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Feminist Critiques of Science

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Introduction : on the singular and the plural

In dealing with questions about the masculine and the feminine, I want to start by noting the significance of the singular and the plural, as they appear in the title.

The singular tends to mythologise a complex reality, as is the case with 'science'. An essential part of modern society, science presents itself to us in various ways, which sometimes happen to be contradictory. It is a symptom of its diffuse and powerful presence that we speak about it using the singular. The word 'science' means many different things. Are we speaking about the scientific method, about the results which are brought about by it, or about the applications it produces ? Are the social sciences really sciences in the same sense as physics or biology ? Are we speaking of the institution which has been established as the keeper of a monopoly on legitimate knowledge, which suppresses all other types of knowledge as backward, obscurantist, irrational or, at best, marginal ?

Discussions about science very often suffer a confusion of these different aspects. The first aim of this article is to present an 'analysis' (in a quasi-chemical meaning of the term) of this omnipresent and complex phenomenon, in order that the various possible options might appear more clearly.

Another approach, which might look firmer would be to start from an analysis of patriarchy and to analyse science through it. Although this approach is seductive because of it seems to be radical, it runs the risk of becoming dogmatic. Patriarchy has existed for thousands of years, modern science only for three centuries. In the case of patriarchy, there has been a slow evolution. Unhappily, this evolution has taken us from 'hard' patriarchy, where gender roles were frozen (as was the case in the last century, provoking the feminist revolts of the turn of the century and the 1960s), to a softer one, such as the one we know today. It therefore seems to me premature to erect the anti-patriarchal position as the only efficient starting point. Consciousness of the patriarchal nature of society and of women's oppression has been an essential part of 1960s feminism. It now seems to me, in this less spectacular phase where we arx now, that what is needed is

to deepen, improve and refine the examination of reality, taking care to avoid any militant self-satisfaction.

'Patriarchy', an essential and useful notion, must now become itself a rigid, simplified, mystified, singular term. Let us recall that the women's movement has refused the mythic 'women', in order to revindicate the existence of plural, different women and also of many different feminisms. Therefore, the title uses the plural in referring to their critiques of science.

This article is aimed primarily at helping me clarify my position towards science, as a scientist and a feminist woman. This implies a refusal to choose between the so-called 'feminine' and 'masculine' worlds, and the recognition of a necessary androgyny. In order to better define my starting points, I mention my experience in passing from the exact sciences to the social sciences, an experience leading also to the impossibility of being satisfied with simple schemes about 'science'.[1]

1. Science in society today

I examine here some aspects of modern society where science is essential, through its evident power upon nature or, in a more diffuse way, through present knowledge of the human being. I then examine the corresponding place of women.

Military technology. One of the reasons governments support science is its efficiency for making weapons, even if many pure scientists have a pacifist sensibility. Women are traditionally absent from these virile confrontations and traditionally against war, but without real means to make themselves heard. Let me here give a tribute to the tenacity of British women standing up against nuclear missiles.

Space exploration. The anti-nuclear struggle is part of the ecological one, and women are present in it.[2] I have not heard of any real movement against space exploration. Even if it is not free from military connections, it is presented as one of the great human, that is universal, adventures. Quite symbolically, it has invited a few women, and a Muslim Arab, to 'fly' in outer space.

We are here confronted with the inescapable influence of a dominant culture on all of humanity, a fact acknowledged by Marxism. This leads to particular problems about what a female culture could be, a point which is discussed with subtlety by Rossana Rossanda.[3]

Civilian technology. This has been contributing to changing the place of women in society. In a traditional society, physical force might relegate women to second place. The place of technology, which should help women to be emancipated from their so-called 'nature', is surely at the heart of feminist revindications of women, as they discover new, subtle ways that they keep them in second place.

Medicine. Contraception and the reduction of birth and infant mortality have greatly helped women to become free from a tight biological definition. Furthermore, although women may be absent from the creation of

modern technology and be only consumers of civil technology. they traditionally are conspicuous in the medical professions. even if it is more often as nurses than as doctors.

Social and human sciences. These new sciences very directly touch women, as they allow a better understanding of the psycho-social construction of gender and gender relationships. It is therefore not surprising that feminist studies are centred here. Women are present here and their presence should be reinforced in coming years, even if the top figures are still men.

Psychoanalysis. This discipline has a rather ambiguous relationship with science, and some readers will be surprised by its mention here. I raise it because psychoanalysis has started within science and, at the same time, contributes to passing beyond it. Moreover, it is of special importance for women, as can be seen from the name of one of the branches of the French feminist movement, Psychoanalysis and politics'.

