Bachelard's Epistemology and the History of the Sciences

The interest of Bachelard's philosophical position lies in its radical and deliberate 'non-positivism' especially in the anti-evolutionism of his notion of the 'epistemological break'. The 'non-positivism' and anti-evolutionism are related to the link he perceives between epistemology and the actual practise of the history of the sciences; the radical displacement undergone by epistemological problems is by virtue of this unity. It is the perception of this unity that links Bachelard's work with that of his pupil, Canguilhem, and later, of Michel Foucault.

In his (re)affirmation of the scientific character of Marx's 'Capital' Althusser makes use of certain of Bachelard's epistemological categories, notably the notion of epistemological 'rupture'. Bachelard's approach to the philosophy of the sciences is analogous to Althusser's - just as Althusser attempts to discover the effects in philosophy of the emergence of a new science, historical materialism, Bachelard's project is to elucidate the effects in philosophy of the development of new concepts in the sciences.[1] Instead of finding a philosophical solution to the 'crisis' in a theory of knowledge Bachelard argues that the change does not take place with the aid of a new philosophy against the old,[2] but without the benefit of philosophy at all, against all existing philosophies, and that this is the rule.

There is thus a strong polemical element, with the purpose of defining the new 'theoretical space' in which Bachelard's epistemology lies; Bachelard announces the time of the 'Anabaptist philosophers'[3]- Anabaptist in that they forswear all the beliefs and dogmas of traditional philosophy; philosophical only in a strict sense to be defined below. They will establish themselves on the territory of scientific knowledge itself, in its actual practise.

The new philosophy lies in a 'new dimension', which is portrayed diagramatically in Bachelard's philosophical spectrum.[4] Sciences are produced in opposition to philosophies; the truth of a scientific statement is not founded upon any philosophical guarantee. It is in its very refutation that the necessity of philosophy appears. Philosophy is defined by its function (not by its object), as an intervention in the area of the sciences. "The role of philosophy must be 'reversed' - it must no longer be the spokesman of ideologies vis-à-vis the sciences, - rather its task is to neutralize their discourse and so hinder as much as possible the emergence of obstacles. At least it must distinguish within a given discourse between what derives from scientific practise and what originates in ideological discourses."[5]

So the function of Bachelard's epistemology is to 'escort' the progress of the sciences, and in so doing it treats problems completely alien to traditional philosophy. The new discipline will be an 'open' philosophy[6] - as the problems vary; as a science progresses the 'values' it may secrete change, and the footholds it gives ideology shift. The emergence of a new science may change the theoretical conjuncture, and the position of a given science in this conjuncture change. Being open the new philosophy rejects the characteristic of traditional philosophy to form a system. This stems from the very nature of scientific knowledge: science is not a unity, and between the different branches of scientific knowledge, development is uneven.[7] "This new discipline will be attentive to the real conditions of scientific works...the different regions...and their inter-relations, i.e. a historical philosophy."[8]

The 'openness' of the new philosophy, that which gives it its historicity and delineates it from an ideological philosophy, is achieved by Bachelard's concept of the dialectic.[9] In the place of the subject-object relation[10] Bachelard substitutes the relation comprehension-extension. These categories demonstrate that in science the thought object is

constructed, and comprehension is a function of the concept which thinks the thought object.[11] Sciences themselves produce their objects and phenomena in their theories and their materialization in experimental proofs. "The materiality of the real world - its existence independent of thought - and the possibility of its appropriation by the sciences (the primary categories of materialism), are sufficiently confirmed by the practise of the sciences themselves, by their ability to inscribe their theories in experimental forms, in what Bachelard calls a phenomeno-technics." [12] So the dissolution of the entity as the object of science dissipates the myth of immediate comprehension.

Having defined the theoretical space that Bachelard's epistemology occupies, it is now time to show how he erects the concept of a theoretical mode of production.

The place of the concept of the dialectic is between, on the one hand hypotheses and theories, and on the other, experiments; the dialogue is a historical process of an exchange of information whose final result is to adjust theory and experiment. It is this reorganization of knowledge, "where the language of theory and experiment are in contradiction", that Bachelard calls the dialectic.[13]

The dialectic of reason and application ensures that a science will go through a series of recastings/recrystalizations, each of which will redefine the basic concepts used by a science i.e. scientific thought progresses by reorganizations of its bases proceeding from its summit - this movement takes place only in and by scientific experiment. While the successive concepts are not equivalent there will be an 'epistemological profile' linking them in the mind of the scientist, which means that the extent to which each scientist uses the concept at any given time corresponds to each phase of development of the theory in which the concept has been used.

