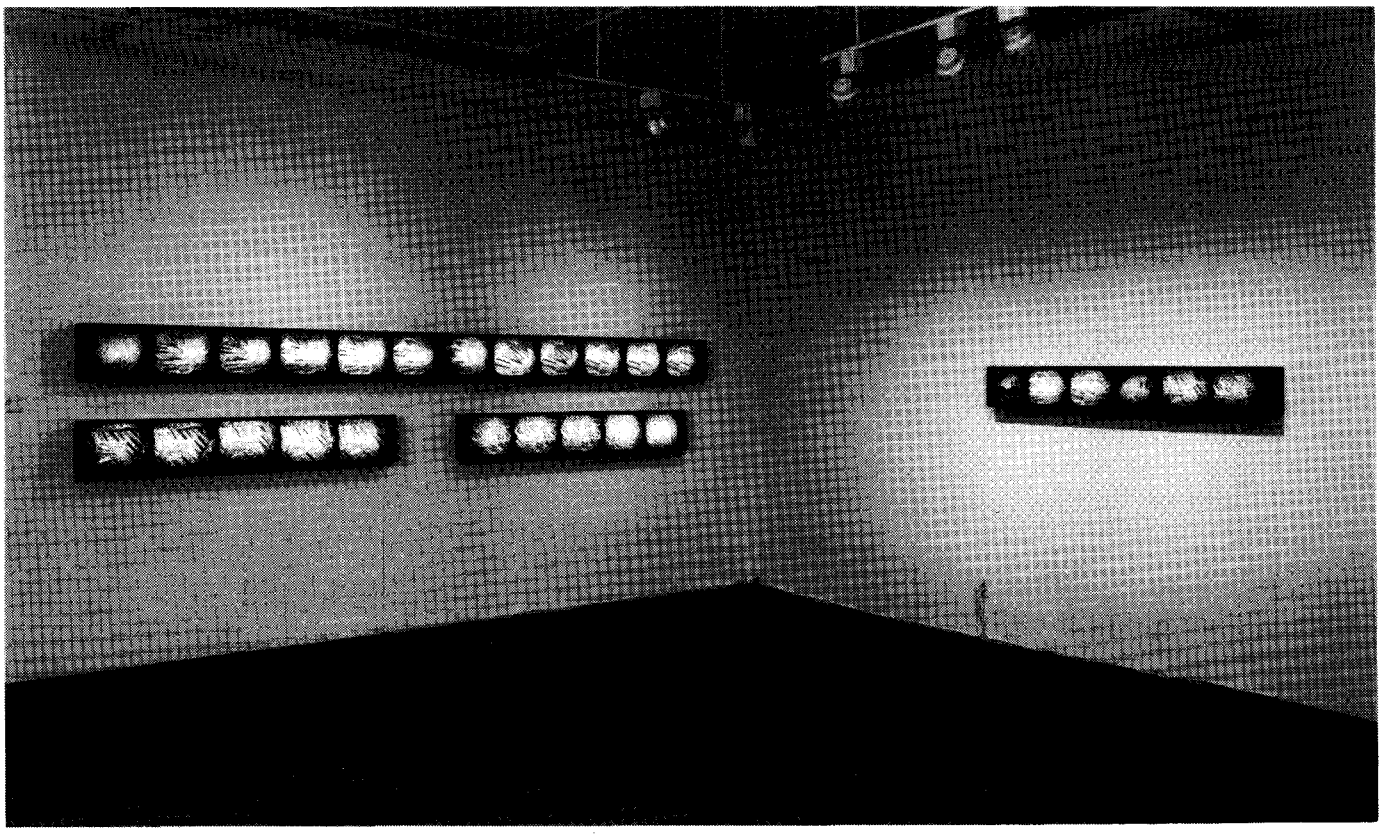