Indeed, while the first feminist wave of the century attacked legal barriers, the second wave in the 1960s and 1970s had to admit, after most of these barriers had been lifted, the enormous strength of psychological obstacles.

Moreover, women have traditionally been dedicated to emotional relationships between people. As we find many women involved in curing bodies, so we find many curing the psyche. The insistence in psychoanalysis on the importance of the very first years of the child gives a significant place to the mother. Centred, in its orthodox version, upon sexuality, it constantly questions sex differences, even if some of its answers might not seem satisfactory to many feminists. Finally, because the psychoanalytical project is a kind of work about one's identity, it is particularly important to modern women, torn between the old models of femininity and the new ones which remain to be defined.

Women's place in this domain is surely one of the best recognised: many choose a woman as an analyst. Even if theoretical leaders are, as usual, mainly men, women have more chances to be heard (for example, Anna Freud and Melanie Klein in the US, Maud Mannoni and Francoise Dolto in France).

2. The scientific institution: a predominantly masculine universe

As an illustration, I quote some 1972 data from France. In the Research Organisation CNRS, 30% of scientists were female. The most masculine science was nuclear physics (14% females), the least so were the life science (biology and psychology, 47% females). There were no women on the political committees. Females were scientific directors of 5% of laboratories and 10% of teams. Until 1977, only one woman had received the gold medal out of 25 awarded.

The main facts here are the classical hierarchy of recognition and power, and the different (traditional) interests of woman scientists, We find few of

them in the mathematical and natural sciences, and most of them in the human (including biological) sciences.

These figures have not drastically changed since 1972. One should also notice the relatively high participation of women in French science, especially in the mathematical and natural sciences, compared to other countries.

Speaking concisely, one might say that because science is so important in society today and because society is patriarchal, it is logical that there are few women in science. Reasoning the same way about advanced fronts in technology, about which most women are not even conscious and no statistics yet exist—artificial intelligence for example—we might expect women to be even less represented, in places where the real decisions about our world are made.

Because science appears to be a meritocratic game, with well-specified rules in order that the best can win, the disproportion between the genders is a real issue in a society which is supposed to aim at equality. A recent article by Londa Schiebinger offers a review of the different writings on this issue[4]; she proposes four different ways to look at it, on which I will comment here.

"Not so few: in search of lost women". Science produces remarkable results indeed, but one of its related activities consists in promoting these results and glorifying their discoverers who are called 'geniuses'. This very social activity can immediately be compared with the anonymity reserved for women in general because they are dedicated to the private life (even if some men are ready to pay tribute to the quality of some remarkable women, including their own mothers).

The image of the genius being essentially that of a man: women participants in science often appear transparent to their colleagues. Therefore it is necessary to point out that there also exist 'famous' women, a long historical stream from the literature,

In the supposedly meritocratic system of scientific reputation, the tendency to obliterate women has its counterpart in the presentation of a few women as 'exceptions', as has been the case for Marie Curie. This is dangerous, but not as much as total obliteration. In a sense, a real evaluation can only exist for equal people and, as women are still predominantly defined as women (rather than as universal human beings), any evaluation is likely to be under or over-estimation.

"Why so few? Identifying (structural) barriers. These barriers can either be of a manifest nature—scientific institutions have long been closed to women—or, more often today, they are due to a more or less conscious discrimination : the mathematician Emmy Noether is denied a university position, or the Nobel Prize winner Barbara McClintock has to wait a long time before gaining recognition.[5,6]

Most often, however, the young student is discouraged in a much more subtle and efficient way. A (female) science journalist tries to understand the failure of an ontherwise gifted girl at Harvard: the girl explains, "In the first

place, all the math teachers are men In the second place, when I met a boy I liked and told him I was taking chemistry, he immediately said, 'Oh, you're one of those science types'. In the third place, it's just a kind of social thing. The math clubs are full of boys and you don't feel comfortable joining." "In other words," concludes the journalist, "she was made to feel unnecessary, and out of place."[7]

The women's movement has stimulated the writing of many texts of this kind. They show, through their analysis of the subtle difficulties in fully participating in the scientific world, the kind of symbiosis which exists between it and the masculine universe.

On the contrary, one may notice that a positive emotional relationship with fathers may have played a determinant role in the professional choice of women scientists. This fruitful relationship is, however, not reproduced by society.

These first two approaches throw light on the psychosocial aspects of what might be called the dissuasion of women from a scientific career. The approaches assume that the two genders should be a priori equal and that society produces the existing barriers. The next two approaches directly confront sex differences.

