SCIENCE IN THE HANDS OF WOMEN

The Paradigm Shifters

RHEA HARMSEN

Science in the Hands of Women:

The Paradigm Shifters[1]

In 1912 a Middle Eastern traveler to the United States by the name of ‘Abdu’l-Bahá made some farsighted pronouncements concerning the role of women. In a talk in Boston, Massachusetts, he specifically encouraged women to “devote their energies and abilities toward the industrial and agricultural sciences" and seek to assist humankind "in that which is most needful."[2]

'Abdu'l-Bahá's thesis was that women could bring a unique dimension to these fields, due to qualities of character in which they excel. Among these qualities are intuition and receptiveness, mental alertness, "abundance of mercy and sympathy," concern for "the needy and suffering," and greater "moral courage." [3]

Can one look to history for the first glimmerings of the application of those unique female qualities when women began to enter previously male-dominated fields of science?

A review of the agricultural sciences in any reputable university catalogue will show them to include a broad range of biological and natural sciences, including botany, agronomy, genetics and breeding, horticulture, soil science, entomology, plant pathology, animal science, zoology, microbiology, public health, food processing, and so on. The industrial

---

[1] Adapted from the article by Rhea Harmsen published in *World Order*, pages 7-29, 1998.

[2] 'Abdu'l-Bahá, *Promulgation* 375, 283.

[3] 'Abdu'l-Bahá, *Paris Talks: Addresses Given by Abdul-Bahá in 1911*. 12th ed. (London: Bahá'í Publishing Trust, 1995) 50.6; 'Abdu'l-Bahá, in Bahá'u'lláh, 'Abdu'l-Bahá, Shoghi Effendi, and the Universal House of Justice, *Women*, no. 25; ‘Abdu'1-Baha, *Paris Talks* 59.8; 'Abdu'l-Bahá, *Promulgation* 284; 'Abdu'l-Bahá, *Abdu'l-Bahá in London: Addresses and Notes of Conversations* (London: Baha’i Publishing Trust, 1981) 103.

sciences encompass all the engineering fields, chemistry, and any and all forms of technology associated with industry.

A survey of the contributions women have made in some of these fields reveals women scientists who have, indeed, exemplified qualities in which 'Abdu'l-Bahá says women excel. When entering previously male-dominated fields they have evinced ground-breaking influence not only by their accomplishments but also by methods and motivations that differed from those of their male colleagues.

Practicality and "That Which Is Most Needful"

A focus on and concern for what 'Abdu'l-Bahá says is "most needful" is richly illustrated by pioneer entomologist Eleanor Ormerod, who was born in 1828 into the English upper class. When she died in 1901, she was one of the most highly honored scientists of her day.[4] Her greatest accomplishment was to bring the study of insects out of academic halls and into the fields. Ormerod invented efficient, inexpensive methods for eradicating injurious insects and for the first time in history brought a systematic approach to saving crops and livestock from their ravages. Her pamphlets and annual reports on pest control, which she produced at her own expense, were the first published guides to farmers on the subject. She worked anonymously for decades, but in 1877, when she began publishing her *Annual Report of Observations of Injurious Insects*, it became immediately popular, and agriculturists throughout the world corresponded with her. Her research was meticulous and scholarly (she built her own meteorological observation station), but her reports also offered common-sense remedies using easily available ingredients. Her widely published remedy for maggots plaguing livestock is credited with saving half the cows in England in the late 1800s. She was also

[4] Ethlie Ann Vare and Greg Ptacek, "Eleanor Ormerod, "*Mothers of Invention, From the Bra to the Bomb: Forgotten Women and Their Unforgettable Ideas* (New York: Morrow, 1988) 175-77.

responsible for devising the remedy when the Mediterranean caterpillar threatened widespread destruction of the stored flour inventory in the United States in 1889. She was not just an entomologist but also an ecologist. When she retired, the London *Times* wrote, "she revolutionized the subject of agricultural entomology, as it was known twenty-five years ago."[5]

By suggesting that women scientists focus on that which is "most needful" to humanity, 'Abdu'l-Bahá may have been tapping into a natural propensity of that sex, as some current analysts are starting to observe. In an article on education in engineering, Joe Alper, a writer for *Science*, summarizes several researchers' observations:

