Mr. Babinet is warned by his porter of the comet's visit. —Honore Daumier

Feminism and Science

—Rita Arditti

This article examines what it has been and continues to be like for women to be scientists in the masculinized world of science. It explores the powerful and positive potential of feminism in developing a truly humane science of the future.

"Women drink water while men drink wine"

In *A Room of One's Own*, published in 1929, Virginia Woolf describes a visit to Oxbridge, an imaginary center of learning in England. She is walking through a grass plot when a man stops her: only the Fellows and Scholars are allowed to walk in the turf path; she should walk in the gravel. She steps into the library and instantly a kindly gentleman informs her that "ladies are only admitted to the library if accompanied by a Fellow of the college." Eating in Oxbridge she notices that the male scholars are served delicious foods and their wine glasses are quickly refilled. At the women's dining hall the food is plain and there is only water in the glasses. Why did men drink wine and women water? Why was one sex so prosperous and the other so poor? She reflects that if there had been more support for women, maybe "we could have been sitting at our ease tonight and the subject of our talk might have been archaelogy, botany, anthropology, physics, the nature of the atom, mathematics, astronomy, relativity, geography."

All through history while male scholars conversed, debated and contributed to the disciplines of their choice, women provided the services that made that work possible. A non-sexist history of science (still to be written) would show the extent to which our culture has been built on the bodies and labor of women.

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From the earliest times women have been denied access to formal education. The training of women in ancient Greece was aimed at producing housekeepers, mothers and mistresses—at the very time that Greek philosophers (called sophists, i.e., "wise men") were trying to answer fundamental questions about the nature of the universe, the meaning of life, etc. Greek "democracy" guaranteed equal rights for its male citizens, but women, foreigners and slaves did not have political rights. Praised for their ignorance, relegated to their own quarters, encouraged to be silent when in the presence of men, women were denied opportunities to pursue formal learning.

In accordance with their social reality the Greek philosophers developed a view of the world which was man-centered and dualistic. Pythagoras expressed this view succinctly: "There is a good principle that has created order, light and man, and a bad principle which has created chaos, darkness and women."[1] Despite this prevailing view, women were important members of the Pythagorean communities where early mathematics was developed. In fact, after his death, his wife, Theano, and his daughters continued his teachings at the central school of the order, referred to as a "brotherhood" by most science historians.[2]

Aspasia, the most learned woman in the ancient world (whom Socrates called "my teacher" and who is credited with writing the best speeches of Pericles) fought against the sexual arrangements of her times. She criticized the institution of marriage as it existed in Athens and tried to educate Athenian women and men about the need for equality of the sexes. But the schools of learning, like Plato's Academy, were bastions for selected males from privileged families who engaged in discussions of mathematics, astronomy and philosophy and who were totally convinced of the intellectual superiority of their sex. One of their beliefs was that the penalty for a man who lived badly was to be reborn as a woman in the second generation.[3] Love between males, love "between equals," was considered the most perfect form of love, and male homosexuality was a widespread and accepted practice.

Even midwifery was forbidden to women as a profession, and Agnodice, a famous Greek midwife, was forced to disguise herself as a man in order to practice.[4] Aristotle took the next step by incorporating the social mores of his time into "scientific theories"; he asserted that women had fewer teeth than men and explained procreation as the creative action of the male seed. There was no such thing as female seed; male seed was the active principle, and menstrual blood was the material provided by the female for the growth of the new being. Matter was primitive, undifferentiated (female), and form, an attempt at perfection, was imposed on it by the mind (male). "The male was the carpenter, the female the timber."[5] The ideas of Aristotle had a great influence on later day scientists, and to this very day this hierarchical and dualistic thinking plagues many minds.

