2. Science, Nature and Gender

The recovery of the feminine principle is an intellectual and political challenge to maldevelopment as a patriarchal project of domination and destruction, of violence and subjugation, of dispossession and the dispensability of both women and nature. The politics of life centred on the feminine principle challenges fundamental assumptions not just in political economy, but also in the science of life-threatening processes.

Maldevelopment is intellectually based on, and justified through, reductionist categories of scientific thought and action. Politically and economically each project which has fragmented nature and displaced women from productive work has been legitimised as 'scientific' by operationalising reductionist concepts to realise uniformity, centralisation and control. Development is thus the introduction of 'scientific agriculture', 'scientific animal husbandry', 'scientific water management' and so on. The reductionist and universalising tendencies of such 'science' become inherently violent and destructive in a world which is inherently interrelated and diverse. The feminine principle becomes an oppositional category of non-violent ways of conceiving the world, and of acting in it to sustain all life by maintaining the interconnectedness and diversity of nature. It allows an ecological transition from violence to non-violence, from destruction to creativity, from anti-life to life-giving processes, from uniformity to diversity and from fragmentation and reductionism to holism and complexity.

It is thus not just 'development' which is a source of violence to women and nature. At a deeper level, scientific knowledge, on which the development process is based, is itself a source of violence. Modern reductionist science, like development, turns out to be a patriarchal project, which has excluded women as experts, and has simultaneously excluded ecological and holistic ways of

knowing which understand and respect nature's processes and interconnectedness *as science*.

Modern science as patriarchy's project

Modern science is projected as a universal, value-free system of knowledge, which has displaced all other belief and knowledge systems by its universality and value neutrality, and by the logic of its method to arrive at objective claims about nature. Yet the dominant stream of modern science, the reductionist or mechanical paradigm, is a particular response of a particular group of people. It is a specific project of western man which came into being during the fifteenth and seventeenth centuries as the much-acclaimed Scientific Revolution. During the last few years feminist scholarship has begun to recognise that the dominant science system emerged as a liberating force not for humanity as a whole (though it legitimised itself in terms of universal betterment of the species), but as a masculine and patriarchal project which necessarily entailed the subjugation of both nature and women. Harding has called it a 'western, bourgeois, masculine project',[1] and according to Keller

> Science has been produced by a particular sub-set of the human race, that is, almost entirely by white, middle class males. For the founding fathers of modern science, the reliance on the language of gender was explicit; they sought a philosophy that deserved to be called 'masculine', that could be distinguished from its ineffective predecessors by its 'virile' powers, its capacity to bind Nature to man's service and make her his slave.[2]

Bacon (1561-1626) was the father of modern science, the originator of the concept of the modern research institute and industrial science, and the inspiration behind the Royal Society. His contribution to modern science and its organisation is critical. From the point of view of nature, women and marginal groups, however, Bacon's programme was not humanly inclusive. It was a special programme benefitting the middle class, European, male entre-

[1] Susan Harding, *The Science Question in Feminism*, Ithaca: Cornell University Press, 1986, p. 8.

[2] Evelyn F. Keller, *Reflections on Gender and Science*, New Haven: Yale University Press, 1985, p. 7.

preneur through the conjunction of human knowledge and power in science.

In Bacon's experimental method, which was central to this masculine project, there was a dichotomising between male and female, mind and matter, objective and subjective, rational and emotional, and a conjunction of masculine and scientific dominating over nature, women and the non-west. His was not a neutral', 'objective', 'scientific' method — it was a masculine mode of aggression against nature and domination over women. The severe testing of hypotheses through controlled manipulations of nature, and the necessity of such manipulations if experiments are to be repeatable, are here formulated in clearly sexist metaphors. Both nature and inquiry appear conceptualized in ways modelled on rape and torture — on man's most violent and misogynous relationships with women — and this modelling is advanced as a reason to value science. According to Bacon 'the nature of things betrays itself more readily under the vexations of art than in its natural freedom.'[3] The discipline of scientific knowledge and the mechanical inventions it leads to, do not 'merely exert a gentle guidance over nature's course; they have the power to conquer and subdue her, to shake her to her foundations'.[4]

In *Tempores Partus Masculus* or *The Masculine Birth of Time*, translated by Farrington in 1951, Bacon promised to create 'a blessed race of heroes and supermen' who would dominate both nature and society.[5] The title is interpreted by Farrington as suggesting a shift from the older science, represented as female — passive and weak — to a new masculine science of the scientific revolution which Bacon saw himself as heralding. In *New Atlantis*, Bacon's Bensalem was administered from Solomon's House, a scientific research institute, from which male scientists ruled over and made decisions for society, and decided which secrets should be revealed and which remain the private property of the institute.

Science-dominated society has evolved very much in the pattern of Bacon's Bensalem, with nature being transformed and mutilated in modern Solomon's Houses — corporate labs and the university

[3] F.H. Anderson, (ed.), *Francis Bacon: The New Organon and Related Writings*, Indianapolis: Bobbs-Merrill, 1960, p. 25.

[4] J. Spedding, *et. al.* (eds.) *The Works of Francis Bacon* (Reprinted), Stuttgart: F.F. Verlag, 1963, Vol. V, p..506.

[5] Quoted in Keller, *op. cit.*, pp. 38-39.

programmes they sponsor. With the new biotechnologies, Bacon's vision of controlling reproduction for the sake of production is being realised, while the green revolution and the bio-revolution have realised what in *New Atlantis* was only a utopia.