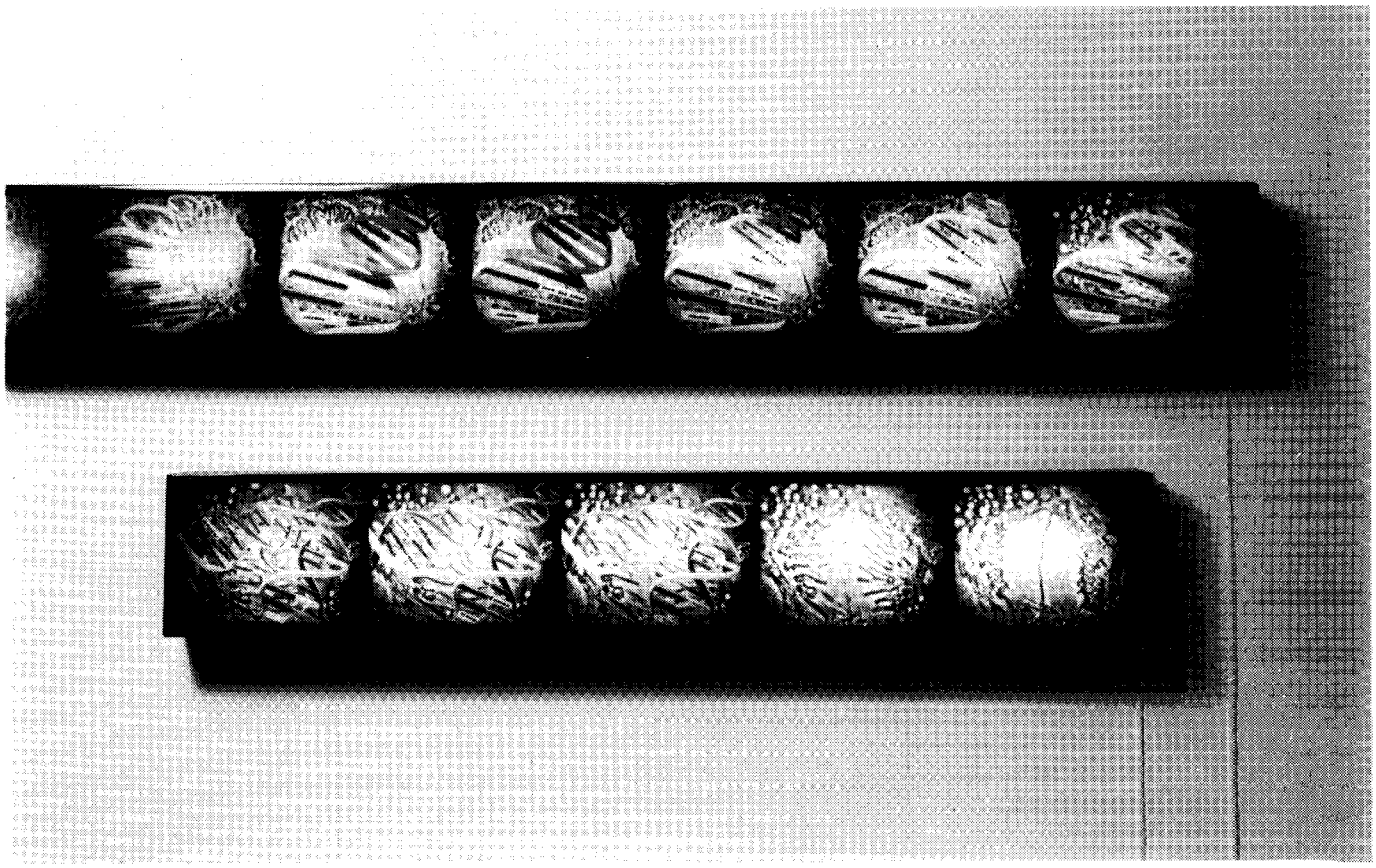