"Males are interested in engineering problems no matter what, but women respond more energetically when these problems are put in the context of helping people or the environment. It's not that women aren't interested in engineering,..it's a question of context: 'Women aren't so interested in engineering as a technical matter, but as a practical matter.'"[6]

Lael Parrot, a writer for *Resource* magazine, recommends a strategy for attracting women into engineering: "make science relevant. Girls should be taught that science and technology can change the quality of people's lives and alter social structures."[7]

---

[5] Quoted in Vase and Pracek, "Eleanor Ormerod," *Mothers of Invention* 177.

[6] Joe Alper, "Science Education; The Pipeline Is Leaking Women All the Way Along," *Science*, 260 (1993): 409-11.

[7] Lael Parrot, "Women and the Culture of Engineering: Society Could Benefit from More Female Engineers," *Resource* (Jan. 1998): 6-8.

Empathy

When 'Abdu'l-Bahá asserted that women's "hearts are more tender and susceptible than the hearts of men," He may have been referring to women's capacity for empathy.[8] *Webster's New World Dictionary* defines empathy as "the ability to share in another's emotions, thoughts, or feelings."[9] History attributes the first use of empathy as a scientific research tool in the field of primatology to Jane Goodall and Diane Fossey, who are considered to have revolutionized this previously male-dominated field by their "female approach" to the study of chimpanzees and gorillas. [10]

In 1960 Goodall's patience and persistence in habituating the animals to her presence and her perceptive-ness in observation led to ground-breaking discoveries. Among other things, she found that chimpanzees were omnivorous (not herbivores as previously thought) and that they made tools from twigs and used them

---

[8] 'Abdu'l-Bahá, *Promulgation* 284.

[9] *Webster's New World Dictionary*, ed. Victoria Neufeldt (New York: Warner, 1990).

[10] Sec Virginia Morell, "Called 'Trimates,' Three Bold Women Shaped Their Field," *Science*,260 (1993): 420-25, and Nini Bloch, "Mothers of Invention: What Are Women Doing to Science," *Earthwatch* (Oct./Nov.1995), 16-22. For a more detailed description of Jane Goodall's discoveries, see Jane Goodall, *Through a Window, My Thirty Years with the Chimpanzees of Gombe* (Boston: Houghton,1990). For a more complete treatment of Diane Fossey's work, see Farley Mowat, *Woman in the Mists: The Story of Diane Fossey and the Mountain Gorillas of Africa* (New York: Warner, 1987) 380.

to extract termites from their nests. The latter discovery prompted a redefinition of the long-held belief that humans were the only toolmakers.

Contrasting the previous research methods to Goodall's approach, researchers now agree "the payoff came from the women's capacity to empathize with their subjects, seeing them as individuals, whose life histories influenced the structure of the group."Instead of numbering the chimpanzees, Goodall "named the animals and used words like 'individual,' 'emotion,' and 'personality.'"[11]

Leaders in the field at the time considered Goodall's approach unscientific and sentimental, ostracizing her and insinuating that what she was doing was not appropriate science. Goodall persisted in this female approach to science against the discouragement of the male scientific culture. Now scientists admit, "empathy is very important in primatology. It helps you to ask questions and to predict what your animals are going to do."[12] Empathy has now become part of the scientific method in primatological research.

"Concern for the Needy and the Suffering"

In Diane Fossey's efforts one sees an illustration of the qualities of "mercy and sympathy" and "concern for the needy and the suffering" that 'Abdu'l-Bahá extolled in women and that would help scientists focus not only on the knowledge to be gained through scientific investigation but also on the needs surrounding the object under study.

When Fossey began studying gorillas in 1966 she also used the empathetic approach; for her the individuality of the apes was paramount. Because so little was known about gorillas, her dissertation became the baseline for understanding the species.

---

[11] Morell, "Called 'Trimates," *Science*, 260(1993):422.

[12]Morell, "Called 'Trimates," *Science*, 260 (1993):423.

