A Career of Her Own: Edith Shreve at the Desert Laboratory

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It is August 1915, and a new set of balances has just arrived at the Desert Laboratory on Tumamoc Hill, two miles west of Tucson, Arizona. Edith Shreve, a plant physiologist in her late thirties, eagerly unpacks the balances and installs them on the laboratory workbench. So pleased is she by the new acquisition she hurries from her house to the laboratory every morning "just to look at them."[1] Edith brings this same energy and enthusiasm to everything she does. She has already published three papers on physiological topics, and in the years to come she will publish seven more, making an important contribution to our understanding of how desert plants adjust to their harsh environment. After this promising start, however, she will gradually drop out of physiological research altogether.

Did Edith lose interest in plant physiology or was she forced out by circumstances? This is just one of the questions we cannot answer now. The few documented details of her life raise more questions than they answer. Why did she never complete her work towards a doctorate? Why did she become a plant physiologist after being trained as a physical scientist? What was the connection between her scientific career and that of her husband, Forest Shreve? We can only guess at the answers, and in doing so we find that the story of Edith Shreve's life emerges as a paradigm of the difficulties women scientists have traditionally faced.

Edith Shreve was born Edith Coffin Bellamy on November 7, 1878 in Grand Rapids, Michigan. Her father, Alfred David Bellamy, was a physician; her mother, Leonora Coffin Bellamy, was a teacher. Leonora died when Edith was three, and for the remainder of her childhood Edith was shuttled back and forth between a maternal aunt in Boston and her father's new wife in Florence, Alabama. Little else is known of Edith's early years, except that she earned a bachelor's degree in chemistry and physics at the University of Chicago in 1902. She then began work towards a Ph.D. but never completed it.

Edith's professional career began soon after she left school. In 1904, she was made head of the science department of Judson College in Marion, Alabama, a position she gave up in 1906 for a job as physics instructor at the Woman's College (now Goucher College) in Baltimore, Maryland. This was a fateful change, for it was at the Woman's College that Edith Bellamy met Forrest Shreve, thus fixing the course of her life.

In 1906, Forrest Shreve was an assistant professor of botany at the Woman's College. Already interested in the infant field of ecology, he had recently published several papers: a popular article on carnivorous plants; an anatomical study of the pitcher plant, *Sarracenia purpurea*; and a series of reports on his sojourn, during 1905 and 1906, in Cinchona, Jamaica, where the New York Botanical Garden ran a tropical research station. Forrest Shreve's major contributions—a study of the physiological ecology of the Jamaican rain forest, a gradient analysis of the Santa Catalina Mountains in southern Arizona, the definitive work on Sonoran Desert vegetation, the delineation and description of the four North American deserts—were still to come.

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[1] *F. Shreve to D. T. MacDougal, 25 Aug. 1915, Arizona Heritage Center.*

The serious, studious, only child of Quaker parents, Forrest Shreve may have been attracted to Edith Bellamy partly by her ambition. At a time when few women sought careers and fewer still practiced science, Edith steadfastly pursued a scientific career. As a Quaker, Forrest would have been taught equality of the sexes, and as the son of a college-educated mother, he would have seen no reason why his wife's horizons could not be as broad as his own. For her part, Edith must have been relieved to find a husband who would take her as seriously as she took herself.

In 1908, Shreve was hired by the Carnegie Institution of Washington to work as a research scientist at the Desert Laboratory in Tucson, Arizona. He left Baltimore for Tucson in June; a year later he returned to the East Coast, where he married Edith Bellamy on June 17, 1909. Shortly after the wedding, they left for Cinchona, where Shreve was to complete the ecological studies of rain forest plants he had begun four years earlier.

Evidently the six months the Shreves spent in Cinchona were something of a watershed in their marriage. Edith apparently took no part in her husband's work during their stay at the tropical research station. Photographs show him dressed for field work or writing at his desk. Edith, on the other hand, is shown sitting stiffly on a dining room chair beside a table set for tea. If Edith helped Forrest with his experiments or accompanied him on his trips around the island, there is no evidence in letters or published papers. Yet once they returned to Tucson, she went everywhere with him. Perhaps they tried the conventional marriage in Jamaica and found it did not work. Edith must have been frustrated to have no outlet for her talents but the management of a household and servants, while Forrest may have discovered that in gaining a housekeeper he had lost a potential colleague. In any case, in the less rigid atmosphere of Tucson, they eventually created a partnership that worked well for both.