Nell Tenhaaf, "Species Life" 1989, Installation View

Photo: Denis Farley



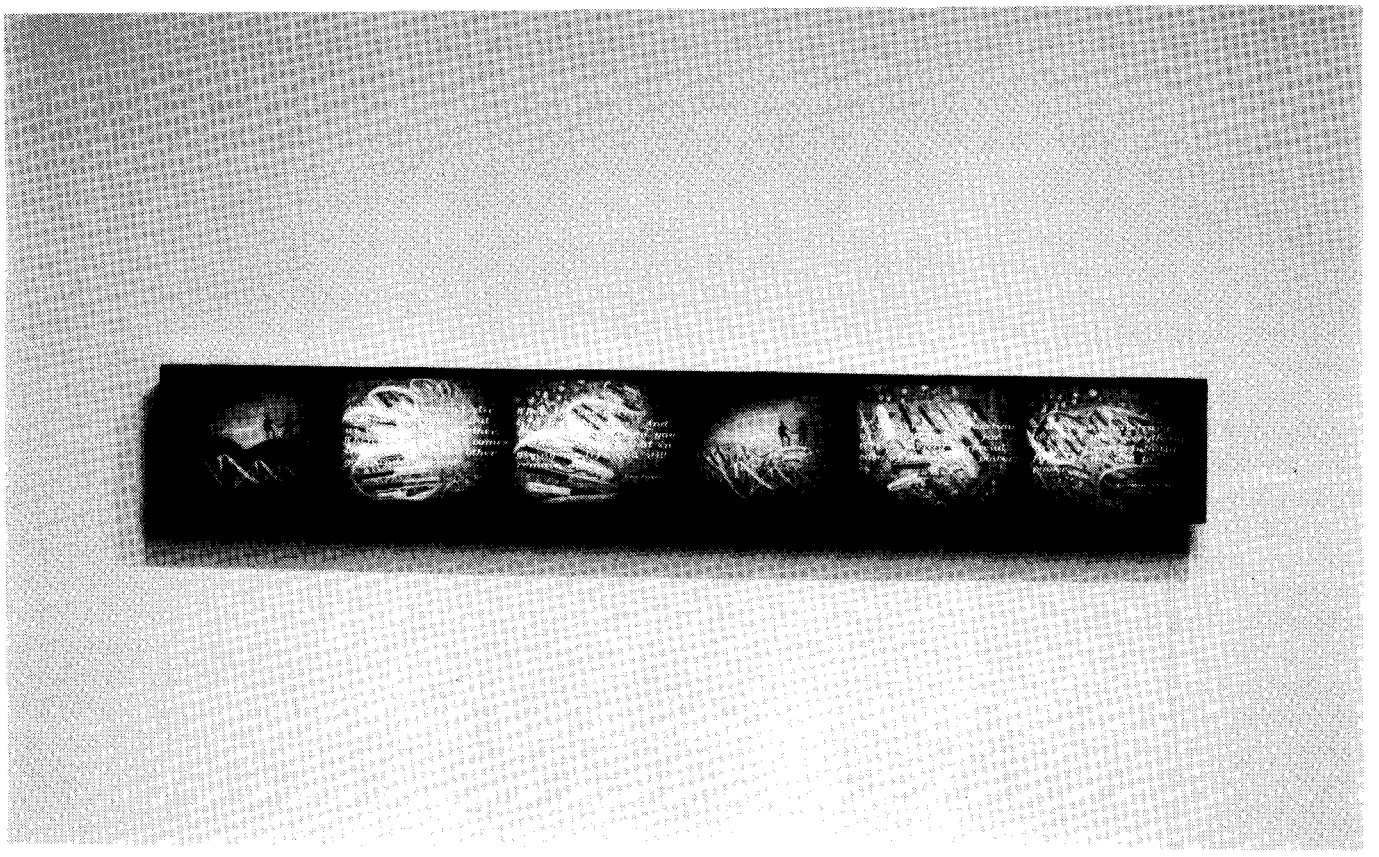
Nell Tenhaaf, "Species Life" 1989, Detail—Part I

Photo: Denis Farley

Nell Tenhaaf, "Species Life" 1989

The work consists of two parts, mounted on two adjoining or opposite walls. One part is a set of three lightboxes, consisting of video images of cell division overlayed with a model of DNA onto which is inscribed portions of a text. The other part repeats and adds to this imagery and also cites in full the fragmented texts of the other part. The citations are from Luce Irigaray and Friedrich Nietzsche.