Roman women received some rudimentary education. To show an interest in literary matters was acceptable, although there are no records of writings by Roman women. A few women physicians practiced, mostly on women.[6] Hypatia of Alexandria (370-415) escaped the socialization imposed on the women of her time thanks to her father, a mathematician named Theon, who had decided to produce a "perfect being" and had trained her in the arts, literature, science and philosophy. A mathematician and a philosopher, she was also practiced in the physical arts of swimming, rowing, horseback riding and mountain-climbing. She refused offers to marry answering that she was wedded to the truth. She invented an astrolabe and a planesphere, an apparatus for distilling water, another for determining the specific gravity of liquids and one for determining the level of water. She wrote three books on mathematical problems which were respected by her contemporaries. Her teachings, however, were considered heretical to prevailing Christian beliefs, and she was accused of being a promoter of pagan thinking. She died at the hands of a mob of religious fanatics. Because of the unusual circumstances of her death, she is sometimes mentioned in histories of science, but little allusion is made to her work. She appears as somewhat of a legendary figure, and the fact that she was a brilliant mathematician and teacher is relegated to the background.[7]

During the Middle Ages the Church monopolized centers of learning, and almost all intellectual activity took place in convents and monasteries. Formal science was at a low point: geometry, arithmetic and some astronomy were all that was taught. The work of the alchemists produced vast amounts of useful and practical

information, but no major breakthroughs in science were made until the 17th century.

The convents were practically the only place where women could get an education. Some of the convents, run by strong-willed abbesses, provided a retreat for women of the upper classes which allowed a few women to explore their talents and creativity. Hildegarde of Bingen, abbess of a convent for more than 30 years, wrote extensively about nature. Much like the Greek philosophers, she asked general questions about the universe and discussed the cosmos, nature, "man," birth and death, the soul and God. Her insights and some of her more elaborate ideas establish her as a remarkable thinker. She recognized that the stars are of different sizes and of different brightness and made a comparison between the movement of the stars and the movement of blood in the veins—an idea that predated the discovery of the circulation of the blood. Other ideas also anticipated later discoveries. She put the sun at the center of the firmament and speculated about the seasons. She argued that if it is winter and cold in one part of the planet, then the other side of the earth should be warm. Her expertise in medical care and herbal medicine attracted the sick from all over Germany.[8] The suppression of the convents in England by Henry VIII signaled the end of organized efforts to educate women. Ironically, when the English convents were closed, their revenues and possessions went to endow Oxford and Cambridge, institutions devoted solely to the education of males.

In Italy, during the Middle Ages, a few women practiced "formal medicine." Women were not allowed to matriculate from medical faculties but could be authorized to practice by passing an examination and obtaining a license. Almost invariably they belonged to the family of a well known male physician. In fact, it was often the desire to keep a secret method of healing inside the family and the lack of a male heir that enabled the wife or daughter of an established physician to get permission to practice. Trotula of Salerno, one such woman physician, gained for herself an impressive reputation as a surgeon in the second half of the XI century; she introduced new methods of suturing and the use of the silk thread.[9] In medieval Europe, large numbers of women were healers. They did abortions, nursed the sick, cultivated healing herbs, delivered babies and travelled from village to village passing on their knowledge and their experience. The suppression of women healers accused of witchcraft and the emergence of a new male medical profession under the protection and patronage of the

nobility is one of the bloodiest chapters in the history of women's oppression.[10]

During the Renaissance, the new science that followed from the work of Copernicus, Kepler and Galileo provided an alternative vision of the world and general impetus to question the established social order. Women's education became a lively topic of discussion. A literary controversy ensued called "La Querelle des Femmes" (the dispute about women), with philosophers taking sides on a debate regarding women's capabilities. A few universities opened its doors to women of the aristocracy.[11]

As new ideas in science were developed, strong women inspired and nurtured the male scientists who were creating the basis of science as we know it now. Sister Celeste, Galileo's oldest daughter, followed every detail of his work for eleven years. Her support allowed him to continue his work whenever despair came over him. Her death was a blow from which he never recovered. Kepler relied on his wife, Barbara, to help him keep up his strength and good spirits. Descartes acknowledged the inspiration and encouragement he received from Elizabeth of Bohemia by dedicating his work to her: "...in her alone were united those generally separated talents for metaphysics and for mathematics which are so characteristically operative in the Cartesian system."[12]

In France the Institute of Saint Cyr opened in 1686, the first state school for women. It was a disappointing enterprise. The superficiality of its curriculum quickly became clear: no word was mentioned about philosophy or the natural sciences. The school became known as a center that provided mistresses to the court of the king.