According to *Science* writer Virginia Morrell, "Fossey saw things primatologists had never viewed: female gorillas transferring between groups; males killing infants to bring females into heat; gorillas eating their own dung to recycle nutrients."[13]

But Fossey became so deeply engrossed with the animals she was studying that she crossed the line from dispassionate observer and began to question the usefulness of her research in light of the fact that gorillas were so endangered (at the time they numbered only 250). Her heartbreaking and often gruesome encounters with poaching led her to dedicate herself aggressively to conservation work and to protecting the gorillas from poachers. Her anger at their condition fueled her international campaign, until she was murdered in 1983. She is credited with having made the world aware of the plight of the gorillas.

Primatologist George Shaller commented on the impact of the path-breaking work of Goodall and Fossey, saying that these primatologists "taught science that the great apes are true individuals...They have given us an empathy with our closest relatives, and that is the only thing that will save these animals in the end."[14] The "empathy" that was used as a tool of scientific research seems to have become transformed here into a "mercy" and "concern for the suffering" that triggered a successful conservation movement. According to Morell,

---

[13] Morell, "Called 'Trimates," *Science*, 260 (1993):423.

[14] Cited in Morell, "Called 'Trimates," *Science*, 260 (1993): 425. (1995), 16-22.For a more detailed description of Jane Goodall's discoveries, see Jane Goodall, *Through a Window, My Thirty Years with the Chimpanzees of Gombe* (Boston: Houghton, 1990). For a more complete treatment of Diane Fossey's work, see Parley Mowat, *Woman in the Mists: The Story of Diane Fossey and the Mountain Gorillas of Africa* (New York: Warner, 1987) 380.

Fossey's [story] raises the issue of what values scientists heed. Many studies have shown that a key difference between men and women is that men often place a high value on theoretical values--knowledge for its own sake--while women tend to evaluate knowledge according to its usefulness. In Fossey's case, the two types of values were intertwined from the beginning—since her scientific interest in the gorillas was triggered by a passion for wildlife and a desire to make a difference in the world."[15]

Greater Moral Courage in Moments of Danger

Abdu'l-Bahá says moral courage is yet another quality in which women excel: "The woman has greater moral courage than the man; she has also special gifts which enable her to govern in moments of danger and crisis."[16]

[15] Cited in Morell, "Called 'Trimates," *Science*, 260 (1993): 424.

[16] Abdu'l-Bahá, *Abdu'1-Bahain London* 103.

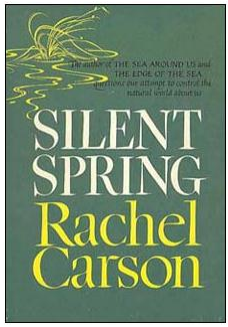
Rachel Carson, an ecologist and the mother of the modern environmental movement, was known for her great moral courage. A highly successful marine biologist and writer, she spent her career with the United States Fish and Wildlife Service. She is credited with having sounded the alarm in 1962 when the widespread use of chemical pesticides in agriculture threatened the ecological chain. [17]

When a friend called her to witness the wholesale killing of birds and harmless insects that had taken place in her private bird sanctuary as a result of the state's spraying with DDT (under its mosquito control program), Carson responded by publishing *Silent Spring*. Because she realized there were no government agencies at the time dedicated to the preservation of the natural environment, Carson felt the issue called for a changed political philosophy. She gathered evidence from scientists in America and Europe on "not only the dangers of DDT but also other chemicals with which modern man was poisoning earth, air and water on a worldwide scale." She was questioning "not only the indiscriminate use of poisons but also the basic irresponsibility of an industrialized, technical society toward the natural world."[18]

[17] See Paul Brooks, Rachel Carson, *Notable American Women: The Modern Period*, ed. Barbara Sicherman et al. (Cambridge: Harvard UP, Belkriap Press, 1980) 138-41. For a more complete description of Carson's work, see Rachel Carson, *Silent Spring* (Boston: Houghton, 1962).

[18] Brooks, "Rachel Carson," *Notable American Women* 140.

Silent Spring was violently attacked by the agricultural chemical industry, which viewed Carson's assertions as a public relations problem. They spent enormous sums of money to ridicule both the author and her book.