'We make by act trees and flowers to come earlier or later than their seasons, and to come up and bear more speedily than by their natural course they do. We make them by act greater, much more than their nature, and their fruit greater and sweeter and of differing taste, smell, colour and figure from their nature.'[6] For Bacon, nature was no longer Mother Nature, but a female nature, conquered by an aggressive masculine mind. As Carolyn Merchant points out, this transformation of nature from a living, nurturing mother to inert, dead and manipulable matter was eminently suited to the exploitation imperative of growing capitalism. The nurturing earth image acted as a cultural constraint on exploitation of nature. 'One does not readily slay a mother, dig her entrails or mutilate her body.' But the mastery and domination images created by the Baconian programme and the scientific revolution removed all restraint and functioned as cultural sanctions for the denudation of nature.

> The removal of animistic, organic assumptions about the cosmos constituted the death of nature — the most far-reaching effect of the scientific revolution. Because nature was not viewed as a system of dead, inert particles moved by external, rather than inherent forces, the mechanical framework itself could legitimate the manipulation of nature. Moreover, as a conceptual framework, the mechanical order had associated with it a framework of values based on power, fully compatible with the directions taken by commercial capitalism.[7]

Modern science was a consciously gendered, patriarchal activity. As nature came to be seen more like a woman to be raped, gender too was recreated. Science as a male venture, based on the subjugation of female nature and female sex provided support for the polarisation of gender. Patriarchy as the new scientific and technological power was a political need of emerging industrial capitalism.

[6] Carolyn Merchant, *The Death of Nature : Women, Ecology and the Scientific Revolution*, New York: Harper & Row, 1980, p. 182.

[7] Merchant, *op. cit.*, p. 193.

While on the one hand the ideology of science sanctioned the denudation of nature, on the other it legitimised the dependency of women and the authority of men. Science and masculinity were associated in domination over nature and feminity, and the ideologies of science and gender reinforced each other. The witch-hunting hysteria which was aimed at annihilating women in Europe as knowers and experts was cotemporous with two centuries of scientific revolution. It reached its peak with Galileo's *Dialogue* concerning the Two Chief World Systems and died with the emergence of the Royal Society of London and the Paris Academy of Sciences.[8]

> The interrogation of witches as a symbol for the interrogation of nature, the courtroom as model for its inquisition, and torture through mechanical devices as a tool for the subjugation of disorder were fundamental to the scientific method as power. For Bacon, as for Harvey, sexual politics helped to structure the nature of the empirical method that would produce a new form of knowledge and a new ideology of objectivity seemingly devoid of cultural and political assumptions.[9]

The Royal Society, inspired by Bacon's philosophy, was clearly seen by its organisers as a masculine project. In 1664, Henry Oldenberg, Secretary of the Royal Society announced that the intention of the society was to 'raise a *masculine philosophy*. . . whereby the Mind of Man may be ennobled with the knowledge of solid Truths'.[10] And for Glanvill, the masculine aim of science was to know 'the ways of captivating Nature, and making her subserve our purposes, thereby achieving the Empire of Man Over Nature.'[11] Glanvill advocated chemistry as one of the most useful arts for 'by the *violence* of its artful fires it is made to confess those latent parts, which upon less provocation it would not disclose.'[12] The 'de-mothering' of nature through modern science and the marriage of knowledge with power was simultaneously a source of subjugating women as well

[8] Brian Easlea, *Science and Sexual Oppression: Patriarchy's Confrontation with Woman and Nature*, London: Weidenfeld and Nicholson, 1981, p. 64.
[9] Merchant, *op. cit.*, p. 172.
[10] Easlea, *op. cit.*, p. 70.
[11] Easlea, *op. cit.*, p. 70.
[12] Merchant, *op. cit.*, p. 189.

as non-European peoples. Robert Boyle, the famous scientist who was also the Governor of the New England Company, saw the rise of mechanical philosophy as an instrument of power not just over nature but also over the original inhabitants of America. He explicitly declared his intention of ridding the New England Indians of their ridiculous notions about the workings of nature. He attacked their perception of nature, 'as a kind of goddess', and argued that 'the veneration, wherewith men are imbued for what they call nature, has been a discouraging impediment to the empire of man over the inferior creatures of God'.[13]

Today, with new ecological awareness, ecologists the world over turn to the beliefs of native American and other indigenous peoples as a special source for learning how to live in harmony with nature. There are many today from the ecology and women's movements who see irrationality in Boyle's impulse for the empire of white man over nature and other peoples, and who see rationality in the words of Indian Chief Smohalla when he cried out: 'You ask me to plough the ground: shall I take a knife and tear my mother's bosom? You ask me to cut grass and make hay and sell it and be rich like white men; but how dare I cut off my mother's hair?'[14]

Chief Seattle's letter, which has become a major inspiration for the ecology movement states, 'This we know — the earth does not belong to man, man belongs to the earth. All things are connected like the blood which unites one family. Whatever befalls the earth befalls the sons of the earth. Man did not weave the web of life; he is merely a strand in it. Whatever he does to the web, he does to himself.'