In the same year Newton's monumental work "Principia Mathematica" was published. Emile de Breteuil, marquise de Chatelet, translated Newton's work from Latin into French and added her own scholarly commentary of the work. The translation of Newton's work into French was a significant event because his work contributed to the climate of skepticism that preceded the French Revolution. De Breteuil was a scientist in her own right, and she devoted much of her work to investigating the nature of fire. She had constructed in her castle at Cirey a physical laboratory in which she performed experiments. She was assisted by Voltaire, with whom she shared 16 years of her life.[13]

In the Western scientific milieu a particular ideology and organization evolved following Francis Bacon's ideas. Nature (female) was the enemy, and science was the instrument for its

control and domination—a way of recovering the lost dignity of "man."[14] Nature was to be conquered. A group of male scholars, devoted to scientific research and the pursuit of wisdom, would guide society. From this vision, his "House of Solomon," derived the European scientific societies of the 17th century—mainly the British Royal Society and the French Royal Academy. Membership was open to "men of all professions...students, soldiers, shopkeepers, farmers, courtiers and sailors, all mutually assisting each other."[15] Membership in the societies was considered proof of scientific ability.

Outstanding scientists like Maria Gaetana Agnesi and Sophie Germain were denied membership because of their sex. Agnesi's work "Analytical Institutions" had gained her a wide reputation and an appointment as an honorary lecturer of mathematics at the University of Bologna, but the secretary of the French Academy turned down her candidacy with a blunt, "La tradition ne veut pas d'academiciennes" (tradition does not want women academicians). Sophie Germain worked for years and corresponded with Gauss on mathematical topics without letting him know she was a female. She signed her work as "M. leBlanc" in order to "escape the ridicule attached to a woman devoted to science." Ironically, she won a prize from the French Academy because of her work on the vibrations of elastic planes but could never become an official member.[16]

In France in the 17th century a few women from the aristocracy showed an interest in astronomy. They became the target of ridicule in Moliere's play *Les femmes savants* (The learned ladies):

> Get rid of this fierce-looking telescope and all the rest of these gadgets...stop trying to find out what's happening on the moon and mind what's going on in your own house where everything is upside down. It's not decent and there are plenty of reasons why it isn't, for a woman to study and know so much...Women today want to write books and become authors. No learning is too deep for them... and here, in my house, they know everything except what they need to know. In my house, they all know about the moon and the pole star and about Venus, Saturn and Mars, which are no concern of mine...and nobody knows how the pot is cooking..."[17]

In the United States, public education started in Boston in 1642, but females were not accepted into schools until 1789 and

then only for half of the year, with teaching restricted to spelling, reading and composition. In private schools, women of the upper classes would also learn French, music and embroidery. Thanks to Emma Willard's persistence and enthusiasm, the Troy Female Seminary opened in 1821, the first endowed institution for the education of women. Among its daring innovations was the teaching of physiology: "Mothers visiting a class at the Seminary in the early thirties were so shocked at the sight of a pupil drawing a heart, arteries and veins on a blackboard to explain the circulation of the blood, that they left the room in shame and dismay. To preserve the modesty of the girls and spare them too frequent agitation, heavy paper was pasted over the pages in their textbooks which depicted the human body."[18] The demand for free education in America was largely based on the rationale that every voter needed to be responsible and intelligent, capable of assessing and discussing information. But since women could not vote, the argument could not be extended to the education of females. Only after the Civil War were free high schools for young women created in Boston and Philadelphia.

The first college to open its doors to women was Oberlin in 1833, but the notion of the inferiority of the female mind prevailed. The Oberlin women students were prepared to be "the mothers of the race" and taught to stay in a well-defined "women's sphere" of activities.

The Declaration of Principles passed at the feminist convention in Seneca Falls in 1848 called attention to the absence of women in the fields of medicine, law, and theology. At the Massachusetts Institute of Technology, Ellen Swallow, the first woman student, received her Bachelor of Science degree in 1873 but was not allowed to enroll in the doctoral program. She was a controversial figure in a conservative milieu. Nevertheless, her work in sanitary chemistry was important to the incipient field of environmental science. Her stressing of the importance of the environment in human development came at a time when heredity was the usual explanation for every major social problem. People were poor or criminal because they were "born that way." She believed that people could be taught to think critically and live in tune with the environment. "We must show that science has a very close relation to everyday life...train (women) to judge for themselves...to think...to reason...from the facts to the unknown results."[19] She arranged for a survey of the health of college educated women in order to refute the myth that education was

harmful to women. Her study was published by the Commonwealth.