The Shreves settled permanently in Tucson in 1910, a year when the Desert Laboratory hummed with activity. Daniel T. MacDougal was studying plant parasites; Burton E. Livingston was working out the relationship between evaporation and plant distribution; William A. Cannon was examining the roots of desert plants; Herman A. Spoehr was starting his early work on photosynthesis; and Forrest Shreve was conducting a census of saguaro (*Carnegiea gigantea* [Engelm.] Britt. & Rose) and palo verde (*Cercidium microphyllum* [Torr.] Rose & Johnst.) populations near the laboratory and riding often into the nearby Santa Catalina Mountains to study the distribution of vegetation in relation to climate. The Desert Laboratory was an exciting place to be a scientist—and a dull place to be nothing but a scientist's wife.

From the first, Edith accompanied her husband on most of his horseback trips in the Santa Catalina Mountains, but within a year or two she evidently found it was not enough to simply follow her husband. Sometime in those early years at the Desert Laboratory, Edith decided to pursue a career of her own. She chose to work in plant physiology, a field that would be complementary to but separate from her husband's. Her choice may have been influenced by the stimulating atmosphere at the Desert Laboratory, where ecology and physiology of desert plants was the primary emphasis. Then, too, her background in the physical sciences probably made physiological research more congenial to her than ecological research. As a physicist and chemist, she would have been accustomed to experimental studies. Moreover, she was already comfortable with the laboratory setting and adept at devising appropriate apparatus for her various experiments. Above all, she may have wanted to avoid her husband's shadow. As an ecologist, she could hardly hope to surpass him, but as a physiologist, she could avail herself of his knowledge while making her own distinct contributions. Whether these thoughts ran through Edith's mind is impossible to say; she has left no record of her decision to become a plant physiologist.

Edith planned her first physiological study in 1911, when she was in her early thirties. It was to be an ambitious project—a study of the transpiration, water-content and anatomical structure of the palo verde tree. She evidently lacked the skills to carry out the project, however, and in 1912, the Shreves went to Baltimore so that Edith could work with Burton Livingston, a close friend and an eminent plant physiologist. As Livingston's research assistant at Johns Hopkins University, Edith learned enough about plant physiology to function independently when she returned to Tucson several months later.

Livingston was not Edith's only mentor. Daniel T. MacDougal, director of the Desert Laboratory and another plant physiologist, gave Edith much valuable advice and support. In fact, without MacDougal's support, Edith could not have had a career at the Desert Laboratory at all. Due to a Carnegie Institution policy against husbands and wives being on the same payroll, Edith could not earn a salary for her physiological research. Antinepotism rules were common at that time. A feminist historian has argued that such policies were "a device used by universities to protect themselves from having to consider employing qualified wives and perhaps to protect the employed husbands from the legitimate professional competition from them as well" (Rossiter 1982: p. 6). Not only did Edith lack a salary, she had no budget for materials and equipment. Though MacDougal generously allowed her to use whatever funds were left over from his own projects, his generosity was a double-edged sword. Once he discovered he had a trained and eager plant physiologist on hand, he turned her into his unpaid research assistant. Edith never complained about MacDougal's cavalier treatment of her, at least not in writing. She was, no doubt, simply grateful to be working at a time when jobs for women scientists were few.

In 1910 there existed only 107 jobs for women scientists in the United States, whereas the number of trained, female scientists available to fill these jobs was 204 (Rossiter 1974). Most of these positions were at colleges and universities, typically at women's colleges. Outside academia, job opportunities for women scientists were even fewer. Many well-trained women had no choice but to work as research assistants at menial tasks not commensurate with their education. Because they had husbands to support them, married women were not expected to work; why should they be allowed to take jobs away from men (Wilson 1979, Rossiter 1982)? Thus, in pursuing a career in science, Edith

not only had to confront stereotyped ideas of "women's work," but also to fight the widespread prejudice against married women working at all.

In 1912 and 1913, Edith worked alternately on autonomic movements in the cholla cactus (*Opuntia versicolor* Engelm.) and on transpiration of the palo verde tree. She was often diffident about her progress and reluctant to claim more credit for herself than she felt was due. Replying to MacDougal, who had requested a statement about her work for his annual report to the Carnegie Institution in 1912, she wrote, "I have been scraping my brain for something to put in such a report. The facts are that I have taken practically a year off for study and that my work stands just about where it did last year. So it seems really that I have no report unless it be that I am continuing and finishing up the work which I reported on last year."[2] MacDougal reassured her that her work on leaf temperatures (Shreve 1912), done largely under Livingston's supervision at Johns Hopkins, was indeed "something definite." He added, "You probably do not realize that you have done considerable during the year."[3] A year later, in response to another request for material for the annual report, Edith told MacDougal, "I am sending you some statements which I fear are too long. I imagine you will want to use the scissors pretty freely."[4]