Crippled by arthritis and suffering from bone cancer as she completed the book, Carson, nevertheless, defended her premise and, until her death in 1964, played an important role in the initial steps toward legislative action to limit the use of pesticides.

A unique set of factors contributed to Carson's insight: she challenged the notion that science belongs in a "separate compartment of its own, apart from everyday life." She "was not ashamed of her emotional response to the forces of nature" and "felt a spiritual closeness to the individual creatures about whom she wrote."[19] Her moral courage may have, indeed, awakened humankind in a moment of danger and crisis, steering it away from environmental destruction and toward a path of greater ecological responsibility.

Intuition and Receptiveness

The use of intuition in science is perhaps most controversially illustrated by Barbara McClintock, Nobel laureate and discoverer of gene transposition.

ʻAbdu'l-Bahá states, "In some respects woman is superior to man. She is more tender-hearted, more receptive, her intuition is more intense."[20] When asked to define the faculty of intuition, He said that

---

[19] Brooks, "Rachel Carson," *Notable American Women* 140.

[20] 'Abdu'l-Bahá, *Paris Talks* 50.6.

> …the second sort of knowledge, which is the knowledge of being, is intuitive; it is like the cognizance and consciousness that man has of himself.
>
> For example, the mind and the spirit of man are cognizant of the conditions and states of the members and component parts of the body, and are aware of all the physical sensations; in the same way, they are aware of their power, of their feelings, and of their spiritual conditions. This is the knowledge of being which man realizes and perceives, for the spirit surrounds the body and is aware of its sensations and powers. This knowledge is not the outcome of effort and study. It is an existing thing; it is an absolute gift. [21]

Abdu'l-Bahá continues to develop the theme of intuition by speaking of the interrelatedness of all things:

> The most noble being on the earth is man. He embraces the animal, vegetable and mineral kingdoms--that is to say, these conditions are contained in him to such an extent that he is the possessor of these conditions and states; he is aware of their mysteries and of the secrets of their existence. [Ibid.]

In this statement one sees that it is not anathema to use intuition in the process of science, which is the delving into the realities of things, for if the conditions of these kingdoms are contained within human beings, the unraveling of their "mysteries and the secrets of their existence" is the same as understanding ourselves. Part of the scientific method, then, is to tap into this connectedness.

---

[21] Abdu'l-Bahá, *Some Answered Questions*, comp. and trans. Laura Clifford Barney, 1st ed.(Wilmette, Ill.: Baha'i Publishing Trust, 1984) 157, 158.

Through meticulous manipulation and observation of the inheritance of pigment patterns in Indian corn, Barbara McClintock, a cell geneticist and plant breeder made what has come to be recognized as the most revolutionary genetic discovery since Mendel's discovery of the gene in 1865. [22]

In 1951 she published the theory of gene transposition, postulating that genes do not always behave in an orderly fashion in heredity but, triggered by developmental events, sometimes actually jump around on a chromosome or from one chromosome to another. Her theory united the disciplines of cell genetics and developmental biology, paving the way for the modern sciences of molecular genetics and genetic engineering.

After McClintock's discovery of transposition, she was ostracized by the scientific community and considered eccentric, perhaps because the discovery was so revolutionary and because at the time there were few geneticists in the world capable of understanding her work. It took the scientific community thirty years to arrive slowly, through numerous other lines of evidence, at an understanding of McClintock's 1951 discovery.

The theory of gene transposition is now accepted, and, though McClintock worked with plants, her discovery has made it possible to study antibiotic-resistant bacteria, to seek a cure for African sleeping sickness, and to help understand the mechanism of cancer.

---

[22] See Evelyn Fox Keller, *A Feeling for the Organism: The Life and Work of Barbara McClintock* (New York: Freeman, 1983).