In 1903 Marie Curie received the Nobel prize for her work on radioactivity together with Henri Becquerel and Pierre Curie. In 1904 she started receiving a salary for the first time in her career. Marie Curie is practically the only woman scientist given the worldwide recognition traditionally accorded to male scientists who are considered competent. Her devotion to scientific research, her inability for small talk and her seriousness made her quite unpopular among many of her colleagues. Her talent elicited mixed feelings. When in 1910 she published her "Treatise on Radioactivity," Rutherford reviewed it favorably in *Nature* magazine, but in a private letter to a friend he expressed his true feelings: "Altogether I feel that the poor woman has laboured tremendously, and her volumes will be very useful for a year or two to save the researcher from hunting up his own literature, a saving which I think is not altogether advantageous."[20] At the height of her career she presented her candidacy for membership in the French Academy of Science. According to the customs of the time she went from house to house and from laboratory to laboratory visiting the members of the Academy and asking for their support. But the Academy was not moved, she was a woman and as such was not eligible. A few days before her name appeared before the Academy as a candidate, its members reaffirmed in plenary session "the immutable tradition against the election of women."[21]

In the United States, women were not admitted to graduate schools until the 1880s. Even so, once admitted, many schools did not allow them to receive advanced degrees.[22] By the beginning of the 20th century the U.S. had become an industrial society. In spite of a generally conservative atmosphere, the needs of the economy for rapid technological development had a positive effect on the position of women. Women started to get out of the home. The number of women in science started to increase and in the 1920s the proportion of women scientists reached an all-time peak. But in the '30s and '40s the depression and WW II made the education of women a low priority. The proportion of women in science decreased and reached an all time low in the 1950s. WW II veterans re-entered school and the workplace, and women retreated to the home.

Current Times

Today, discrimination against women is still overt and socially acceptable within the academic community. Among 207,500 science and engineering PhD's in the U.S. labor force 93.1% are white and 92.1% are male. Only 0.8% are black, 0.6% Latin, 0.04% Native American while East Asians who make up 0.7% of the U.S. population comprise 5% of science and engineering PhD's.[23] Women scientists (8% of the total) have markedly lower salaries than men and are concentrated in certain fields: four-fifths are life scientists, psychologists, or social scientists. The unemployment rates for women in science are two to five times higher than for men in the same field with comparable training and experience. Although women comprise 5 to 8% of physical science researchers, the National Science Foundation gives them only 0.03% of 1% of its awards and grants.

Like the scientific societies of the 17th century, the Cosmos Club in Washington D.C. (an elite club for prestigious scientists) does not admit women scientists to its membership. Among 1,134 living members of the National Academy of Sciences, only 25 are women (of whom 6 were elected in 1975).[24]

Discrimination against females starts early. Young females in the seventh through twelth grades "tend" to lose interest in mathematics. Later in college they feel they lack the necessary fundamental skills and avoid science courses whenever possible.

In order to become a scientist, both women and men have to learn to behave in a way that will be acceptable and recognizable to other people in the field. Years of informal role learning are necessary before we complete the socialization process that transforms us into "the scientist." During those years—and quite apart from the courses' content—cultural messages concerning the attitudes and expectations for women in science are transmitted. Basically, the message for women is "be a good little girl scientist." While it is accepted that women can efficiently perform technical and data-gathering functions, there is a general feeling that the truly original work, the work that "makes a difference," is produced by male scientists. That truly creative work is beyond women's capabilities. This debilitating thought has in effect prevented many women from ever fully exploring their abilities or believing in themselves. However, such a view of creativity ignores the realities of the organization of work in the scientific world. The image of the distracted and genial scientist, oblivious to practical details, de-

voting heart and soul to finding a solution to a research problem, is an image that bears little resemblance to what actually takes place. What is essential is a knowledge of how to operate within a certain framework and follow the often implicit rules. Acceptance and recognition from one's peers, a clear understanding and the use of appropriate networks of support, i.e., organizational abilities, the "know-how" of pursuing formal and informal contacts, the mentor system: these are some of the attributes necessary in order to work successfully as a scientist.