"Species Life" sets up a counterpoint between the ability within scientific research to create direct imaging of the body at the microscopic level or to picture the body through model-making and the idea that a "social text" is inscribed on the body at a subcellular level. The quotations, each bearing a "truth," are fundamentally incompatible. The work questions whether this microscopic scientific imaging, still predominantly a male domain, gives us knowledge of our bodies that corresponds to an implicit knowledge of ourselves (male or female) or whether it repeats the gender biases of culture.



Nell Tenhaaf, "Species Life" 1989, Detail—Part II

Photo: Denis Farley

Nell Tenhaaf has been living in Montreal since 1969 and has been participating in solo and group exhibitions throughout Canada for the past decade. In her art and in her writing , she addresses gender issues in relation to electronic media, especially computer technologies. She current teaches in the Visual Arts Department of the University of Ottawa.

Science Through Her

by Heather Menzies

L'exclusion des femmes du courant dominant des sciences a mené à des découvertes importantes et capitales. On constate ce phénomène dans le travail de plusieurs femmes scientifiques de renom, de même que dans les sciences pratiquées par les Premières nations et qui comprend l'étude des objets liés à la science dans leurs contextes et leurs environnements.

What I most admired about Maggie Benston was her lack of pretense, her blissful indifference to proper roles and social demeanour. She was herself from the way she dressed and did her hair, to the way she gave a speech, to the way she played the guitar and sang in that light, wistful voice of hers. She was my kind of scientist, and a lovely illustration of what I want to talk about here.

This is a speculative piece, selectively pulling out examples of women and the science they do or have done to suggest another model of the scientist in society, the woman scientist. The portrait I want to sketch here is one grounded in historical and current life circumstance. Hence the meaning of looking glass as mirror. I want to take seriously the particulars of women's lives and their cultural environment to see how these are reflected in the science women do, and what they can accomplish as a result.

I want to focus on three things: first, the relative position of women away from the centre of science, often in the border regions between science and other institutions in modern society; second, the social relationships and related priorities women have pursued in the process of doing science; and, third, the posture of the scientist in seeking to know the world scientifically. In the first, I will talk about women in present-day science. In the second, I will talk about pre-modern science, and in the third, which is also the most speculative of the sections, I will draw on some material written about the science of Canada's first peoples.

The first part of the looking-glass pattern I want to address has to do with women scientists' tendency to have atypical career paths and eclectic, often inter-disciplinary backgrounds. They might go into an applied science area where getting into science seems easier, and move laterally from there. They might interrupt careers to follow husbands, having to make do with whatever science they can find along the way. They might also interrupt their full-time career work to have children and stay home with them during their infancy, or juggle their work between the lab, daycare centre, and home. Or they might be actively marginalized by the old boys' network.

What does this imply in terms of the looking glass? It implies that women bring to their work unique perspectives because of their inter-disciplinary, inter-institutional social experience and even their tendency to be relegated to the margins of science. In a survey of Canadian women scientists and their work, Anne Innis Dagg and Rachelle Sender Beauchamp confirm that a sizeable proportion—45 per cent—of women natural scientists in Canada do feel that being a woman affects the science they do. They also explore some of the ways this effect shows up. For instance, they find that women scientists tend toward research in the broader context of "the total picture," not abstracted from the context either into a theoretical model or a lab experiment.

I'd like to suggest that the perspective women gain through their eccentric, inter-institutional background and often marginal position in science uniquely positions them to pursue their science less at the centre of organisms, in the command and control centres of genes, for instance, but more on the margins, in the border regions between organisms and their environments. Furthermore, I think this has contributed to women doing some important, path-breaking science.