Hence sciences progress by breaking with pre-existing modes of thought: progress is then discontinuous, and can be seen as overcoming 'epistemological obstacles' secreted by those modes of thought;[14] e.g. immediate experience, general knowledge, pragmatic knowledge. Bachelard gives no general theory of epistemological obstacles, only examples. Three things emerge about them; (1) Once a science has been constituted they arise within the science.[15]
(2) Epistemological obstacles are a trap for scientific knowledge and concepts set by the 'thought-habits' of everyday life and experience.[16] Bachelard opposes the abstraction necessary to scientific thought to the 'revery' - the dream-like character of everyday experience. To constitute itself a science must break away from revery, but the latter does not thus lose its right to exist - the domains of knowledge and art are simply separated.
(3) The two poles of the 'philosophical spectrum', realism and idealism, are the most characteristic epistemological obstacles, whose psychological power gives a foothold to the philosophies which claim to guarantee the knowledge produced by the sciences, whilst really only battening onto and supporting the epistemological obstacles produced at each stage of scientific development.[17]

In this way scientific thought progresses by successive recrystallizations. As stated above this takes place only in and by scientific experimentation. Bachelard lays down a theory of scientific instruments as 'materialized theories' and of their assembly, forming a new body of

doctrine - technical materialism - the study of the material which science uses for the organization of its experiments.[18]

The essential element of the activity of scientific thought is to produce couplings of the abstract and of the concrete via the installation of theoretically defined instruments and via assemblages of apparatuses following programmes of rational realization - i.e. to "concretize the abstract". In this way 'scientific phenomena' are produced - termed phenomenotechnics - and ideological intervention prevented. This is radically different to a phenomenology that can only talk about phenomena, never produce any.[19] "The true scientific phenomenology is therefore essentially a phenomenotechnics. It reinforces what shows through behind what appears. It instructs itself by what it constructs...Science raises up a world not by a magical force immanent in reality, but rather by a rational force immanent to the mind."[20]

It is in this 'concretizing of the abstract' that Bachelard's epistemology is situated - thus experience again becomes a central philosophical theme, but with a completely new meaning - "In the end experimental conditions are the same as preconditions of experimentation."[21] The 'objects' of these experiments must be understood in a new manner.[22] Bachelard concludes "if one is to hold one's position at the centre of the working mind and of worked matter, one must abandon many philosophical traditions of the native translucence of the intellect and of the reality of the sensory world."[23]

Here we have defined the epistemological disciplines that fill the blanks on the philosophical spectrum, on the level of scientific activity. They are 'Applied Rationalism' and 'Technical Materialism'. The two disciplines are reciprocal - in the production of concepts attention must be paid to the conditions of application of the concepts; conversely the problems of assembly must integrate into their solution the theoretical conditions of their formulation.[24]

So Bachelard studies the realities of research, at the level of the difficult formulation of problems. He introduces[25] the concept of the problematic to indicate a structural field, to explain the set of concepts of technical materialism within the metaphor of a field structured by two operations - experiment and definition. The problematic is the positive notion which 'stands in for something else' - for the philosophical idea of the given.[26] "(Against the parade of universal doubt), scientific research demands the setting-up of a problematic. Its real starting point is a problem, however ill-formulated. The scientific ego is then a programme of experiments; while the scientific non-ego is already a constituted problematic."[27]

Bachelard goes further in the determination of the structure of all production of scientific concepts. The problematics of the different sciences are not wholly independent of each other, but only relatively autonomous, and zones of over-lap may appear. (What Bachelard terms transrationalism establishes itself at the end of prolonged theoretical labour, by the intermediary of algebraic organization. It is at the level of ever-more precise variables that interferences between domains of rationality can arise).

The organization of the production of scientific concepts is materialized in the form of institutions, meetings, colloquia etc., i.e. a 'city of science'. This has communications within itself (a 'mutual

pedagogy'), so theories circulate more rapidly, and permit an acceleration of discoveries. The city's cohesion allows the elimination of every aberration related to the subjective character of any researcher - thus modern science is freed from reveries. In this sense it is more difficult for epistemological obstacles to form, thus the apparent acceleration of present scientific time, although their appearance is inevitable (above).

