present programs were not providing the factual material needed to avoid future disasters, and students were repelled by ecology's lack of rigor. Narrow specialization, the kind that presumably missed the warnings given by Rachel Carson, was "a real dilemma."[32]

The committee further concluded: "The biological sciences traditionally served as a refuge for students who found physics, chemistry, and mathematics distasteful and were not inclined toward abstract theory. Ecology went one step further and attracted those who discovered that chemistry was also a requirement for research in physiological fields." The initial impetus for the study had come from Paul Sears in 1957—out of concern that ecologists were not providing the service to mankind they were capable of—but it did not gather real impetus until February 1964. That impetus was acknowledged by the authors to have been propelled by the publication of *Silent Spring*.[33]

A crisis was brewing in ecology. A number of ecologists in the 1950s, Sears and Egler among them, had been pushing ecologists to take stands on environmental issues. By 1963, instead of just a few voices, a Committee on Public Affairs in the ESA was appointed as "the most important action," by his own estimate, in that ESA President's term. Meanwhile, ecology's persistent identity crisis was coming to a head in the competing points of view of Odum and MacArthur.[34]

In 1964 *BioScience* gave space to Stewart Udall to urge biologists to "spread this Gospel" that Rachel Carson had presented. That same year it devoted an issue "to cover the basic concepts and ideas of ecology." Eugene Odum used it to preach a new ecology based on the ecosystem concept. Pierre Dansereau made the claim that "'ecosystem ecology' is the ecology of the future." Frank Blair blamed the primitive state of knowledge about ecosystem interactions "in part on the modesty of ecologists in seeking financial support for their research and in part on the failure of both ecologists and formulators of public policy to face up to the fact that knowledge of the interactions and interdependencies at the levels of organization with which ecology deals is essential to man's present and future welfare."[35]

The results of all of this heightened activity by ecologists are too many to fully cover in a paper of this length. One was the mistaken impression that Deep Ecology had its roots in the ecosystem concept of Eugene Odum. Another was a drive toward professionalization in ecology that was not entirely compatible with the multifaceted subject that was ecology. Still another was the peculiar identity crisis suffered by ecologists to this day having to do philosophical viewpoints of nature, environmental activism, and the need for a scientific detachment.[36]

The most important impact, however, may have been on the schism between ecosystem and evolutionary ecology. It is not until passage of the National Environmental Protection Act (NEPA) of 1969, and the fact that the character of the International Biological Program (IBP) began to be apparent, that the exact effects of *Silent Spring* on ecology became clear. Both were strongly influenced by the book and both resulted in changes to the quietly subversive science.

By having its emphasis changed from human welfare to biomes (in the current meaning of the term)

between its 1961 inception and its 1970 funding authorization, the IBP established ecology as Big Science with a big budget. The ecology was ecosystem ecology. Frank Blair no longer had to apologize for the modesty of ecologists in securing funding. The IBP funded ecology because it had the proper image to be the basic science to solve environmental problems. By then ecosystem science had been tied to Rachel Carson's "ecological concept" through the efforts of Odum, Egler, and others.[37]

Until that point, ecology had been seen to be weak intellectually, a science lacking in rigor. Ecologists themselves disparaged ecology as "a descriptive science with no real principles." However, mathematical analysis was every bit as legitimate a path to rigor as energy and nutrient analysis. Ecologists who found mathematics and the physical sciences distasteful found that they could fit their naturalistic studies into the framework being created around the work of Robert MacArthur. Ecology found itself suddenly split into two camps competing for prestige and funding, a situation that persisted into the 1980s.[38]

Besides being a force in the funding of the IBP, *Silent Spring* was also a force in the creation of NEPA legislation, an "ecological 'Magna Carta'" by which ecology was "rather suddenly thrust into a period of great individual and collective opportunity," in the words of a 1972 address by the ESA President. "Rachel Carson's book had been published a few years earlier and it was still the major topic of discussion during late 1969 and early 1970," when much environmental legislation was being enacted, according to an ecologist then serving on the White House staff. A legal and policy analyst concluded in 1972 that: "The courts have, in effect, legitimized ecology."[39]

"There was a major sea change in the ESA from the Applied Ecology Committee having little respect before the publication of *Silent Spring* to becoming very respectable," is one impression of the shift that took place from an essentially academic orientation in ecology to one of practical applications. Purists then running the Society did not think ecologists should be involved in applied problems. Indeed, a common criterion in the choice of study habitats was their relative lack of influence by man's activities. Today the Applied Ecology Section has the biggest membership of any section in the ESA.[40]

Conclusion

Circumstantial evidence presented supports the conclusion that Rachel Carson was exposed to ideas of ecology, probably as early as her Johns Hopkins experience, and kept herself up-to-date on the science as it evolved. The condescension shown by LaMont Cole and other ecologists toward Carson's ecological knowledge can be interpreted as an attempt to protect their professional turf. Time has vindicated Carson on many of their criticisms. Cole, for example, pointed out that honey bees faced a more difficult threat to survival from the old, nonsynthetic pesticides than from DDT. He attributed Carson's "bias and oversimplification" to "what it takes to write a best seller." We now know, however, that synthetic pesticides do not exactly lead to peace of mind in the honey bee hive.[41]

The grudging acceptance of Carson's ecological expertise may have had to do with the condition of the science at the time. A science insecure about its status had suddenly found itself promoted to a highly visible role in solving environmental problems before it had developed the body of knowledge and tools to fill that role. Indeed, before it had come to terms with what it actually was as a science. Ecologists were still trying to sort out whether ecology was a general point of view, a specific predictive science, or an arcane set of descriptive terms and data. And if it was on the verge of becoming a predictive science, there was little agreement on what that science would be like. Would it be physiological? Ecosystem oriented? Or would it return to its roots in the working out of evolutionary adaptations? It had not been a time to have what appeared to be an outsider communicating to the public what ecology was.

Ecology was to undergo other wrenching controversies over methodology and identity; *Silent Spring* merely exacerbated a conflict that had already been brewing between ecosystem and evolutionary ecology.

It is a field not without controversy even today, some of which may be traced back to the publication of Silent Spring. In the general terms of its transition from an arcane, academic science of natural environments to one in which more members of the ESA consider themselves as applied scientists, and even theoretical research is often on global issues, Rachel Carson's influence has been considerable.[42]

William Dritschilo
Proctor, Vermont 05765
E-mail: wdritschilo@adelphia.net

Endnotes

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11 Ralph W. Dexter, "The Marine Communities of a Tidal Inlet at Cape Ann, Massachusetts: A Study in Bio-Ecology," *Ecological Monographs* 17 (1947): 261–294. Frederick E. Clements and Victor E. Shelford, *Bio-ecology* (New York: John Wiley and Sons, 1939).

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