One example is an American scientist called Lynn Margulis, who has an arts-and-science educational background and a zigzag career pattern of following a famous husband and mothering four kids. She began with a stubborn interest in the fact that genetic material could be found in certain cellular structures outside chromosomes, something which mainstream scientists dismissed because it didn't fit Mendelian models of genes all tidily housed in the control centre of chromosomes. Pursuing this, she developed a maverick theory of evolution which turns traditional theories on their heads. While normal theories of evolution hinge on competition among species, all of which

Women bring to their work unique perspectives because of their inter-disciplinary

Looking Glass

can trace their ancestry back to one progenitor cell, Dr. Margulis explains evolution as a process of symbiotic relations between microbes which create an environment in which more complex forms of life can emerge, and vestiges of which keep on living in the higher forms of life such as trees and people. (Keller, 1986)

When she first set out her bold new theory of evolution in a book published in 1970, one reviewer commented that "It has to be a young scientist and a woman who dared to challenge the scientific establishment by writing such a book." (Keller, 1986: 48)

Dr. Barbara McClintock has also overturned genetic dogma with her path-breaking theory about jumping genes based on her amazed observation that corn plants don't just grow as a blind expression of static genetic codes; rather they exhibit minute changes as the genetic codes interact with conditions in the world around them. As her biographer Evelyn Fox Keller persuasively argues, this discovery followed from the fact that Dr. McClintock took the time to let the corn plants reveal themselves on their own terms, in the open field, the context of their normal existence, as well as because she empathized with the plants as living beings. She had, in that wonderful phrase which Fox Keller took as the title of this biography, a feeling for the organism. (Keller, 1983)

A third example of a woman who has done breakthrough science by observing life in the border regions is Dr. Margaret McCully, one of Canada's and Carleton University's famous scientists. She discovered, or rather "rediscovered" something called soil sheaths, which are neither animate nor inanimate, organic nor inorganic, but a mixture of root cells, soil bacteria and soil particles held together by the equivalent of mucus secreted by the root. In these soil sheaths, Dr. McCully found an illustration of what seems to be emerging as a crucial modification of Darwin's theories of evolution: namely that organisms don't blindly adapt to their environments or die. Rather organisms interact with the world outside them to create the environment they need for survival. We gather wood and build heated houses to survive Canadian winters. Corn plants construct soil sheaths. To hear Dr. McCully describe it, it's sort of a dialogue between the roots—which she sees as active agents of their own destiny, "working hard" to collect the nutrients they need from the soil—and the "friends" they have in the soil, microbes, which, she says, help unlock the nutrients from the soil so the root can absorb them. It's a complex negotiation and symbiosis. The corn exudes amino acids, sugars, and other "goodies" into the soil to attract the specific type of bacteria and fungi that are needed to break down the soil nutrients the corn plant needs and nourish them while they do this important work. Through careful research with Martin Canny, her colleague in the lab and her husband, she pieced together the general outline of this discovery. (McCully and Canny)

Now, Margaret McCully doesn't like to be thought of as a woman-scientist. But she contributes to and fits the pattern. First, she studied corn in the larger context of the field, and it was due to this that she discovered soil sheaths in the first place. They don't usually grow in the small seedling pots which are used to grow corn in the lab, and if they do, they tend to be washed off as scientists follow lab procedure and rigorously separate research materials from their living context before examining them. Dr. McCully only discovered that her discovery was actually a "rediscovery" when she was flipping through a very old book and saw a drawing dated 1882 demonstrating their existence and naming them. But this knowledge was lost in the move toward modern laboratory science.

Margaret McCully was doing field work in the first place partly because she grew up on a farm, one of the first in Southwestern Ontario to specialize in corn. She entered pure science by way of agriculture, getting a B.Sc. in agriculture from the University of Guelph before doing a master's in plant ecology at the University of Toronto and a Ph.D. in cell biology at Harvard. Although the Harvard experience trained her for a life of pure laboratory research, she found herself going against that grain into fieldwork. She did this partly because her eclectic background (in agriculture) made it possible for her to do work outside the lab, and partly because her farm childhood kept pulling her back to the larger context of the fields in

experience as well as their tendency to be relegated to the margins of science.

which corn is grown. As she told me: "I'd always wanted to go back and apply what I knew to the real thing, corn in the field."