Another role expectation concerns competition. Competitiveness, racing to be "the first," is an openly acknowledged characteristic of the scientific world. But a woman who is competitive is received with hostility and mistrust.*

The position of women in research laboratories is suspiciously similar to the position we have in the nuclear family. The laboratories resemble a patriarchal household, with the "head" of the laboratory usually male, women in marginal positions without independent status, job security or benefits, and younger students playing child-like roles. A woman in a research laboratory is often expected to perform "mothering" functions, the supportive and nurturing functions that nobody else will take on. It is still a

*Two books in recent years give an excellent portrayal of competition and elite male scientific networks: *The Double Helix* by James Watson and *Rosalind Franklin and DNA* by Anne Sayre. Both books describe well how groups of scientists interact informally, communicating and making "gentlemen's agreements" (literally) about how their work should proceed. However, the books diverge radically in their view regarding Rosalind Franklin. For Watson, Franklin was an argumentative character who made life hard for people around her and who "assisted" Maurice Wilkins. "The best place for a feminist was in another person's lab" is the way Watson summarized his feelings towards Franklin. Sayre, who was a personal friend of Franklin, reports that Franklin was assigned to work on the DNA problem at a meeting in which Wilkins was not even present. She was not an appendage to Wilkins but a co-worker. Franklin was the first to establish the helical structure of DNA, but credit for this discovery has been consistently give to Wilkins. Franklin's basic work on X-ray diffraction patterns on the B chain of DNA was the key to understanding DNA structure. Shortly after Watson and Crick were raised to stardom for their discovery of the structure of DNA, Franklin left King's College and changed the area of her research. She was finally out of the way, and the male network gave her practically no recognition for her findings. She died in 1959, at age 37, leaving the scenario to her co-workers. In 1962, Wilkins, Watson, and Crick received the Nobel prize for their work. In their acceptance speeches Franklin's crucial contribution is lightly acknowledged among a host of other citations.

common attitude that a woman should consider herself fortunate to be assisting an eminent scientist, to be his "second" or his "shadow." Of course, like in a marriage, if the eminent scientist leaves, dies or changes his mind, the woman is left in a poor situation.

Even in the most sophisticated laboratories women are expected to accept the inferior and less prestigious tasks and to be proud to assist the "big" scientist in keeping his energy for superior and directive functions. The sexual dynamics are such that very few women manage to develop the skills and self-confidence necessary to survive in an extremely competitive environment. And very few are encouraged to do so. The scenario is set for the "failure" of the majority and acceptance of a "few" exceptions.

One mechanism that ensures the perpetuation of this exploitative situation is the alienation that many women who do research feel. This alienation originates from the contradiction between the work experience and what one has been told or taught to believe. Having become a scientist, having "made it" in a man's profession, one is supposed to have overcome the disadvantages of belonging to the female sex. On the other hand, the day-to-day experience of being in a subordinate position (even if one is doing scientific work) negates the previous optimistic viewpoint. As a result many women feel ambivalent about their own capabilities. Having been taught that when there is something wrong in a situation it is likely to be our fault, we keep reticent about our confusion. Consequently, we do not join forces to oppose the oppressive situation.

The Personal is Political

One of the central ideas of feminism, the *the personal is political*, allows us to see how the exploitation of women is perpetuated. By reflecting on our personal experiences, we begin to gain an understanding of how oppressive patterns are allowed to run our lives. Nothing clamorous need happen. Things go as usual. Our lives are filled with what is familiar. And the thread of oppression binds us without our even noticing it. We know very little about the experiences of women in the sciences. Only recently have women begun to speak up.*

In my own case it took many long years before I could see what the situation clearly was. I got attracted to biology in the fifties because it seemed a field that offered the promise of scientific rigor and at the same time relevant knowledge useful to my own life. As

*See "The anomaly of a woman in physics" and "How can a little girl like you teach a great big class of men" in *Working It Out*, Sara Ruddick and Pamela Daniels, ed., Pantheon, 1977.

a student at Rome University in Italy, I was struck with the news of the discovery of the DNA structure. The field looked exciting, and I decided to become a geneticist. Genetics related to people; its internal logic, its consistence and its elegance delighted me. In my early years I dismissed manifestations of hostility from some of my teachers and colleagues toward me as "personality" problems, and I immersed myself completely in the genetics of microorganisms. It never occurred to me that my sex had anything to do with some of the difficulties I encountered—this in spite of the fact that I was one of the few women doing that type of research and that I had picked up sexual innuendoes from some of my teachers. I cannot offer any reasonable explanation for my blindness.