The ecological and feminist alternatives to reductionist science are clearly not the first attempts to create a science of nature that is not gendered and disruptive. The period of the scientific revolution itself was full of alternatives to the masculine project of mechanistic, reductionist science, and it was also full of struggles between gendered and non-gendered science. Bacon and Paracelsus are the leading exponents of the two competing trends of modern science in seventeenth century Europe.[15] The Paracelsians belonged to the hermetic tradition which did not dichotomise

[13] Easlea, *op. cit.*, p. 73.
[14] Easlea, *op. cit.*, p. 73.
[15] J.P.S. Oberoi, *The Other Mind of Europe: Goethe as a Scientist*, Delhi: Oxford University Press, 1984.

between mind and matter, male and female. The mechanical school represented by Bacon created dichotomies between culture and nature, mind and matter and male and female, and devised a conceptual strategy for the former to dominate over the latter. The two visions of science were also two visions of nature, power and gender relations. For Paracelsus the male did not dominate over the female, the two complemented each other, and knowledge and power did not arise from dominating over nature but from 'cohabiting with the elements',[16] which were themselves interconnected to form a living organism. For the Paracelsian, 'The whole world is knit and bound within itself: for the world is a living creature, everywhere both female and male,' and knowledge of nature is derived through participating in these interconnections.[17]

With the formation of the Royal Society and in the context of emerging industrial capitalism, the contest between the mechanical and hermetic traditions was won by the masculine project which was the project of a particular class. Paracelsus and Bacon did not merely differ in their ideology of gender and science; they were also differently rooted in the politics of class, with Bacon committed to middle class values (finally becoming Lord Chancellor and Bacon Verulam in 1618 in the reign of James I) and identifying with capitalists, merchants and the State in his scientific project, and Paracelsus, on the side of the peasants in their uprising in the Tyrol.[18] Reductionist science became a major agent of economic and political change in the centuries to follow, dichotomising gender and class relations and man's relationship with nature. 'Given the success of modern science, defined in opposition to everything female, fears of both Nature and Woman could subside. With the one reduced to its mechanical substrata, and the other to her sexual virtue, the essence of *Mater* could be both tamed and conquered.'[19]

For more than three centuries, reductionism has ruled as the only valid scientific method and system, distorting the history of the west as well as the non-west. It has hidden its ideology behind projected objectivism, neutrality and progress. The ideology that hides ideology has transformed complex pluralistic traditions of knowledge into a monolith of gender-based, class-based thought

[16] Keller, *op. cit.*, p. 48.
[17] Merchant, *op. cit.*, p. 104.
[18] Oberoi, *op. cit.*, p. 21.
[19] Keller, *op. cit.*, p. 60.

and transformed this particular tradition into a superior and universal tradition to be superimposed on all classes, genders and cultures which it helps in controlling and subjugating. This ideological projection has kept modern reductionist science inaccessible to criticism. The parochial roots of science in patriarchy and in a particular class and culture have been concealed behind a claim to universality, and can be seen only through other traditions — of women and non-western peoples. It is these subjugated traditions that are revealing how modern science is gendered, how it is specific to the needs and impulses of the dominant western culture and how ecological destruction and nature's exploitation are inherent to its logic. It is becoming increasingly clear that scientific neutrality has been a reflection of ideology, not history, and science is similar to all other socially constructed categories. This view of science as a social and political project of modern western man is emerging from the responses of those who were defined into nature and made passive and powerless: Mother Earth, women and colonised cultures. It is from these fringes that we are beginning to discern the economic, political and cultural mechanisms that have allowed a parochial science to dominate and how mechanisms of power and violence can be eliminated for a degendered, humanly inclusive knowledge.

The violence of reductionism

The myth that the 'scientific revolution' was a universal process of intellectual progress is being steadily undermined by feminist scholarship and the histories of science of non-western cultures. These are relating the rise of the reductionist paradigm with the subjugation and destruction of women's knowledge in the west, and the knowledge of non-western cultures. The witch-hunts of Europe were largely a process of delegitimising and destroying the expertise of European women. In 1511, England had an Act of Parliament directed against 'common artificers, as smythes, weavers and women who attempt great cures and things of great difficulties: in the witch they partly use sorcerye and witch-craft'.[20] By the sixteenth century women in Europe were totally excluded from the practice of medicine and healing because 'wise women' ran the

[20] Quoted in Muriel J. Hughes, *Women Healers in Medieval Life and Literature*, New York: Libraries Press, 1968, p. 86.

risk of being declared witches. A deeper, more violent form of exclusion of women's knowledge and expertise, and of the knowledge of tribal and peasant cultures is now under way with the spread of the masculinist paradigm of science through 'development'.

I characterise modern western patriarchy's special epistemological tradition of the 'scientific revolution' as 'reductionist' because it reduced the capacity of humans to know nature both by excluding other knowers and other ways of knowing, and it reduced the capacity of nature to creatively regenerate and renew itself by manipulating it as inert and fragmented matter. Reductionism has a set of distinctive characteristics which demarcates it from all other non-reductionist knowledge systems which it has subjugated and replaced. The basic ontological and epistemological assumptions of reductionism are based on homogeneity. It sees all systems as made up of the same basic constituents, discrete, unrelated and atomistic, and it assumes that all basic processes are mechanical. The mechanistic metaphors of reductionism have socially reconstituted nature and society. In contrast to the organic metaphors, in which concepts of order and power were based on interconnectedness and reciprocity, the metaphor of nature as a machine was based on the assumption of separability and manipulability. As Carolyn Merchant has remarked: 'In investigating the roots of our current environmental dilemma and its connections to science, technology and the economy, we must re-examine the formation of a world-view and a science that, by reconceptualising reality as a machine, rather than a living organism, sanctioned the domination of both nature and women.'[21] This domination is inherently violent, understood here as the violation of integrity. Reductionist science is a source of violence against nature and women because it subjugates and dispossesses them of their full productivity, power and potential. The epistemological assumptions of reductionism are related to its ontological assumptions: uniformity allows the knowledge of parts of a system to be taken as knowledge of the whole. Separability allows context-free abstractionof knowledge and creates criteria of validity based on alienation and non-participation, then projected as 'objectivity'. 'Experts' and 'specialists' are thus projected as the only legitimate knowledge seekers and justifiers.