Though Edith's modesty tended to mask her commitment and competence, she was an imaginative, dedicated researcher. She followed likely leads until they led no further, then pursued other channels, seeking always the most reasonable explanation for her observations. "The cactus plants are working pretty vigorously now," she reported to MacDougal in 1913, "but are moving through smaller angles than they were last year. I thought I had hit upon something worthwhile when I found the cactus gaining at night as much as 100 miligrams [of fluid], but Dr. Livingston later took me back to earth a little when he told me that Mr. Caldwell found out the same thing two years ago."[5] The following year, after discovering that cholla joints accumulated acids during the night, she told MacDougal, "Now, of course, I am keen to know the real cause of the variation in the aborbing capacity of the cactus. It might even turn out that the acid was not the cause at all but merely an associated phenomenon."[6]

Early in 1916, the Shreves once again spent time on the East Coast. Forrest Shreve and Burton Livingston worked on a joint project they had begun eight years before, and Edith Shreve and Livingston tried to perfect the cobalt chloride method of determining leaf transpiration (Livingston and Shreve 1916). Edith's growing confidence in her abilities can be seen in a letter to MacDougal later that year, when she wrote, "Since you have always asked

Edith Shreve at about age twenty.

me for a report in former years I am enclosing one this year. Perhaps I am conceited, but just the same I think I can stand being so considered. You see I have always been delighted at the idea of being included in the Annual Report." Even so, her confidence was not complete, for she added, "In case you do want the report I have fears that maybe it is too long; but the conclusions just came of themselves."[7]

She may have been deferential and self-effacing at times, but she was determined to make her own way in science, as can be seen by her application for the Sara Berliner Fellowship in 1916.[8] MacDougal, in his letter of recommendation for Edith, stated that "the general importance of the problems with which she is concerned is such as to warrant any support that may be given her," and he would "be willing to go far in vouching for her ability."[9] MacDougal was certain that if Edith were awarded the fellowship, she would "make the best use of the facilities which it brings."

Edith's scientific output in her first decade at the Desert Laboratory was not large, but it was of high quality. She showed that the success of palo verde trees in the desert was linked to their ability to adjust transpiration rates as en-

[2]*E. B. Shreve to D. T. MacDougal, 22 Aug. 1912, Arizona Heritage Center.*

[3]*D. T. MacDougal to E. B. Shreve, 26 Aug. 1912, Arizona Heritage Center.*

[4]*E. B. Shreve to D. T. MacDougal, 14 Aug. 1913, Arizona Heritage Center.*

[5]Ibid.

[6]*E. B. Shreve to D. T. MacDougal, 30 Aug. 1914, Arizona Heritage Center.*

[7]*E. B. Shreve to D. T. MacDougal, 6 Sept. 1916, Arizona Heritage Center.*

[8]*It is not certain that Edith received the fellowship, which had been established in 1911 by the German-born scientist and inventor Emile Berliner to give women scientists an opportunity to continue in research after receiving their doctorates.*

[9]*D. T. MacDougal to C. Franklin, 2 Jan. 1917, Arizona Heritage Center.*

Edith Shreve in Jamaica.

vironmental conditions changed (Shreve 1914). In studying autonomic movements in cholla joints, she discovered that the plants apparently lost water during the night and took up water during the day, the opposite of the expected pattern (Shreve 1915). Her continued attempts to learn the cause of this pattern led her to the verge of discovering crassulacean acid metabolism, the specialized mode of photosynthesis used by cacti and other succulents.[10] But since little was known about photosynthesis in those days, she had no basis for interpreting the results of her experiments. She could only conclude that chemical changes within the cells were somehow "responsible for variations in the water-holding capacity of the whole plant and, through this, for variations in root absorptance and in transpiration" (Shreve 1916: p. 125). She also worked on methods of determining leaf temperature and leaf transpiration (Shreve 1918a, 1919a) and absorption of water by gelatine (Shreve 1918b, 1919b).

Edith's approach to scientific research was quite different from her husband's He was primarily a field scientist; his laboratory was the out-of-doors, his experimental treatments the variations in topography, climate and geology that nature itself provided. In short, he relied more on observation than experiment. Edith, on the other hand, was an experimentalist through and through, which is not suprising, given her background in chemistry and physics. Most of her studies were conducted in the laboratory, where she subjected experimental plants to a variety of controlled conditions. In keeping with their opposite styles of research, the Shreves investigated desert plants at different levels. Forrest Shreve was interested in the whole plant and its place in the environment. Edith Shreve was interested primarily in the mechanics of how individual plants function and only secondarily in how these mechanics suit the plant to its habitat.