As the years went by, however, I began to notice that women scientists had special problems, such as lack of advancement. They seemed to be stuck in the same position while men were moving ahead rapidly. The few women who were around did not show up at meetings or participate actively in them. Family obligations seemed to tear them apart.

Before long, I was one of them, struggling with my own marriage, child care arrangements, and the need to keep focused on my work. At the same time, I was receiving all kinds of mixed messages from husband and colleagues. I also began to notice the particular situation of women scientists married to men in the same field of research. All had secondary positions to their husbands regardless of ability, and their loyalties as wives had led them to accept a precarious work situation in which their research had become dependent on their marriages. They did the day-to-day work necessary to produce a solid piece of research, and the credit would invariably go to their husbands. Naively, I thought I was safe from exploitation because my husband (soon my ex-husband) worked in a different field. I did not know then that all men are potential "husbands." By this I mean that the pattern of accommodations and expectations that I had observed between women scientists married to men in the same field, could and would also arise with male colleagues. This led to confusion and disappointment.

In the late sixties in the U.S. I got involved in the movement against the war in Vietnam and began meeting with a group of scientists who were questioning the role of science in the war. Our analysis soon led us into discussions about the contradictions of trying to do humane science in an inhumane society. Scientific laboratories were supposedly dedicated to the discovery of new

knowledge. Which kind of knowledge, we asked, and for what purposes? Who benefits from it? And what are the allegiances of the scientific community? These were exciting meetings, and I felt I was getting in touch with deep questions that would in some way or other alter the course of my life.

At about the same time I started to read and reflect about women. I had once attended a women's group meeting where questions had been raised regarding our position in society and statements had been made about our lives being "political." It took me almost a year before I was ready for another meeting like that, but in the interim I did a lot of thinking and, more importantly, I began to observe everyday situations in a new way. I realized how my professional training had often led me to disassociate myself from other women, especially if they were not professional women. I had grown to accept feelings of inadequacy and isolation as a normal part of life. Next, I sadly discovered that my questioning colleagues so ready to fight against the war did not have any understanding of how their own behavior was a declaration of war against women. They branded me as "difficult" and "oversensitive." "What do you mean women's issues when there is a war going on?" Comparisons were made about whose oppression was "worse," and women were always at the losing end. It finally dawned on me that you do not discuss how to overthrow oppression with your oppressors. I started to reach out to other women, and after an initial period, we found that indeed we had many common experiences and could validate each other's perceptions. We were not crazy. We all had received destructive messages, and we all had deep insecurities regarding our role as scientists. On the surface we had all been led to believe that we were "one of the boys" but we feared being found out: we "knew" we were inadequate. Would they know?

Exploring my feelings in a safe context allowed me to remember experiences that I had buried deep down and I saw them with a fresh eye. I understood why blood had flushed to my cheeks when the head of my department, years ago, running into me one Saturday morning in the cold room of the laboratory had exclaimed affectionately: "What are you doing here? You should be home with your child!" I remembered how tense I would get before making a public presentation about my work, and I realized why. Most of the time I would be judged as much for my appearance as for the quality of my work. I was told many times, jokingly, that with my new awareness I had to give up my female "privileges."

What this meant was that I was not supposed to ask for help if I needed it and that if I did I would be most likely ridiculed for being "weak." Carrying a 25-gallon flask of distilled water was not easy for me (I am a short person) but once my colleagues decided I was "liberated," I was on my own.

Talking with other women made the difference between sanity and insanity. I knew that my own life had to conform to my changing awareness and that the next task was to start looking for alternatives. The elitism of the research laboratories suffocated me. Concomitant with my personal growth was a new interest and delight in teaching. In my search for alternatives I read some of Rachel Carson's work. Her words, as she accepted the National Book Award for her book, *The Sea Around Us*, spoke directly to me:

> Many people have commented with surprise on the fact that a work of science should have a large popular sale. But this notion, that "science" is something that belongs in a separate compartment of its own, apart from every day life, is one that I should like to challenge. We live in a scientific age, yet we assume that knowledge of science is the prerogative of only a small number of human beings, isolated and priestlike in their laboratories. This is not true. That materials of science are the materials of life itself. Science is part of the reality of living; it is the what, the how and the why for everything in our experience.[25]

When I found out that Rachel Carson was looked upon with suspicion by the scientific community because she did not have a PhD and because she was so deeply concerned with educating the public, I laughed and I cried. Here was somebody who had done more than anybody else I was aware of to integrate science with public concerns, and she was mistrusted and put down! My ideas about my own future began to change. It became clear to me that my interest in doing research in genetics of microorganisms was minimal and that I enjoyed working with people. Teaching became a source of deep satisfaction and continuous learning. I decided to put my energies into trying to change some of the oppressive conditions that I and many others had encountered. Learning about the social and political implications of science, with a focus on women, became a priority. Learning about power relations is also learning about how to change them.