[21] Merchant, *op. cit.*, p.*xvii.*

Profits, reductionism and violence

The close nexus between reductionist science, patriarchy, violence and profits is explicit in 80 per cent of scientific research that is devoted to the war industry, and is frankly aimed directly at lethal violence — violence, in modern times, not only against the enemy fighting force but also against the much larger civilian population. In this book I argue that modern science is related to violence and profits even in peaceful domains such as, for example, forestry and agriculture, where the professed objective of scientific research is human welfare. The relationship between reductionism, violence and profits is built into the genesis of masculinist science, for its reductionist nature is an epistemic response to an economic organisation based on uncontrolled exploitation of nature for maximization of profits and capital accumulation.

Reductionism, far from being an epistemological accident, is a response to the needs of a particular form of economic and political organisation.[22] The reductionist world-view, the industrial revolution and the capitalist economy were the philosophical, technological and economic components of the same process. Individual firms and the fragmented sector of the economy, whether privately owned or state owned, have only their own efficiency and profits in mind; and every firm and sector measures its efficiency by the extent to which it maximizes its gains, regardless of the maximization of social and ecological costs. The logic of this internal efficiency has been provided by reductionism. Only those properties of a resource system are taken into account which generate profits through exploitation and extraction; properties which stabilise ecological processes but are commercially non-exploitative are ignored and eventually destroyed.

Commercial capitalism is based on specialised commodity production. Uniformity in production, and the uni-functional use of natural resources is therefore required. Reductionism thus reduces

[22] J. Bandyopadhyay & V. Shiva, 'Ecological Sciences: A Response to Ecological Crises' in J. Bandyopadhyay, *et al., India's Environment,* Dehradun : Natraj, 1985, p. 196; and J. Bandyopadhyay & V. Shiva, 'Environmental Conflicts and Public Interest Science,' in *Economic and Political Weekly,* Vol. XXI, No. 2, Jan. 11, 1986, pp. 84-90.

complex ecosystems to a single component, and a single component to a single function. It further allows the manipulation of the ecosystem in a manner that maximizes the single-function, single-component exploitation. In the reductionist paradigm, a forest is reduced to commercial wood, and wood is reduced to cellulose fibre for the pulp and paper industry. Forests, land and genetic resources are then manipulated to increase the production of pulpwood, and this distortion is legitimised scientifically as overall productivity increase, even though it might decrease the output of water from the forest, or reduce the diversity of life forms that constitute a forest community. The living and diverse ecosystem is thus violated and destroyed by 'scientific' forestry and forestry 'development'. In this way, reductionist science is at the root of the growing ecological crisis, because it entails a transformation of nature such that its organic processes and regularities and regenerative capacities are destroyed.

Women in sustenance economies, producing and reproducing wealth in partnership with nature, have been experts in their own right of a holistic and ecological knowledge of nature's processes. But these alternative modes of knowing, which are oriented to social benefits and sustenance needs, are not recognised by the reductionist paradigm, because it fails to perceive the interconnectedness of nature, or the connection of women's lives, work and knowledge with the creation of wealth.

The rationality and efficacy of reductionist and non-reductionist knowledge systems are never *evaluated* cognitively. The rationality of reductionist science is, a priori, declared superior. If reductionist science has displaced non-reductionist modes of knowing, it has done so not through cognitive competition, but through political support from the state : development policies and programmes provide the financial and material subsidies *as well as* the ideological support for the appropriation of nature for profits. Since the twin myths of progress (material prosperity) and superior rationality lost their sheen in the working out of development patterns and paradigms, and were visibly exploded by widespread ecological crises, the state stepped in to transform the myths into an ideology. When an individual firm or sector directly confronts the larger society in its appropriation of nature on grounds of progress and rationality, people can assess social costs and private benefits for themselves; they can differentiate between progress and regression, rationality and irrationality. But with the mediation of the state, subjects and citizens become objects of change rather than its determinants, and consequently lose both the capability and the right to assess progress. If they have to bear the costs instead of reaping the benefits of 'development', this is justified as a minor sacrifice for the 'national interest'.

The nexus between the state, the dominant elite and the creation of surplus value provides the power with which reductionism establishes its supremacy. Institutions of learning in agriculture, medicine and forestry, selectively train people in the reductionist paradigms, in the name of 'scientific' agriculture, medicine and forestry to establish the superiority of reductionist science. Stripped of the power the state invests it with, reductionism can be seen to be cognitively weak and ineffective in responding to problems posed by nature. Reductionist forestry has destroyed tropical forests, and reductionist agriculture is destroying tropical farming. As a system of knowledge about nature or life reductionist science is weak and inadequate; as a system of knowledge for the market, it is powerful and profitable. Modern science, as we have noted earlier, has a world-view that both supports and is supported by the socio-political-economic system of western capitalist patriarchy which dominates and exploits nature, women and the poor.