"Naturally few? Biology as destiny." This third approach has a long history, from Aristotle who "argued that women did not have sufficient heat to boil the blood and purify the soul"[8] to the actual theory of the 'brain sex'. But it is also possible to reverse the issue and ask what scientific discourses on sex differences might teach us about science and society.[9]

"The impact of the few ? Gender distortions in science." This last approach starts from the actual masculinity of science and takes issue with it. What does this masculinity involve with respect to the supposed objectivity of science, when only one gender defines what science is ? At which level do masculine deviations appear ? Is it in the choice of subjects of research, in the manner of treating them, in the building of models describing reality or, at a deeper level, in the very ways of knowing ?

This approach brings out new and bold questions, and the rest of the article is intended as a dialogue with it. But, before proceeding, it is necessary to be precise about the different types of scientific knowledge with respect to the degree of certainty of their results, and to define my own position about the irritating and central question of sex differences.

3. On the different degrees of certainty in science

Science is the legitimate knowledge in our society. Scientists are paid in order to make facts as secure as possible. Scientific argumentation is the type which prevails in discussions. These are the reasons why the spirit of rigour, which was at the origin of science and through which lay people are entitled to trust the scientist, should be defended against the perversions that the growth of the institution inevitably brings.

If classical philosophy has always insisted on clearly separating certainty

from opinion, the development of science has involved covering more and more territories where certainty is far more difficult to reach than, for example, in mechanics (where it is not so easy either).

By speaking of and eventually criticising science, one should always keep in mind that its different domains entail different kinds of scientificity. Mathematics is built to avoid ambiguity. In physics, truth rests both on the mathematical expression of the theory and on experimental confirmation. Biology has only some really exact parts in a complex body of models and notions. Social sciences and psychoanalysis have their epistemological problems, which are far from resolved.

The fact that all this diversity is brought under *one* name, science, is often prejudicial, and prematurely brings philosophies, which swing from a dogmatic scientism to a nowadays fashionable scepticism, into the intellectual market place.

This danger of a confusion between different aspects of science is prejudicial to the acute and critical examination which is particularly necessary today. I wish here to defend, together with Henri Atlan,[10] the necessity to be aware of the specificity of different ways of knowing, so that the truth involved in each domain is dependent upon that domain, and so that limits to this truth can be made precise.

This is all the more true when discussions of sex differences are involved. A criticism of the multidisciplinary work *The Feminine Fact* [1] is that it often does not make clear the degree of validity that the layperson can expect in 'results' given by specialists.

4. The sex difference aporia

In logic, an aporia is some difficulty presenting itself in a rational discourse, which seems without solution. The word stems from the Greek *aporein*, to be in trouble,

The situation concerning sex brings our reasoning into trouble: the difference exists. It is first biological, but one has only to look around at children's education to see how much our society seems to need to reinforce these differences and, some sociologists would say, to create many of them.

Is it or will it ever be possible to sort out what stems from biology and what from external constraints? One could only answer if societies existed which brought up their offspring in exactly the same fashion, a utopia which does not seem likely to come about; nor, perhaps, is it desirable.

In order to go beyond discussions of hypothetical futures, I propose to admit that it is basically impossible to conclude the issue. Such an admission of the impossibility of a conclusion is just a case of the spirit of rigour advocated in the last section. Keeping this impossibility at the horizon does not prevent us from going on with this issue.[12] I shall quote here two positions.

The geneticist Albert Jacquart points out the difference between genetics, where there exist mechanisms (whose regular actions can be elucidated) and

statistics (where complex phenomena are only subject to a summary analysis).[13]

In the same line of thought, the biologist Andre Langaney proposes to distinguish between four sexes: the genetic sex of the chromosomes which is, apart from a few exceptions, unambiguous; the physiological sex of hormones, where an overlap is already present; social gender; and personal gender which everybody has to define for her/himself in the kind of open society to which we belong.[14]

It is precisely the new and great task of philosophy today to conduct a real reflection on gender, as proposed by Luce Irigaray.[15]

One should be aware of sex differences and of the necessity for any society and any person to be defined by them. One should refuse to decide a priori whether they stem from biology or society. One should however be aware that the biological argument, which relies upon mechanism and reduction, can be dangerous if taken outside of its own domain, while sociological argumentation tends to open possibilities.

5. Science: also a spiritual adventure

It might seem surprising to speak of spirituality in connection with science. This term is more usually associated with religion. Has not science developed in opposition to religion by refusing truth by revelation?

I have decided to use this term for two reasons. One concerns the state of science today and the other the fact that this article primarily addresses women.