In 1918, with six papers to her credit, Edith might well have felt that she was established as a professional scientist. That year, however, her career was deflected when she became pregnant at age thirty-nine. The pregnancy was unplanned .[11] Since the Shreves were strong supporters of Margaret Sanger, the early birth control activist,[12] it seems likely that they had used some form of birth control for the first nine years of their marriage. (Though birth control was not sanctioned by physicians or federal law in those days, various methods were known and practiced [Reed 1978].) Perhaps Edith had deliberately avoided motherhood so she could concentrate on research. After the birth of Margaret, their only child, in September 1918, Edith's career never quite got on track again, though she did her best to keep in the running.

The handyman at the Desert Laboratory built a small corral for Margaret outside Edith's office, so that, as she worked, Edith could keep an eye on her small daughter. She managed to publish two papers in 1919, the year after the baby was born. After that, though, she published only two more scientific papers: a study of seasonal water relations in desert plants (Shreve 1923) and a study of transpiration in the brittle bush *(Encelia farinosa* Gray) (Shreve 1924). As any woman with small children can attest, it is virtually impossible to maintain a demanding career and be a full-time mother as well.

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[10]*Edith was not the first scientist to come to the verge of discovering crassulacean acid metabolism (CAM). The two main aspects of CAM, diurnal exchange of carbon dioxide and metabolism of malic acid, had been discovered about one hundred years before Edith's research on* Opuntia. *De Saussure in 1804 found that* Opuntia *stems took up carbon dioxide at night, and Heyen in 1815 learned that organic acids accumulated in* Bryophyllum *leaves at night. It was not until the 1960's, however, that the mechanisms of CAM were fully elucidated (Kluge and Ting 1978).*

[11]*Margaret Shreve Conn, interview, 8 Oct. 1983.*

[12]Ibid.

Edith Shreve in the Santa Catalina Mountains.

Predictably, Edith brought her scientific outlook to the problems of rearing a child. Evidently not trusting the quality of Tucson's schools, Edith taught Margaret at home until 1934, when the teenager was sent to boarding school in Pasadena, California. During the years when Margaret was at home, Edith also taught in a Montessori school, tutored children of various ages, and started a science club for children of elementary-school age. She even published a brief paper in an educational journal (Shreve 1925).

After a hiatus of several years, Edith eased back into scientific research in the late 1920s. She was, as Forrest Shreve told Burton Livingston, particularly eager to "get to work again on her investigation of the behavior of water columns acted upon simultaneously by evaporation and osmotic pull."[13] Edith was as much interested in research as ever, Forrest told another colleague and added that during her relatively inactive years "she has had more opportunity to read and keep in touch with the literature than she would have had had she been working."[14]

But by 1932, Edith had run into insoluble technical problems with her research. Forrest Shreve told Livingston that Edith "has been discouraged for some time about her work on the tensile strength of water and the physics of transpiration."[15] According to Forrest, Edith's experiments had produced "a lot of curves showing the behavior of atmometers with sugar solutions of different strengths under indoor and outdoor conditions."[16] Bewilderingly, she had found that the sugar solutions behaved "just like plants," and in fact, she was beginning to ask "whether stomata really do anything at all."[17] These were desperate problems indeed, yet isolated from other plant physiologists, Edith could not get the professional assistance she needed to overcome her difficulties.

Too discouraged to continue her research, she left the Desert Laboratory to work as a technician in a local medical laboratory. Forrest Shreve, as supportive as ever, tried to enlist the cooperation of more physiologically oriented colleagues, including Burton Livingston, to whom he wrote, "Mrs. Shreve has been doing clinical work again, and I am not sure that I will ever be able to coax her back into botany again, unless you will come out and help me."[18] Forrest encouraged his wife to write up a "tentative account of her work" for comment and criticism by Livingston and another physiologist; that way she could

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[13]*F. Shreve to B. E. Livingston, 11 Oct. 1929, Special Collections.*

[14]*F. Shreve to J. W. Shive, 14 June 1930, Special Collections.*

[15]*B. E. Livingston, 20 June 1933, Special Collections.*

[16]*F. Shreve to B. E. Livingston, 10 Nov. 1933, Special Collections.*

[17]Ibid.

[18]*F. Shreve to B. E. Livingston, 22 May 1933, Special Collections.*

The Desert Laboratory group in the late 1930s: Left to right: Arthur Hinckley, Forrest Shreve, Edith Shreve, Howard Gentry, T. D. Mallery, William Turnage.

compensate for the scientific contacts not available in Tucson.[19] Edith apparently never followed up on his suggestion. Perhaps her irregular position at the laboratory made her reluctant to approach established researchers.