The ultimate reductionism is achieved when nature is linked with a view of economic activity in which money is the only gauge of value and wealth. Life disappears as an organising principle of economic affairs. But the problem with money is that it has an asymmetric relationship to life and living processes. Exploitation, manipulation and destruction of the life in nature can be a source of money and profits but neither can ever become a source of nature's life and its life-supporting capacity. It is this asymmetry that accounts for a deepening of the ecological crises as a decrease in nature's life-producing potential, along with an increase of capital accumulation and the expansion of 'development' as a process of replacing the currency of life and sustenance with the currency of cash and profits. The 'development' of Africa by western experts is the primary cause for the destruction of Africa; the 'development' of Brazil by transnational banks and corporations is the primary cause for the destruction of the richness of Amazonian rainforests, the highest expression of life. Natives of Africa and Amazonia had survived over centuries with their ecologically evolved, indigenous

knowledge systems. What local people had conserved through history, western experts and knowledge destroyed in a few decades, a few years even.

It is this destruction of ecologies and knowledge systems that I characterise as the violence of reductionism which results in: *a) Violence against women:* women, tribals, peasants as the knowing subject are violated socially through the expert/non-expert divide which converts them into non-knowers even in those areas of living in which through daily participation, they are the real experts — and in which responsibility of practice and action rests with them, such as in forestry, food and water systems. *b) Violence against nature:* nature as the object of knowledge is violated when modern science destroys its integrity of nature, both in the process of perception as well as manipulation. *c) Violence against the beneficiaries of knowledge:* contrary to the claim of modern science that people in general are ultimately the beneficiaries of scientific knowledge, they — particularly the poor and women — are its worst victims, deprived of their productive potential, livelihoods and life-support systems. Violence against nature recoils on man, the supposed beneficiary. *d) Violence against knowledge:* in order to assume the status of being the only legitimate mode of knowledge, rationally superior to alternative modes of knowing, reductionist science resorts *to the suppression and falsification of facts* and thus commits violence against science itself. It declares organic systems of knowledge irrational, and rejects the belief systems of others without full rational evaluation. At the same time it protects itself from the exposure and investigation of the myths it has created by assigning itself a new sacredness that forbids any questioning of the claims of science.

Two kinds of facts

The conventional model of science, technology and society locates sources of violence in politics and ethics, in the *application* of science and technology, not in scientific knowledge itself. The assumed dichotomy between values and facts underlying this model implies a dichotomy between the world of values and the world of facts. In this view, sources of violence are located in the world of values while scientific knowledge inhabits the world of facts.

The fact-value dichotomy is a creation of modern reductionist

science which, while being an epistemic response to a particular set of values, posits itself as independent of values. By splitting the world into facts vs. values, it conceals the real difference between two kinds of value-laden facts. Modern reductionist science is characterized in the received view as the discovery of the properties and laws of nature in accordance with a 'scientific' method which generates claims of being 'objective,' 'neutral' and 'universal'. This view of reductionist science as being a description of reality *as it is*, unprejudiced by value, is being rejected increasingly on historical and philosophical grounds. It has been historically established that all knowledge, including modern scientific knowledge, is built on the use of a plurality of methodologies, and reductionism itself is only one of the scientific options available.

> There is no 'scientific method'; there is no single procedure, or set of rules that underlies every piece of research and guarantees that it is scientific and, therefore, trustworthy. The idea of a universal and stable method that is an unchanging measure of adequacy and even the idea of a universal and stable rationality is as unrealistic as the idea of a universal and stable measuring instrument that measures any magnitude, no matter what the circumstances. Scientists revise their standards, their procedures, their criteria of rationality as they move along and enter new domains of research just as they revise and perhaps entirely replace their theories and their instruments as they move along and enter new domains of research.[23]

The assumption that science deals purely with facts has no support from the practise of science itself. The 'facts' of reductionist science are socially constructed categories which have the cultural markings of the western bourgeois, patriarchal system which is their context of discovery and justification. Carolyn Merchant has shown how, until the sixteenth century in the west, organic metaphors were considered scientific and sane. 'An organically oriented mentality in which female principles played an important role was undermined and replaced by a mechanically oriented mentality that either eliminated or used female principles in an exploitative manner. As western culture became increasingly mechanized in the 1600s, the female earth and virgin earth spirit were subdued by

[23]Paul Feyerband, *Science in a Free Society:* New Left Books, 1978, p. 10.

the machine.'[24] The subjugation of other traditions of knowledge is similarly a displacement of one set of culturally constituted facts of nature by another, not the substitution of 'superstition' by 'fact'. The cultural categories of scientific knowledge are not merely cognitive, they are also ethical.

Whereas the nurturing earth image can be viewed as a cultural constraint restricting the types of socially and morally sanctioned human actions allowable with respect to the earth, the new images of mastery and domination functioned as cultural sanctions for the denudation of nature. Controlling images which construct facts also operate as ethical restraints or sanctions as subtle 'oughts' and 'ought-nots'.