In western countries, religious dogmatism is no longer the first danger. There exists the danger of Technics, which tends to reduce to mechanism the very way of obtaining knowledge and to flatten complex realities. The spiritual adventure of science tends to be relegated to bureaucratic career considerations. The nowadays fashionable sceptical philosophies contribute to dissolving the very strong relationship with Truth which existed in the beginnings of science. Just as the development of religious institutions threatens the very spirit of religion, so the development of science threatens its very spirit.

As already stated, the rhythm of historical development for women is not the same as the one for so-called universal history. The former has been, until now, slower than the latter, and it is necessary to go back very far into the past to understand it. From the point of view of women, the whole story of culture has to be recaptured. The western story of knowledge starts with religion, continues with philosophy and leads to science. Women have been excluded from each of these three major developments.

In this very long development there are different steps in the work of the mind which lead to today's scientific spirit.

Religious *abstraction* which goes with monotheism has very probably played a central role in the work of separation and specialisation. Recall here the Judaic interdiction against representing God or even naming it.

Already at that time, women were suspicious of religious people and kept apart from most of the spiritual work.

Philosophy may be defined as the effort towards *rationality*. Western civilisation has been training for it since ancient Greece. This thought instrument allows for both the coherence of discourse and a certain adequacy in fitting it to reality. Rationality needs abstraction, in order that discourse goes on independently of the immediate, sensitive reality. It demands very good self-control, a sharp critical sense. All this is responsible for western efficiency and prepared it for science, which adds objectivity.

Objectivity brings another separation from the external world, which is carefully investigated with an experimental method when that is possible. Objectivity implies that scientists agree with the definition of the object, and calls for separation between the scientist and his/her study object. That is why the external objects have been first the physical world and then, with more difficulties, the biological one. Here, the scientific way departs from other, more internal ways of knowing (mystical, religious, philosophical, psychoanalytical).

If we forget about all the social prohibitions which have existed against women's education and focus on this adventure of the mind, it is possible to understand better why science has become mainly a male world.

This spiritual, rational, objectivist, intellectual story is a long and difficult process for humanity, which involves a real self-discipline. It is as if humanity, in its path towards an objective knowledge of external reality, wanted at best to 'protect' or at worst to 'put aside' the second sex, as it has been 'protected' or 'put aside' from wars and political responsibility. Men have wanted 'natural' women, that is, spontaneous, sensual, emotional, affectionate women. So, one may indeed oppose the rationality of men to the intuition of women. The quest for objectivity, which goes together with control of the external world, is for the first sex, while the second sex is left with an uncultivated subjectivity. The rigour, systematisation and critical mind (intellectual weapons all) of men are opposed to the 'charming' emotionality of women, which, together with a real pragmatism, is not to be devalued.

These "feminine" qualities are encouraged in areas well controlled by men. In this difficult separation between intelligence and emotion, men needed (and, as we can still see around us, still need) to be able to fall back on the warm immediateness of their women, who again provide a place for warriors to rest.

One can see that this separation is much more likely to happen in young boys, who have to separate from their mother image, than in young girls, who may continue their whole life to stay in warm fusion with their mother.

It is only if one is clear about the extra difficulty of the scientific life, that one can understand why so few women are tempted by it, as they are more likely to be loved if they stay outside this world.

Before ending this section, let me recall the importance in science of

imagination. In order to discover, one has to imagine, but in accordance with given rules. As the physicist Richard Feynman puts it, "one has to imagine reality"[9]. This game aspect has been emphasised by many scientists, from Newton to Atlan. But the game implies that separation we have already met. It means escape from daily contingencies. The game is mostly something for men, whereas women concentrate on daily necessities. The necessity to be useful, devoted first to the family: that of course is contrary to freedom. Some wings have here again been cut.

6. The universality of science and its psycho-social supports

This title might seem provocative Either science is indeed universal and, as a consequence, independent of social context, or it does depend on a context and, as a consequence, is not universal. In this section I defend both theses : science is universal and context-dependent.

Science, emerging from the Enlightenment, pretends to be universal, as does Reason, the primary tool necessary to conduct humanity towards Truth. For the sake of that universality, Science forces back, puts aside or tries to eliminate other ways of knowing, defining them as 'pre-scientific' and 'obscurantist',

This once beautiful project has problems today. As noted earlier, science too often has become too efficient, with some rather irrational results, It has also remained a domain that only initiates can understand. While everybody is able to use electricity and microcomputers, only a minority of people have access to real understanding of the basic laws. Worse, it is not clear that the scientific spirit is more common today than three centuries ago.

The critical movements of recent years have pointed out that science is a feature of industrially advanced societies, that is mainly western society. So, how can something be all that universal if it is restricted to one sex and to a few human groups ?