A second aspect of science through her looking glass is that science as a social process is embedded in collegial if not loving personal relationships. To illustrate this theme, I want to talk about Mileva Einstein Maric, Albert Einstein's first wife. Mileva Einstein's story is fascinating because it so dramatically illustrates the exclusion of women from recognition as scientists. There is considerable evidence to indicate that Mileva Maric was the co-author of a key paper which won Albert Einstein fame and the Nobel prize for the theory of relativity. Although she was not honoured by the Nobel committee, nor publicly recognized at the time by Albert himself, he fulfilled a promise he'd made to her at the time of their divorce, and sent her the entire Nobel prize money, something which only came to light much later, many years after Mileva had died in poverty and obscurity. (Troemel-Ploetz)

This is a clear-cut case of exclusion, with Mileva as its victim. But the story becomes even more fascinating if one looks at it from Mileva Maric's point of view. Instead of seeing a woman stripped of recognition as a scientist *the same* as Albert, consider her as someone who followed her own quite different sense of being a scientist. I think she succeeded in being true to those terms, even though that meant being rendered invisible as a scientist in the terms that allowed Albert to be so honoured.

Mileva's sense of herself as a scientist was quite in keeping with the conception of science that prevailed before the influences of industrialism, commercialism, and atomistic individualism in the modern liberal era. Pre-modern science in the Europe that Mileva grew up in was still very much a personal vocation with the scientific activity flowing from all that you were as a person. It was practised in the domestic sphere, with the living room or "salon" as a major centre of scientific discourse (Outram, 27), and with women acting as patrons of scientists as well as men. (Outram, 22) Mileva broke off her own doctoral studies to work with Albert and be his patron. As she put it, "we are both ein stein, one stone."[1] (Troemel-Ploetz, 419) Just because Albert Einstein demeaned her by taking advantage of the collaborative oneness he enjoyed with Mileva and, at a more material level, broke his commitments to her both as her husband and as the father of their three children, shouldn't cause us to devalue the cultural priorities with which Mileva shaped her life and pursued her science.

I think vestiges of this pre-modern scientific culture survive today. I detect echoes of it in Roberta Mura's study of Canadian mathematicians where she finds that more women write journal articles cooperatively than their male colleagues.

Similarly, a significant number of women scientists in Anne Innis Dagg and Rachelle Sender Beauchamp's study reported feeling that their approach to research was more collaborative than that of their male colleagues, and that they paid more attention to relationships within their research group.[2] One respondent, a biological anthropologist, noted that she was

It's not the systematized knowledge of facts disembodied from context, but knowledge which is embedded in the process of life and living itself.

"much less likely to use terms of ownership over graduate students..." Another said: "I always share my methods and ideas, and am repeatedly shocked and surprised when a colleague (a male colleague) withholds or protects information." (Dagg and Beauchamp, 15)

But why does this difference in doing science as social process and social relations persist, especially among women? It may be explained simply by the fact that when modern science followed modern economics out of the home into the "public" sphere of formally specialized institutions, women as a group were left behind. As long as the household continues to function according to the more traditional values that put the social above the strictly economic, and as long as women continue to be socialized and to orient themselves strongly toward that centre of existence, there's a good chance that these influences will filter into the science that women do. Thereby, they will end up preserving and applying vestiges of a pre-modern scientific mindset.

This brings me to the third, and possibly the most subtle of the looking-glass differences I want to discuss here: the orientation of the individual scientist in seeking to know the world scientifically.