In the Third World, the conflict between reductionist and ecological perceptions of the world are a contemporary and everyday reality, in which western trained male scientists and experts epitomise reductionist knowledge. The political struggle for the feminist and ecology movements involves an epistemological shift in the criteria of assessment of the rationality of knowledge. The worth and validity of reductionist claims and beliefs need to be measured against ecological criteria when the crisis of sustainability and survival is the primary intellectual challenge. The view of reductionist scientific knowledge as a purely factual description of nature, superior to competing alternatives, is found to be ecologically unfounded. Ecology perceives relationships between different elements of an ecosystem: what properties will be selected for a particular resource element will depend on what relationships are taken as the context defining the properties. The context is fixed by priorities and values guiding the perception of nature. Selection of the context is a value determined process and the selection in turn determines what properties are seen. There is nothing like a neutral fact about nature *independent of the value determined by human cognitive and economic activity.* Properties perceived in nature will depend on how one looks and how one looks depends on the economic interest one has in the resources of nature. The value of profit maximization is thus linked to reductionist systems, while the value of life and the maintenance of life is linked to holistic and ecological systems.

[24] Merchant, *op. cit.*, p. 2.

Two kinds of rationality

The ontological and epistemological components of the reductionist world-view provide the framework for a particular practice of science. According to Descartes, 'Method consists entirely in the order as a disposition of the objects towards which our mental vision must be directed if we would find out any truth. We shall comply with it exactly if we *reduce* involved and obscure propositions step by step to those that are simpler, and then starting with the intuitive apprehension of all those that are absolutely simple, attempt to ascend to the knowledge of all others by precisely similar steps.'[25] This method was, in Descartes' view, the method to 'render ourselves the masters and possessors of nature'. Yet it singularly fails to lead to a perception of reality (truth) in the case of living organisms such as nature (including man), in which the whole is not merely the sum of parts, because parts are so cohesively inter-related that isolating any one distorts the whole.

Kuhn, Feyerband, Polanyi and others have convincingly argued that modern science is not practised according to a well defined and stable scientific method; all that can be granted it is that it is a single mode of thought, among many.

The controlled experiment and the laboratory are a central element of the methodology of reductionist science. The object of study is arbitrarily isolated from its natural surroundings, from its relationship with other objects and the observer(s). The context (the value framework) so provided determines what properties are perceived, and leads to a particular set of beliefs. The Baconian programme of domination over nature was centrally based on the controlled experiment which was formulated and conceived in the language and metaphor of rape, torture and the inquisition. The 'controlled' experiment was therefore a political choice, aimed at control of nature and exclusion of other ways of knowing. It was assumed that the truth of nature was more accessible through violence, and it was recognised that this truth is a basis of power. In this way, 'human knowledge and human power meet as one'.[26] Sandra Harding has characterised this as the contemporary 'alliance of perverse knowledge claims with the perversity of dominating power'.

[25] Descartes, *A Discourse on Method,* London: Everymans, 1981, p. *xv.*
[26] Quoted in Merchant, *op. cit.*, p. 171.

The knowledge and power nexus is inherent to the reductionist system because the mechanistic order, as a conceptual framework, was associated with a set of values based on power which were compatible with the needs of commercial capitalism. It generates inequalities and domination by the way knowledge is generated and structured, the way it is legitimised, and by the way in which such knowledge transforms nature and society. The domination of the South by the North, of women by men, of nature by westernised man are now being identified as being rooted in the domination inherent to the world-view created by western man over the last three centuries through which he could subjugate or exclude the rest of humanity on grounds of humanity. As Harding observes,

> We can now discern the effects of these cultural markings in the discrepancies between the methods of knowing and the interpretations of the world provided by the creators of modern western culture and those characteristic of the rest of us. Western culture's favoured beliefs mirror in sometimes clear and sometimes distorting ways not the world as it is or as we might want it to be, but the social projects of their historically identifiable creators.[27]

Exclusion of other traditions of knowledge by reductionist science is threefold : *(i)* ontological, in that other properties are just not taken note of; *(ii)* epistemological, in that other ways of perceiving and knowing are not recognized; and *(iii)* sociological, in that the non-specialist and non-expert is deprived of the right both to access to knowledge and to judging claims made on its behalf. All this is the stuff of politics, not science. Picking *one* group of people (the specialists), who adopt *one* way of knowing the physical world (the reductionist), to find *one* set of properties in nature (the mechanistic) is a political, not a scientific mode. Knowledge so obtained is presented as 'the laws of nature', wholly 'objective ' and altogether universal. Feyerband is therefore right in saying: 'The *appearance* of objectivity that is attached to some value judgements comes from the fact that a particular tradition is *used* but not recognised. Absence of the impression of subjectivity is not proof of objectivity, but an oversight.' The 'controlled' experiment which was assumed to be a mode for 'neutral' observation

[27] Harding, *op. cit.*, p. 15.

was, in effect, a political tool for exclusion such that people's experimentation in their daily lives was denied access to the status of the scientific.

It is argued in defence of modern science that it is not science itself but the political misuse and unethical technological application of it that lead to violence. The speciousness of this argument was always clear, but it is totally untenable today, when science and technology have become cognitively inseparable and the amalgam has been incorporated into the scientific-military-industrial complex of capitalist patriarchy. The fragmentation of science into a variety of specializations and sub-specializations is used as a smoke-screen to blur the perception of this linkage between science and a particular model of social organisation, that is, a particular ideology. Science claims that since scientific truths are verifiable and neutral, they are justified beliefs and therefore universal, regardless of the social context. Yet from the perspective of subjugated traditions, the 'truths' of reductionism are falsehoods for the subjugated. Why should we regard the emergence of modern science as a great advance for humanity when it was achieved only at the cost of a deterioration in social status for most of humanity including women and non-western cultures? Sandra Harding, locating the culture of destruction and domination in science-as-usual, not in bad science, asks,