Here again, it is necessary to distinguish between different aspects of sciencs. Science needs material and special cultural means, whence the existence of particularly active centres, which leave other teams in the periphery.[16] There cannot be any doubt about it: science is very unequally distributed.

But physical and biological laws are indeed universal. as they are verified in every country. The problem is more complex for the social and human sciences, where ideological presuppositions are still mixed up with knowledge. and where the research 'object' might evolve faster than the research programme.

What remains universal is the process which supports the efforts towards knowledge, and the objectivity which is sought in each case, with the inescapable difficulties in each spec ial domain.

In the last section I mentioned spiritual adventure. Any spiritual adventure pretends to universality, even when it explicitly defines itself as esoteric (which is not the case for science). What this means is that speculation is

taken upon what is common to the human mind, beyond the evident differences brought about by local customs and native inequalities. Every spirtitual adventure is transcendental to daily reality, even if it occurs in a well-specified historical and social context.

No universality can exist by itself, but only a faith about a certain kind of potentiality going beyond the socio-cultural context. This is the case for science, taken as a declaration that any human being who is appropriately educated can aspire towards a knowledge of reality which is as objective as possible.

This declaration goes along with those other ones which were proclaimed in the universal declaration of human rights by the French Revolution. In a feminist oriented article, it is not necessary to recall that this declaration forgot women and that the French revolutionists very properly guillotined 'excited' feminists such as Olympe de Gouges who had the bad taste to point it out. What is important to notice is the significance of setting up the abstraction 'equality', which contains its own dynamics, so that it was responsible a century later for the feminist movement and is still pertinent today.

In order for an internal, spiritual happening to survive, be passed on and be sedimented so that it becomes a well implanted tradition and even seems quasi-natural, it must be able to rely on the firm support of social-cultural surroundings. That was once the case for religion and is today for science. Most critics of science use its own weapons, that is, objectivity, rationality and a critical spirit.

Between social choice and personal choice, group mediation must exist; an intellectual process is difficult and must be encouraged by masters, colleagues, disciples. Recall the intense sociability of the Greek philosophers surrounding Socrates, as described by Plato: intellectual research went along with strong interpersonal relationships, with affection and even love and sexuality, so that the difficult and beautiful abstract flowers of reasoning and dialogue might be given birth and support. This affective stimulation was and is lacking for women and has played against them[17].

7. Criticisms of science

With its universalistic aims, science has behaved as a conqueror. In reaction, critics have arisen. The more powerful one is, the more critics one gets.

Three periods can be distinguished. In the 17th and 18th centuries, science belonged to a minority of people who fought for recognition from the whole society. Science had first to create its own ways of thinking, working, its community; its publications.

In the last century, science has become well established and tends towards hegemony. Here begins the real critique. The romantic movement refuses the cold separation between intelligence and emotion and is aware of the dangers and excesses this separation might carry. A woman, Mary

Shelley, created the Frankenstein character.

Worth mentioning here are two streams of thought which define themselves as scientific but nevertheless incorporate severe criticisms of some aspects of science: Marxism points out the relationship between science and society; psychoanalysis may provide a critical description of the scientist.

New criticisms of science have emerged in recent decades, the new feature being the participation of scientists themselves in making the criticisms. One can understand this internal criticism as due to the loss of prestige of the profession, which has become bureaucratic. The average scientist is part of a great machine, having little freedom[18], [19].

There is also great disillusionment with the capacity of science to bring about progress. Reason, seemingly triumphant in the 18th century, has changed into narrow, short-sighted rationalities[20].

Following the student and women's movements, in the 1970s there was a stream of radical critiques of science. All that had been set apart from science—traditional knowledges, eventually religions—was rediscovered. In the area of philosophy of science, dogmatic positivism has been replaced by the sceptical relativism school, which wants to take science as one among many human belief systems.

This is the general context in which the women's movement comes to take up the question of science. I am not quite sure whether there is any theme which is really specific to the women's movement's critique of science. It is certain that the peculiar situation of women makes them emphasise some of the features of science and very dynamically make them apparent.

This is the case for *witchcraft*: repression of witches especially hit women. The women's movement was entitled to take up this particular theme as an illustration of women's repression[21].

The witch is the marginal woman who posseses some threatening, non-institutionalised knowledge. The witch evokes woman who 'drops out', who for one reason or another refuses to submit to her cultural role. When she is young and beautiful she seduces, when she is old and ugly she frightens (something that the Danish writer Karen Blixen seems to have been aware of and been able to use).