Evelyn Fox Keller, McClintock's biographer, has written about the reasons for the dual themes of success and marginality characterizing her career.[23] McClintock saw transposable elements as the key to developmental regulation. Her contemporaries were not able to absorb her discovery because she was a philosophical and methodological deviant. Her concept of nature, for example, was that "anything you can think of you will find...organisms...do everything we can think of, they do it better, more efficiently, more marvelously." This meant that one had to "listen to the material," to respect individual differences, not as aberrations, but as possible clues to the greater picture. Instead of trying to fit knowledge into a central dogma, discarding all exceptions as irrelevant, she pursued the single exception with the greatest respect. Her work on transposition began, in fact, from the observation of an aberrant pattern of pigmentation on a few kernels of a single corn plant. "The important thing is to develop the capacity to see one kernel [of maize] that is different and make it understandable," she wrote. Her major criticism of contemporary research was what she saw as inadequate humility, the scientist wanting to impose an answer on the material; "if you'd only just let the material tell you," she cautioned.[24]

McClintock's approach, now dubbed "a feeling for the organism," is illustrated in her description of chromosomes she was trying to identify through microscopic observation:

> I found that the more I worked with them, the bigger and bigger [the chromosomes got], and when I was really working with them I

[23] Evelyn Fox Keller, 'A World of Difference," *Reflections on Gender and Science* (New Haven: Yale UP, 1985) 158-76.

[24] Keller, 'World of Difference," *Reflections on Gender and Science* 162.

> wasn't outside, I was down there. I was part of the system...And you forget yourself.[25]

McClintock's language shows her love for her object, a love that allows for intimacy without annihilation of difference. This, Keller asserts, describes a form of thought that informs her work. It is "a vocabulary of affection, of kinship, of empathy...McClintock can risk the suspension of boundaries between subject and object without jeopardy to science precisely because, to her, science is not premised on that division.... [this] is the wellspring of her powers as a scientist." "Love revealeth with unfailing and limitless power the mysteries latent in the universe," 'Abdu'l-Bahá asserts. [26]

Furthermore, McClintock saw the anomalous corn kernels not as evidence of disorder or lawlessness but as part of a larger system of order, one that cannot be reduced to a single law. It was part of the connectedness of all things. Her interest was not so much in knowing the mechanism and structure of genes but in understanding the function and organization, the relationship to the organism as a whole. The traditional division between genetics and developmental biology was one that McClintock could not accept, her foresight perhaps presaging the development of the currently all-powerful science of molecular biology. But what was heretical in McClintock's thinking was that she saw in transposition a mechanism enabling genetic structures to respond to the needs of the organism. In

[25] Keller, "World of Difference," *Reflections on Gender and Science* 165.

[26] Keller, "World of Difference," *Reflections on Gender and Science* 164; Abdu'l-Bahá, *Selections from the Writings of Abdu'l-Bahá*, comp. Research Department of the Universal House of Justice, trans. Committee at the Bahá'í World Centre and Marzieh Gail (Haifa: Bahá'í" World Centre, 1997) 27.

1953, two years after McClintock presented her findings, biochemical scientists James Watson and Francis Crick had elucidated the structure of DNA. This mechanism of inheritance became the central dogma, one that postulated a one-directional flow of genetic information from DNA to RNA to protein. The claim was made that the secret of life had been unraveled. This hierarchical structure of genetic organization, similar to organizational charts of corporate structures, became a textbook illustration. McClintock's views, which added another layer of complexity by suggesting that nature responded more fluidly to the needs of the organism, did not fit into that scheme. Hence she was marginalized until science slowly sorted through and incorporated that additional piece of the puzzle decades later.

One of the many lessons of these scientists stories lies in the relevance of gender not just to the questions scientists ask but in the answers with which they content themselves. Therefore, the influx of large numbers of women into the sciences must have the effect not just of adding another component to the creative vision now represented in science but of incorporating a fundamentally different view of nature and perhaps a scientific mind more inclusive of subjectivity. Although this could hardly be articulated by most women scientists, it is a fundamental component of their right to be scientists. To accept anything less would have the same demoralizing effect as being invited to sit at the men's table but having to laugh at misogynist jokes.

In making such a review of the effect of women on the sciences the relevant questions are: if we encounter women scientists practicing these qualities in which women excel did they act as paradigm shifters? Was humanity the better for it? And can they be taken as role models by *both* men and women seeking to conduct a more enlightened practice of science (one in which the male and female aspects of civilization are more evenly balanced)?