> Could the uses of science to create ecological disaster, support militarism, turn human labour into physically and mentally mutilating work, develop ways of controlling 'others' — the colonised, the women, the poor — be just misuses of applied science? Or does this kind of conceptualisation of the character and purposes of experimental method ensure that what is called bad science or misused science will be a distinctively masculinist science as usual?[28]

Modern science and ecological crises

The supernatural-natural divide. It was not so long ago that most philosophers, sociologists and anthropologists, both western and non-western, relegated all traditional thought to the realm of the supernatural, the mystical and the irrational. Modern science, in contrast, was uniquely posed as natural, material, empirical,

[28] Harding, *op. cit.*, p. 102.

rational. Scientists, in accordance with an abstract scientific method, were viewed as putting forward statements corresponding to the realities of a directly observable world. The theoretical concepts in their discourse were in principle seen as reducible to directly verifiable observational claims. Of course, an elementary investigation into the nature of scientific theories showed that such a reduction was not possible and, instead, it was pervasive theoretical presuppositions which determined observation and facts. Further, the lack of existence of a theoretically neutral observational vocabulary excluded the possibility of definite and conclusive verification of theoretical claims. Scientific claims, like all others, were slowly recognised as arising not in accordance with a verificationist model but from the commitment of a specialist community of scientists to presupposed metaphors and paradigms which determined the meaning of constituent terms, concepts and the status of observation and facts. Meaning and validity were controlled by the social world of scientists and not by the natural world. These new accounts of modern science left no criteria to distinguish between the myths of traditional thought and the metaphors of modern science, between supernatural entities presupposed by traditional communities and theoretical entities presupposed by modern scientists.

Thus, awareness of and familiarity with the theorising and practise of both modern science and traditional thought forces a collapse in the distinction between the supernatural and natural, the irrational and rational, the social and scientific. It removes modern science from its presumed privileged epistemological status, and elevates traditional thought to the status of ethno-science, because it constitutes legitimate ways of knowing and because its claims are expressed in the everyday languages of the people and are influenced by the structures of their languages. To that extent they are particular to each society and its people. However, though theoretical explanation in traditional thought is now recognised as being about the natural and not the supernatural domain, and is of the same epistemological status as explanation in modern scientific thought, its cognitive power is seen as inferior to that of the latter. There are, however, a number of problems in holding on to such a perspective on the cognitive superiority of modern science while conceding epistemological status to traditional and modern belief systems.

Firstly, as Kuhn[29] has shown, scientists are not in practice typically and consistently aware of the existence of alternatives in any case. Science is not nearly as open as has been popularly thought. Scientific inquiry does not range freely amongst boundless alternatives as the popular image suggests, but at any given time is constrained by the currently dominant paradigm. On the other hand, one knows so little about traditional beliefs, especially in the diachronic perspective, that claims about their stagnation, lack of creativity etc., can only be speculation. Thus one cannot legitimately talk of the 'open' and 'closed' predicament but merely of rapidly versus slowly changing belief systems.

Why should more change in thinking per se amount to more rational and cognitively superior theorising? Popper's falsificationism seems to identify the willingness to give up beliefs with a critical spirit, and hence rapidly changing belief systems are viewed as evolving towards more rational and objective claims. However, this view of progress-through-revolution again faces problems. If, following Kuhn, scientific change is guided by social and political factors and not by purely logical and empirical criteria provided by an abstract scientific method, it becomes difficult to conceive how change in itself ensures progress. Even in Popper's unworldly third world of ideas and knowledge, it is therefore not possible to defend the claim that the higher the turnover of beliefs, the more rational one's beliefs will be. In the real world, however, where ideas and beliefs act as guides to action, and play a transformative as well as an interpretive role, too rapid a change in belief systems at times becomes a sign of irrationality and irresponsibility rather than rationality and a critical spirit. The most glaring example of such irrationality and irresponsibility is the situation of contemporary ecological crises. While traditional belief systems did, in rare cases, lead to material transformation of the environment that led to ecological disasters, in most cases ethno-sciences have proved to be adequate in maintaining societies and nature. On the other hand, threatening the conditions of natural and human sustenance through human intervention seems to be the rule rather than the exception in modern scientific thought and the practise it gives rise to, especially in fields dealing with health, food produc-

[29] T. Kuhn, *The Structure of Scientific Revolution*, Chicago: University of Chicago Press, 1972.

tion and food consumption.

The new philosophies of science which have broken down the supernatural-natural divide and the society-science dualism, and have established epistemological equivalence between ethno-science and modern science, have however created models which do not allow one to discuss the status of beliefs about nature in the materialist perspective of the ecological crises. Kuhn's conclusion about nature fitting into the inelastic boxes of paradigms leaves no room to introduce those material situations when nature boomerangs. His view thus leads to material vacuity. Knowledge about nature can be materially assessed only when the dualism separating thought from action and belief from practice is broken.

This materialist criterion allows one to view belief systems as weak when the unanticipated and unpredicted change in the material environment is far more extensive and intensive than the predicted transformation. When antibiotics create super-infection and flood control measures accentuate floods and fertilizers rob soil of its fertility, the problem is not merely between use and misuse of technology. It is rooted in the very process of knowledge-creation in modern science, a process which is increasingly turning out to be more preoccupied with the material problems created by intervention through scientific beliefs, than material problems posed by nature itself.