It is not surprising that it is a woman anthropologist in France who tackled the problem of witchcraft in a novel way. Jeanne Favret-Saada approached it in such a deep manner that she became involved in witchcraft, a dangerous and rich experience which enabled her, after she regained self-possession, to tell us much about it.[22]

While I was working on this article, I listened to two pharmacists on the radio telling about their work with traditional drugs. They take medicine men seriously, question them and then investigate their traditional drugs in the laboratory. In both cases there is respect for both traditional knowledge and modern science. But the approach is also internal in the first case[23].

The theme of *ecology* is particularly close to women, including the roughness with which nature is often treated. Relevant here is the thesis

defended by Carolyn Merchant in her study of the birth of science and the metaphors which were used to describe it[24].

In general, as seen earlier, women resist drastic scientific divisions. In the world of science, women, because they hold human relationships in higher esteem, tend to choose teaching rather than laboratory research. Similarly, Evelyn Fox Keller has pointed out the different, more respectful relationship that Barbara McClintock had with her study 'object'[6].

In the same way, the women's movement has from its start insisted upon 'self-help' and self-consciousness. I must emphasise the recent contributions of women to the techniques of dance, song and holistic gymnastics: self-consciousness is indeed one of the necessities and one of the riches of today's women.

In quite another area. the critique of science is carried out with the very tools of science: women make us aware of the male-centrist bias. To quote only one example, the ethnologist Levi-Strauss describing a village activity: "The *whole village* left the day after in about thirty pirogues, leaving us alone with the *women* and the *children* in the *abandoned houses*[25].

From a critique of a suspicious sociobiology which too easily jumps from the biological to the social level, to the denunciation of discourses which use the notion of nature without much critical spirit, there is a *scientfic criticism* of the male-centred deviations in science which began to exist along with the critical character of science, and should exist as long as patriarchy does.

Another type of critical approach aims at reaching the very foundations of scientific thought. It is considered in the next section.

8. A feminist/feminine science?

"A more fundamental project now confronts us. We must root out sexist distortions and perversions in epistemology, metaphysics, methodology and the philosophy of science—in the 'hard core' of abstract reasoning thought most immune to infiltration by social values." This is the self-definition of a project which produced a book with 14 articles[26].

These questions are fully legitimate and are very difficult. Their boldness should be credited to the lively and creative stream of reflection in the women's movement. I must confess that the arguments are not yet fully convincing.

Let me first remark that most of the criticisms do not really reach the 'hard core' which is so difficult to deal with, but go on developing themselves around political philosophy which goes back to the beginnings of the women's movement, or developing themselves against some biological theories, which is not new either.

When the 'hard core' is really challenged, Aristotle is a favourite target. He is indeed one of the central charachers in the development of science and, at the same time, a coarse, rude. unrefined misogynist, Lynda Lange writes, "Challenging Aristotle's sexism requires that we re-evaluate the soundness of the rest of his thought".

This conclusion is not evident at all. It does not accept the separation which takes place in scientific thought: Aristotle's misogyny does not necessarily invalidate his discoveries in logic, which eventually were taken up by other, nonmisogynist, thinkers (they are not all women's haters). From the beginnings of science, scientists have proceeded to sort out what was valid in Aristotle and what was coarsely wrong: the latter does not just concern women.

Criticisms which recall the philosphical, metaphysical and psychoanalytical backgrounds of scientific thought are always interesting, because they help us introduce some space between currently dominant habits of thought and their justification. However we must not forget the incredible efficiency of this type of thought which is the main reason for its adoption today including by its own critics. It may be useful and necessary to reinstitute a place for other ways of thinking, but they should be taken as complements and not rivals with scientific thought.

Moulton notes that the fundamental rule of philosophy is based on an 'adversary method' where women are disadvantaged. I have noted how the research atmosphere is not appropriate to women. However, truth is only built by opposing others' opinions, and aggressiveness is present in women as well as men (the differences being in modes of socialisation).

Other critiques, especially in France, have questioned the formalism in science.[27] This is again, I think, the wrong way to get hold of the reality of science. Formalism is a reconstruction occurring after the main break, abstraction, has been achieved. Feminist criticism here happens again to use ideas from the general critique of science, without being aware of it.

To imagine what science would have been if it had been built only by women is a science fiction exercise, and science fiction is far from useless to science. The dream of a feminist science should, however, be careful to remember the misadveuture of those who tried a 'proletarian' science with Lyssenko.

If scienee is taken as a thought approach together with a social encouragement, science is neither bourgeois nor proletarian, neither male nor female, even if male bourgeois scientists are indeed in a dominant position in it. Women's resistance to it should be aware of choosing the right targets.