Learning about the past and present position of women in science and understanding my own experiences made me realize

that feminism and science (my two main interests) did not mix easily, and that some of the fundamental ideas and insights from the women's movement run contrary to the way science is now. The potential of feminism in the development of a truly humane science became an issue to explore.

Feminism and Science

While lack of encouragement and blatant sexism have prevented women from fully participating in the sciences, the dehumanization of science has also played an important role in keeping women away. Women, generally more in touch with their feelings, often raise uncomfortable questions about "detached scientific objectivity." The prevalent mode in science today presents serious problems for people who have human concerns, as many women have. "Objectivity" applied to people often leads to objectifying them, or perceiving only their object aspects. As mentioned before, the scientific community is composed mainly of white males who have been socialized into the professional value system. Professionalism, an elitist concept, provides the means to control others and to maintain privilege over them. It divides economic and occupational groups into the thinkers at the top and the unthinking masses at the bottom.[26] It protects scientists from external evaluation or even egalitarian discussions with the people affected by their work and dependent upon their performance.

As scientists we are taught to approach problems with a purely cerebral attitude and *not* to bother with the consequences or ramifications of our work. We are taught to "keep things separate": scientific inquiry on the one hand and human concerns on the other. This way of working leaves little room for our development as human beings and opens the door to the creation of exploitative technologies. We stand powerless, producing knowledge that can be used against people. Nuclear weapons, chemical weapons, recent advances in the life sciences have all been developed by scientists who gave their energies to the narrow task before them without concern for the larger issues that would affect the community at large. It is clear that scientific inquiry without concern for the pressing social problems of our time will only create new ones. We do not live in a vacuum. Scientists will have to deal with new concepts (like being accountable) and seek closer contact with other parts of the community. More and more people are beginning to

question the right of scientists to divest themselves of responsibility for the direction of their work and the use of scientific results.

Because of our experience as women in a patriarchal culture, we know, first hand, that a purely mechanistic approach does not add much to knowledge. Scientists have studied us as the reproductive system of the species, and we have been reduced to our reproductive organs, our secondary sexual characteristics and/or sexual behavior. "Scientific" rationalizations are offered for the secondary status of women, racial minorities, and poor people. Sociobiology, the study of sex differences, and anthropology contain our own cultural myths about women. Sexism is rampant in the hard and soft sciences.[27] For women to take the place of male scientists and not to advocate a humanistic and committed science would be a tragic mistake. A man-centered science serves a man-centered society—we have to question the process by which scientific work is accomplished as well as its product. We have to question the professionalism that keeps people separate.

Out of the experience of support groups in the women's movement some of us have learned that the conditions under which people are able to work creatively and joyfully are practically non-existent in the scientific milieu. We know now that in order to communicate clearly it is essential to feel that one is being listened to with attention and interest, that qualities that one may seem to lack can be developed, and that leadership skills can be learned, if there is an interest in sharing them. All this runs against the competitive patterns prevalent in the research environment.

A feminist perspective in science would involve the creation of an environment that maximizes the development of minds and bodies and encourages positive attitudes towards one's own biological identity. It would involve the conversion from an exploitative "value free" technology to a commitment to a humane technology: to preventive medicine, fair distribution of material goods and educational opportunities. The concept of self-help would be fully accepted and fostered by the scientific community. The whole area of reproductive research, contraception and sex differences would be revamped to eliminate sexist stereotypes. Females would no longer be considered the sole reproductive units of the species.

A feminist perspective would not necessarily hail new technological developments as "liberating" because it would realize that oppression is not the result of biological or natural conditions but of social constructs. Technology would be assessed for the impact it

has in bringing meaningful change in social relations.

Feminism is also a special form of "knowing." By eliminating the division between intellect and emotion, scientists can perform intellectual tasks without becoming intellectual robots. We do not know how science would have evolved if women had been full participants in its development. There seems to be a connection between the specialization and reduction, the indifference to values and the masculinization of science.