In 1935, Edith and a close friend opened their own clinical laboratory in Tucson, then becoming a center for patients with respiratory illness. Unfortunately, the country was in the depths of the depression, and they went out of business about eighteen months later, mainly because they had difficulty collecting fees from their clients. After her laboratory closed, Edith continued to work at other clinical laboratories in Tucson. She had not lost interest in plant physiology, though, and she worked intermittently at the Desert Laboratory until November 5, 1938, when the chemistry building burned to the ground. Forrest recorded in his diary, "It is a sad spectacle and a heavy blow to Edith." All her notes from the last twenty-eight years of research were destroyed in the fire.

Edith resumed work soon afterwards in a jerry-built laboratory in the main building, but 1939 was her last year of physiological research. The prospect of starting from scratch at the age of sixty was evidently too much to face. In 1940, at the meetings of the Botanical Society of America in Seattle, she gave a paper on her transpiration work, then turned her back on plant physiology forever. That same year she resumed regular duties as a medical researcher at the Desert Sanatorium (now Tucson Medical Center), and worked on blood chemistry and arthritis research until she retired a few years later.

After Forrest Shreve died in 1950, Edith moved from Tucson to Long Beach, California, where her daughter and son-in-law lived. Here Edith's life "took another turnabout," as Margaret later described it, and she became active in various ladies' groups.[20] Edith died in Long Beach in 1956. No obituaries of her appeared in physiological journals or in the Carnegie Institution's yearbook: it looks as though she had been forgotten by all but family and friends. Three decades after Edith's death, we can only guess at what happened to the high hopes of her early thirties, when she worked side by side with her husband at the Desert Laboratory. We can only speculate on what happened to the enthusiastic, young plant physiologist whose perseverance and precision MacDougal warmly commended.

In retrospect, Edith's life seems to have been a balancing act between the traditional woman's role and her conflict-

[19]*F. Shreve to B. E. Livingston, 10 Nov. 1933, Special Collections.*

[20]*Margaret Shreve Conn, interview, 8 Oct. 1983.*

ing desire for a scientific career. When the Shreves moved to Tucson in 1910, the change was primarily to benefit Forrest Shreve's career. That Edith was able to find a way to channel her energies and intellect is a tribute to her determination. Nevertheless, in leaving the East Coast, where jobs were relatively plentiful, she also left in all likelihood any prospect of regular, scientific employment. Edith's very choice of plant physiology as a career embodied her balancing act: as a plant physiologist she took a step away from her own natural bent and approached closer to her husband's work. Once she became a mother, she departed even further from her professional goals. Margaret's birth, when Edith was thirty-nine, forced her into semi-retirement at an age when most scientists are reaching their full stride. It would be easy to suggest that Edith had sacrificed her career to motherhood, but Edith herself might well have disagreed; a close friend of the Shreves during the 1930s later reported that Margaret was "the total joy" of her parents' lives.[21]

Even had she not been sidetracked by motherhood, Edith would still have been hampered by her lack of a proper position. Her husband could be associated with the Desert Laboratory in a paying job, but Edith, in common with many female scientists of the first part of this century, worked without the financial and administrative backing of a powerful institution (Rossiter 1982). The lack of such backing meant more than the absence of a salary. It meant that Edith had no technical or secretarial assistance, no chance for advancement and, worst of all, no professional standing in the world of science.

The story of Edith's life is that of feminine aspirations colliding with feminine reality. Read as fiction, the story of her life lacks continuity; yet women's lives have traditionally been discontinuous, fragmented between the demands of husband, children and home and the internal cry for some greater outlet for talents that lie wasting.

Acknowledgments

In writing this essay on Edith Shreve, I have relied mainly on three manuscript collections: the Desert Laboratory papers in the Special Collections of the University of Arizona Library; the Daniel T. MacDougal correspondence in the Arizona Heritage Center, Tucson; and unpublished family papers in the hands of the Shreve family. In letters and an interview, Margaret Shreve Conn provided much insight into her parents' lives. Marjorie Denney, a close friend of the Shreves in the 1930s, was also very helpful. Mrs. Conn provided the photographs of Edith Shreve. I thank Julio Betancourt, Betty Fink and Steve McLaughlin for thoughtful and thought-provoking reviews of the manuscript. I have documented Forrest Shreve's career more fully in *A Sense of Place: The Life and Work of Forrest Shreve*, a biography currently in preparation.

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[21]*Marjorie P. Denney, interview, 17 Oct. 1983.*