Science in tribal society was embedded in the context of everyday life. It was the science of roots and the technology of using fire-hardened digging sticks to get at those roots. (Stanley) It was the science of plants women cultivated from seeds they selected from the best they found in the wild. It was the science of knowing when to harvest the leaves, the roots or the seeds, how to treat them to neutralize any poisons they contained and to release the nutrients into the human metabolism. (Weiner) As well, it was the science of herbal medicines both to prevent and to treat illness and disease. One rather amusing indicator that women were health as well as food scientists of the time is the abundance of herbal treatments for things related to child bearing. In fact, when I look at the variety of herbal medicines they had to ease the pain of child birth, to bring on contractions or slow them down, to help expel the afterbirth, to bring on sleep after giving birth, to treat colic and so on.... And then there are the treatments to bring on a miscarriage, to prevent conception. It goes on and on... (Weiner) I'm tempted to conclude that women had better health care then than we do now through modern medical science.

We also know from the annals of Jacques Cartier that in the winter of 1535 when his men were dying of scurvy, he asked the native people for help. In his journal, he recorded watching two women bring ten or twelve branches of black spruce, strip the bark and leaves, and boil this to prepare a tonic. After drinking this every other day for six days, Cartier's men recovered. (Weiner, 5)

But to get a feel for these pre-literate people's scientific knowledge on their own terms, you have to listen to the stories that were passed down from generation to generation through their oral culture. As feminist science historian Autumn Stanley argues, you have to take seriously the ancient mythologies.

What you get in these old stories is not the definitive stuff of modern science under the bright lights of a laboratory, but almost the obverse of this. It's not the systematized knowledge of facts disembodied from context, but knowledge which is embedded in the process of life and living itself, where what's known is still, like the tip of the iceberg and the stalk of the corn plant, attached to all that lies unknown under the surface.

For example, the tree is the symbol of native science. As Pam Colorado writes: "To the Indian, the tree is the first person on earth. Indeed, the tree which oxygenated earth's atmosphere, is the precursor to our human existence." Accordingly, she goes on to say, the tree "is a respected elder." (52)

What I find fascinating is how much this truth, having been sensed and communicated by pre-literate science, is now being explicated through the instruments of present-day science. You cannot draw a direct connection between this mythic statement about the symbiotic evolutionary link between trees and humankind and the work of scientists such as Lynn Margulis, Barbara McClintock and Margaret McCully. But there is a connection, and it's worth thinking about.

To receive knowledge of this sort, to participate in this way of knowing requires a certain posture on the part of the knower: a posture of attentive listening, and openness to what is being revealed, by the corn plant, by the animal, by the patterns of wind and weather. As Pam Colorado explains it, this is central to native science, both flowing from its sacral nature and extending to its traditions of apprenticeship. A contract of apprenticeship is entered into and is a bond of trust and respect between the elder and the apprentice. As the relationship grows, the elder tells stories revealing (not explaining or proving) the connectedness between all things. As the apprentice senses the truth of these stories, he or she also learns to sense the relationships and feel the connections in the life around her. From listening to the defined words of the elder, the native scientist is able to sense the indefinite speech of the trees, the soil around its roots, the wind and sun in its branches.

What I also find fascinating is how you can find traces and echoes of this approach to science carrying on through history even into the present day. In the days when Descartes' ideas of a mechanistic world of inert matter were emerging as the central motif of modern science, Anne Conway was one of the most eloquent voices in mid-17th. century scientific discourse who was resisting this. As Margaret Alic writes of her in *Hypatia's Heritage,* "Conway denied this distinction between matter and spirit, viewing them as inextricably entwined. To her, nature was a living entity, made up of individual monads, endowed with a vital force and organized and integrated by the Cosmic Order."(7)

Another echo comes through the science associated with women in the religious orders. This is one of the areas that I researched for this talk, but I didn't come up with much myself. I did discover something quite fascinating in a Ph.D. thesis by

To receive knowledge of this sort, to participate in this way of knowing requires a posture of attentive listening, and openness to what is being revealed.