The natural-unnatural divide

The belief-action and theory-practise unity which provides the unit of assessment in a materialist epistemology can be interpreted at two different levels in modern science. At the first level, the activity or practise which involves material transformation can be restricted to the scientist's practice in his specialised environment of a laboratory. This level however does not create conditions in which ecological instabilities arising from mistaken beliefs about natural processes can be seen. For an ecological evaluation of the materialist adequacy of theories it therefore becomes essential to consider a more general level of practise in which the material transformation is in the wider natural setting and not in the manipulated setting of a laboratory. Quite obviously, certain types of scientific theorising do not reach the second level of practise. Examples of this are theories in astrophysics or particle physics which, in their contemporary state, stop at the material transformation required to

create an experimental situation and do not spill over into the larger environment. However, such theorising is uninteresting in the context of a comparison with ethno-science and an evaluation in an ecological perspective, though for a dualist philosophy of science restricted to the analysis of ideas alone it is just these fields which are most interesting since they are the most advanced in the reductionist-positivist scheme of thought. For our task, the scientific theory and practise that is of relevance is the type that does have ecological implications and involves scientific practise in a wider natural setting.

There is a third category of knowledge in modern science, which unlike particle physics, transcends the material context of the experimental laboratory and, unlike knowledge of fields related to health and food and agriculture, does not create ecological imbalances. Electronics and its background specializations are such an example. Such scientific domains are characterised by both the levels of practise taking place in materially artificial and man-made environments. The artifacts created as part of the transformative activity arising from such beliefs do not interfere with natural processes and relationships in nature. Though derived from nature, they continue to exist independent of it after creation. However, the creation of such artifacts does not replace the natural processes ensuring human survival; they merely supplement the natural material world and do not provide a substitute for it. What could be a better indication of man's continued dependence on nature than the fact that today's so-called post-industrial societies satisfy most of their food needs through imports from so-called underdeveloped countries? It is in the context of the continued central role of nature in human survival that the material inadequacy of scientific thought in the ecological perspective becomes essential.

For those who have internalised linearity in history and nature, taking guidance from ethno-science will seem like 'going backwards'. For others, who see plurality as the stable order for natural ecosystems and human societies, being enlightened by ethno-science will amount to returning to the appropriate path after having gone astray for a while on the reductionist road. Nature is, after all, diverse, and authentic knowledge of nature should account for this diversity. Ethno-sciences are not less reliable because they are pluralistic, and reductionist science universalised does not provide a more reliable account of nature because it is singular. Objectivity

cannot, after all, be equated with a singular inappropriate answer that destroys its very object.

Recent history has shown that in certain areas of human activity a return to ecological thought and action is possible and desirable. The primitive practise of breast-feeding had been discredited by the advertising and reductionist claims of the baby-food industry. The ecology of breast-feeding has, however, become appreciated once again, and the 'primitive' practise is enlightened practise today. Chemicalisation of health care seemed to be the only way to develop in the reductionist paradigm. Work in ethno-medicine is again bringing back wholesome drugs and treatment. Sustainable organic farming which created 'farmers of forty centuries' is on its way back, in all the diversity and plurality of its traditional base. Each of these steps towards ecological thought and action has been possible because contact was made with an ethno-scientific tradition. If the world is to be conserved for survival, the human potential for conservation must be conserved first. It is the only resource we have to foresee and forestall the destruction of our ecosystems.

Contemporary women's ecological struggles are new attempts to establish that steadiness and stability are not stagnation, and balance with nature's essential ecological processes is not technological backwardness but technological sophistication. At a time when a quarter of the world's population is threatened by starvation due to erosion of soil, water and genetic diversity of living resources, chasing the mirage of unending growth, by spreading resource destructive technologies, becomes a major source of genocide. The killing of people by the murder of nature is an invisible form of violence which is today the biggest threat to justice and peace.

The emerging feminist and ecological critiques of reductionist science extend the domain of the testing of scientific beliefs into the wider physical world. Socially, the world of scientific experiments and beliefs has to be extended beyond the so-called experts and specialists into the world of all those who have systematically been excluded from it — women, peasants, tribals. The verification and validation of a scientific system would then be validation in practise, where practise and experimentation is real-life activity in society and nature. Harding says:

> Neither God nor tradition is privileged with the same credibility as scientific rationality in modern cultures. . . The project that science's sacredness makes taboo is the examination of science in just the ways any other institution or set of social practises can be examined. If we are not willing to try and see the favoured intellectual structures and practises of science as cultural artifacts rather than as sacred commandments handed down to humanity at the birth of modern science, then it will be hard to understand how gender symbolism, the gendered social structure of science, and the masculine identities and behaviours of individual scientists have left their marks on the problematics, concepts, theories, methods, interpretation, ethics, meanings and goals of science.[30]

The intellectual recovery of the feminine principle creates new conditions for women and non-western cultures to become principal actors in establishing a democracy of all life, as countervailing forces to the intellectual culture of death and dispensability that reductionism creates.

Ecology movements are political movements for a non-violent world order in which nature is conserved for conserving the options for survival. These movements are small, but they are growing. They are local, but their success lies in non-local impact. They demand only the right to survival yet with that minimal demand is associated the right to live in a peaceful and just world. With the success of these grassroots movements is linked the global issue of survival. Unless the world is restructured ecologically at the level of world-views and life-styles, peace and justice will continue to be violated and ultimately the very survival of humanity will be threatened.

[30] Harding, *op. cit.*, p. 30.