Since science does not progress only by inductive analytical knowledge, the importance of imagination and emotion in the creative process should be obvious. The role of intuition in science is consistently undervalued in a science which is exploited for corporate, military and political reasons. A feminist perspective would re-introduce and re-legitimize the intuitive approach. The benefits of this in terms of new knowledge might well be incalculable.

Adrienne Rich notes that Virginia Woolf suggested that "women entering the professions must bring with them the education—unofficial, unpaid for, unvalued by society—of their female experience, if they are not to become subject to the dehumanizing forces of competition, money lust, the lure of personal fame and individual aggrandizement, and 'unreal loyalties'."[28] Rich adds: "In other words, we must choose what we will accept and what we will reject of institutions already structured and defined by patriarchal values...We need to consciously and critically select what is genuinely viable and what we can use from the masculine, intellectual tradition, as we possess ourselves of the knowledge, skills and perspectives that can refine our goal of self-determination with discipline and wisdom...In fact, it is in the realm of the apparently unimpeachable sciences that the greatest modifications and revaluations will undoubtedly occur. It may well be in this domain that has proved least hospitable or attractive to women—theoretical science—that the impact of feminism and of women-centered culture will have the most revolutionary impact."

Today, in science we know "more and more" about "less and less." Science as an instrument of wealth and power has become obsessed with the discovery of facts and the development of technologies. The emphasis on the analytical method as the only way of knowing has led to a mechanistic view of Nature and human beings. We should remember that the concept of evolution, for instance, did not emerge from developments in the field of genetics or biochemistry but from "inspired guesses based on a sort of

Gestalt awareness of complex relationships in natural situations. The modern scientific techniques have served merely to verify the theory and to elaborate its details."[29]

The task that seems of primary importance—for women and men—is to convert science from what it is today, a social institution with a conservative function and a defensive stand, into a liberating and healthy activity. Science needs a soul which would show respect and love for its subjects of study and would stress harmony and communication with the rest of the universe. When science fulfills its potential and becomes a tool for human liberation, we will not have to worry about women "fitting" into it because we will probably be at the forefront of that "new" science.

FOOTNOTES

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4. Mozans, *op. cit.*, p. 268.

5. Mason, *op. cit.*, p. 45.

6. Mozans, *op. cit.*, p. 271.

7. Lynn M. Osen, *Women in Mathematics*, Cambridge, Massachusetts, MIT Press, 1974, p. 31.

8. Mozans, *op. cit.*, pp. 41-42, 46; also Charles Singer, "The Scientific Views and Visions of Saint Hildegard (1098-1180)," in *Studies in the History and Method of Science*, Oxford, Clarendon Press, 1917.

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11. Julia O'Faolain and Lauro Martines, Eds., *Not in God's Image: Women in History from the Greeks to the Victorians*, Scranton, Pennsylvania, Harper Torchbooks, 1973, p. 181.

12. Mozans, *op. cit.*, p. 370.

13. Osen, *op. cit.*, pp. 49-69.

14. Joseph Haberer, *Politics and the Community of Science,* New York, Van Nostrand-Reinhold, 1969.

15. Rene Dubos, *The Dreams of Reason: Science and Utopias,* New York, Columbia University Press, 1961, p. 34.

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17. Quoted in O'Faolain and Martines, *op. cit.,* p. 245.

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23. Betty Vetter, "Women and Minority Scientists," editorial in *Science,* 189, September 5, 1975, p. 75.

24. Betty Vetter, "Women in the Natural Sciences," *SIGNS: Journal of Women in Culture and Society,* 1, 1976, pp. 713-720.

25. Paul Brooks, *The House of Life: Rachel Carson at Work,* New York, Fawcett-Crest, 1974, pp. 116-117.

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27. Evelyn Reed, *Sexism and Science,* New York, Pathfinder Press, 1978; R. Hubbard, M.S. Henifen, and B. Fried, *Women Look at Biology Looking at Women,* Cambridge, Schenkman, 1979.

28. Adrienne Rich, "Toward a Woman-centered University," in Florence Howe, *Women and the Power to Change,* New York, McGraw-Hill, 1975, p. 15.

29. Dubos, *op. cit.,* p. 116.