Elizabeth Smyth at the Ontario Institute for Studies in Education on the Sisters of St. Joseph in Toronto. It is revealed in the philosophy of science that was pursued in the girls' school run by the Sisters since 1854. According to the Constitution of 1881, advancing in "piety and virtue" was to go hand in hand with advancing in scientific knowledge. Dr. Smyth quotes from the obituary of Mother Bernard Dinan, one of the four initial members of the Toronto community who believed that "Science is but the handmaid of religion and...both should blend to cultivate the mind and teach the heart."(145)

There are shades here of both the sacral view of life and knowledge, and of the importance of cultivating a respectful receiving aspect in the student of knowledge. This latter theme is also generally apparent in the culture of pre-modern science. From what I've read about the domestic salons as sites both of scientific discourse and of learning, it seems that the patrons acted much like the elders which Pam Colorado describes in native science. In an account of these 18th and 19th century salons in Europe, Dorinda Outram writes that "women, just as much as the male patron, provided....a medium through which the aspiring young savant could locate his [or her] authentic self...authentic selfhood was seen as the sine qua non of the ability to view the natural world correctly." (29)

As well, there are echoes of the accepting attitude toward the unknown in some of the differences which Anne Innis Dagg and Rachelle Sender Beauchamp discovered in their survey of Canadian women scientists, specifically in their inclination to go back to "square one," to pay attention to what is still unexplained and to tolerate ambiguity "more than most men." (11)

This is what prompts scientists like Margaret McCully, Barbara McClintock and Lynn Margulis to let research subjects speak (or reveal themselves) on their own terms. It's that spirit or scientific posture which makes for ethical, accountable, participatory research.

Consider the implications of the image I've been tracing, not just for women aspiring to careers in science, but for men as well. What if the majority not only of women but of men wanted to follow this pattern: pursuing scientific questions in context, putting the process ahead of the product, listening and attending to research subjects in a posture of respectful acceptance of difference and ambiguity? Are the grant-giving bodies and other institutions geared to this sort of scientist? Is the environment hospitable and conducive to a long and productive career along these lines? Or does it obstruct, suppress, and destroy such a career, such a scientist?

Heather Menzies is an Ottawa-based writer who also teaches Women's Studies and Canadian Studies at Carleton University. Her forthcoming book, By the Labour of their Hands, *is a history of cheddar cheese making in rural Ontario.* *This article is a revised version of a paper given at Carleton University's Institute of*

Women's Studies' lecture series on women in science and technology.

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[1]The first and only biography written about Mileva Einstein-Maric was written by a retired Serbian mathematician, Desanka Trbuhovic-Gjuric, as a labour of love and respect; it was published in 1969. It remained fairly inaccessible to Western readers until a German translation from the original Serbian was published in 1988.

[2]I am reminded of something Bronwen Wallace said about her artistic work as a poet. "Women get criticized for only writing about relationships, but it seems that understanding relationships is a big part of understanding who we are...I am talking about relationships in its biggest term, not just relationships between men and women, but our relationship to other animals and our relationship to our planet and our relationship to other countries." (57).

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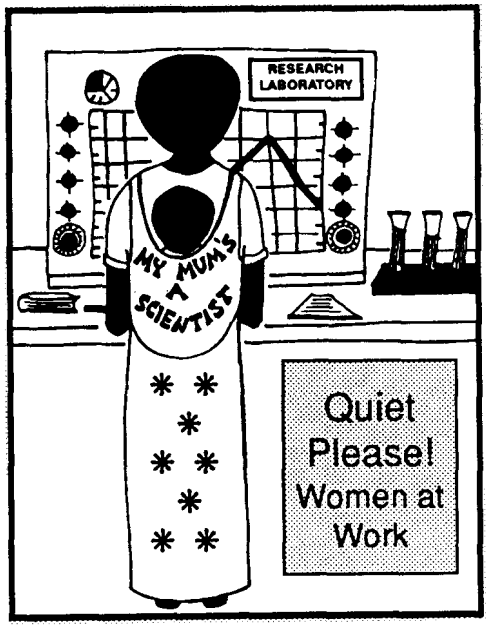

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