The scientific approach is an emancipation from philosophy. Women will not succeed in bringing philosophy back into science, even if philosophical, psychoanalytical, historical, feminist and feminine viewpoints on science are very necessary to humans, who cannot be satisfied with science by itself.

9. Conclusion: outlooks and strategies

Feminisms. Feminism seems to spring up in waves. There was the one at the turn of the century and the one of the 1970s. I wrote about that the rhythm of social relationships between the two sexes is different from so-called universal historical development; it reacts to the different states of the society where it happens to be.

Nineteenth century feminism was a response to the universality demanded by the French Revolution. It asked for equality for women. The corresponding strategy was entryism into male society, refusal of discrimination.

1970s feminism, on the contrary, insisted on sex differences and fought for a reassertion of the traditional feminine values: pacifism, consideration of human relationships, refusal of competition, morality, interiorisation. The same argument that was applied to science can be applied to these values: they are universal, they are not possessed only by women, and they are indeed proposed by mixed social streams today. However, social or even perhaps biological circumstances mean that they are found more often in women's groups.

In a situation where feminism is first of all a necessary reaction against two injustices (discrimination and devaluation), there is one danger that it must avoid: being trapped in the reaction phase and, in an overestimation of women, making the adversary patriarchy responsible for everything and only negative. A third phase is necessary, in a dialectical movement, where the complexity of societies and problems are taken into account. The women's movement is not independent of society-wide ideologies. The nineteenth century wave was influenced by socialisms, the 1970s one by Third World liberation movements from which it took its name. The feminist critique of science is, in many respects, influenced by the general critique of science

This only confirms the essential point that we, as women, belong to a man-made society. We do participate in its universal properties but, as a plus, we also have our own specificities. The two kinds of feminism which are present in any women's group, egalitarian and differential feminism, can also be seen in the intervention of women in science.

Feminist presences in science. For what concerns *epistemology*, I have defended the thesis that it does not differentiate along gender lines. The danger here is the ease of deviations, due to the size of the present scientific institution. There is a parallel with law, which has not always been fair to women, but gives us weapons to fight against injustice. In the same way, the scientific approach provides intellectual weapons which must be used by feminists.

The intellectual effort which is called upon by science is heavy, and it is necessary that a satisfactory *emotional atmosphere* help it. Here, sisterhood, mutual encouragement. should prevail over the internal rivalries which too often occur in oppressed groups.

The choice of research *subjects*, and the *viewpoints* from which they are treated, do call for great watchfulness, acute criticism and creativity which can be seen to be exercised by feminists, especially in those domains which concern women and human beings.

One last level is the *social spinoff* of science and, in a more subtle way, what may be called its *social congruences*. A spinoff is, for example, the technical use of nuclear physics; a congruence is this hyperspecialised,

technocratic and technicist society which is ours. In the first case, a direct application, in the second, the same structure envelops scientific knowledge and social organisation. Here, we find women more sensitive to over-armament, ecology and bioethics and also critical of technicist society.

An essential marginality? When one looks at the strength of the techno-scientific structure today, one may predict that if more women are going to participate in it, with the growth of competition, they will continue to occupy places of second rank. That may seem rather pessimistic, but my impression is that, after the second feminist wave of the century, the current phase is digesting the recent conquests: the recognition of the existence of patriarchy, bodily freedom, the theoretical possibility of choice in life and work and, above all, the entrance of women into culture, which might be the major event of the century.

The first priority is that women take hold of the until now male-dominated culture, that they make its intellectual tools theirs, in order to build another culture where we shall be actively, consciously present. Secondly, we may expect women to be, for a long time, a minority in science and also in philosophy where new questions are posed (those which are considered secondary as they primarily concern women[28], [29]). There is a need to face these facts and start the reflection from the long-term 'vocation' of women to be on the margins of society. □

Notes

1. This article is a shortened version of an article in French : it rests on a variety of experiences, approaches and reflections in and on science. The interested reader may consult J. Feldman, 'Le Savant et la Sage-femme', *Impact. Science et Societe*, Vol. 25, no. 2 (1975), pp. 133-143 ; J. Feldman, 'People, knowledge and science', in T. Segerstedt (ed.), *Ethics for Science Policy* (Pergamon Press, 1979), pp. 133-144 ; J Feldman, *Voyage mal poli a travers Le Savoir et al Science* (Tierce, 1980) ; Armatte et la, *Le Sujet et l'Objet Canfrontations* (Editions du CNRS, 1984) ; J. Feldman et F. Laborie (eds.), *Le Sujet et l'Object : Implications* (Editions du CNRS, 1986).

2. Dorothy Nelkin, 'L'energie nucleaire dans le discours feministe', *Sociologie et Societes*, Vol. 13, no. 1 (1981), pp. 147-160,

3. Rossana Rossanda, 'Sur la question de la Culture Feminine', *Peuples Mediterraneens*, nos. 22-23 (Jan-June 1983), pp. 287-305. Articles originaux : Orsa minore, via Muzio Clemente 68/A, 00193, Roma, Italia, no. 0, ete 1981 : no. 6, mai 1982.

4. Londa Schiebinger, 'The history and philosophy of women in science : a review essay', *Signs*, Vol. 12, no. 12 (1987), pp. 305-332.

5. See for exrmple Alice T, Shafer, 'Women and mathematics', in Lynn Arthur Steen, *Mathematics Tomorrow* (New York and Berlin : Springer Verlag, 1981).

6. Evelyn Fox Keller, *A Feeling for the Organism* : *The Life and Work of Barbara McClintock* (San Francisco : Freeman, 1983).

7. K.C. Cole, 'Hers', *The New York Times*, 3 December 1981.

8. Londa Schiebinger, op. cit. note 4, p. 323.

9. Londa Schiebinger, op. cit. note 4, pp. 327-328.

10. Henri Atlan, *A tort et a raison. Intercritique de la Science et du Mythe* (Paris : Le Seuil, 1986).

11. *Le fait feminin* (Paris : Fayard, 1978).

12. In the same manner, the recognition of the existence of the 'unconscious' by psychoanalysis does not prevent development of the capacities of cousciousness. The philosophical option of the impossibility of a hard reductionism (where everything is brought back in physics) does not prevent the scientist pursuing all possible reductions in scientific knowledge (see Atlan, op. cit. note 10).

13. Albert Jacquart, 'L'inne et l'acquis. A propos du concept d'heritabilite', in *Le fait feminin*, op. cit. note 11, pp. 113-119.

14. Andre Langaney, Chacun de nou sest une femme', *Le Monde*, 28 December 1982.

15. Luce Irigaray, *Ethique de la difference des sexes* (Les Editions de Minuit, 1984),

16. Cf. 'Centre-periphery analysis of science', *Philosophy and Social Action*, Vol. 13, nos. 1-4 (1987) pp. 9-56.

17. I illustratc the statement by the case of the above quoted physicist who seems to reduce his relations to women to mockery (may be for him a sign of tenderness !). He makes it clear to the scientist applicant that her first problem is not the discovery of the laws of nature but the affirmation of herself in a male-dominated world (R. Feynman, *La nature de la Physique* (Le Seuil, 1980), pp. 215-216).

18. J. Feldman, 'La Science en mutation', in Armatte et al., op. cit. note 1, pp. 21-38.

19. Lewis Mumford, *Le Mythe de la Machine* (Paris : Fayard, 1973-74) [*The Myth of the Machine* (New York : Harcourt Brace. 1967)].

20. Sonia Dayan-Hesbrun, 'La critique de la rationalite chez Jurgen Haberamas', in Feldman and Laborie, op. cit. note 1, pp. 33-44.

21. In France, a review named 'Sorcieres' was issued from 1976 to 1981.

22. Jeanne Favret-Saada, *Les mots, la mort, les sorts ; la sorcellerie dans le Bocage* (Paris : Gallimard, 1977). See also J. Feldman and F. Laborie, 'Rencontre avec Jeanne Favret-Saada autour de la sorcellerie', op. cit. note 1 ; J, Feldman, 'Une demarche de science exemplaire, ou comment la prise en compte de la subjectivite du chercheur rend plus scientifique sa science', in Armatte et al., op. cit. note 1, pp. 229-250.

23. Jean-Marie Pelt and Jacques Fleurentin, *Guerir par les plantes : de la tradition a la science* (France-Culture, 3-7 August 1987).

24. Carolyn Merchant, *The Death of Nature : Women, Ecology and the Scientifie Revolution* (New York : Harper and Row, 1980).

25. C. Levi-Strauss, *Les Bororo* (1930), cited in C. Michard-Marchal and C. Ribery, *Sexisme et Sciences humanies* (1982).

26. Sandra Harding and Merrill B. Hintikka (eds.), *Discovering Realitv : Feminist, Perspectives on Epistemology, Metaphysics, Methodology and Philosophy of Sciences* (Dordrecht : Reidel, 1983).

27. Seminaire Limites-Frontieres, *Femmes et Formalisme* (1985).

28. Edmee Mottini-Coulon, *Essai d'ontologie specifiquement feminine* (Paris : Vrin, 1978).

29. Catherine Chalier, *Les Matriarches : Sarah, Rebecca, Rachel et Lea* (Paris : Les Editions du Cerf, 1985).