Thus the 'city of science' creates its own norms, maintaining the criteria of objectivity and truth; this function is shown in the technical region, where one can read in material form the general characteristics of the 'city of science';[28] thus the 'city of science' stands in for the 'Reason' of philosophers.[29]

Bachelard's epistemology erects the concept of a theoretical mode of production. This allows: firstly the characterization of the obstacles in an ideology of science, and secondly to think the transition from one given mode of production to another - the new concept of the history of the sciences.

The obstacles in an ideology of science which oppose the construction of the concept of its history are threefold:[30]

(1) That science is a unity - "Science (in the singular) is neither a philosophical category nor a scientific concept, but an ideological notion. The object it designates does not exist. Sciences (in the plural) however do exist."[31]

(2) That the development of science is continuous and uniform - a temporal aspect of the essential unity of science (no breaks, recrystallizations etc).

(3) The unity of the different interpretations of what science is in its essence (positivist, pragmatist, conventionalist) is the empiricism which lies in the definition of the 'pseudo-object' adopted by the history of science conceived as a history of methods and results.

The history of a science can only find the concept of its object in the science of which it is the object; the real history of the science is the real conditions of the production of its concepts. Further, each science is irreducible, a practise. A science is born by constituting a body of concepts with their rules of production, the development of a science is the formation of the concepts and theories of that science. Different sciences have different forms of development, and within the nominal unity of a single science, concepts or theories may have different developments, types of constitution of formation. The history of a science implies an epistemology - the theory of the scientific production of the concepts and theories of each science. (The exact point of contact between the epistemology and the history of the science is difficult to delimit).

The question thus posed is to know how a philosophy of science in action can think its relation to the history of science - "the modern point of view thus determines a new perspective on the history of the sciences, a perspective which poses the problem of the current effectivity of this history of the sciences in scientific culture."[32] This history of the sciences cannot therefore be a "history like the others",[33] it is not only the narration of events, but a duplicated history in which the unfolding of values duplicates that of facts.[34] It is not a question of reliving the past but of judging it, for "once the solution is found, its clarity lights up the previous data." "This new perspective on the history of the sciences is precisely recurrent history."[35]

The history of the sciences therefore presupposes the filtering or critical function of an epistemology directly informed by the activity of science - it constitutes its object by judging the claims of past judgments to truth on the basis of contemporary scientificity. This critical function allows the distinction between an outdated history and sanctioned history - the current past.[36] The dialectic of the liquidation of the past is translated into that of obstacles and epistemological acts. It is in respect of recurrent reflection that the acts are confirmed as such and the obstacles recognized as overcome or avoided.

Historical epistemology teaches that science progresses by means of mutations, reorganizations of its principles. The history of the sciences must itself be dialectical. The use of historical recurrence is only legitimately founded if the science concerned has itself attained the level of rigour which makes it possible to reorganize the hierarchy of epistemological values and through it to discern the real state of the genealogy of the concepts. One must beware of false recurrence, but affirm the progressive value of the scientific past. In a recurrent history "the consciousness of modernity and the consciousness of historicity are rigorously proportional",[37] and the history of a science is never completed for an epoch.

Since Bachelard's epistemology is a history in action, its history continually threatens to dissolve into the current epistemology, so it seems that the historicity of science is biased much more towards its future than its past.[38] So a history is a discourse (based on a current past) on a past as such - the history of recognized errors.

Historical time is abolished in this logical time which the epistemology creates. The construction of this 'real' time of science poses two problems, which lead onto a consideration of the limitations of Bachelard's epistemology.

(1) That a critical history is the 'fruits of past errors', and that it finds the norms of its jurisdiction in the current rationality of the work of science.

(2) The epistemological problem of the status of past truths.

The source of the limitations of Bachelard's epistemology is that the epistemologist and the historian of the sciences are located by Bachelard only with respect to the development of the science in question.[39] Its progressive side comes from (1) its denial of any empiricist history of the sciences - the history will always be epistemologically grounded departing from scientific rationality. (2) It never departs from givens - so the events of any history are never equivalent as elements, - there is at every point a division between scientific objectivity and ideology.[40]

However, Bachelard's epistemology is ideological because it has no concept for the possibility of its hisotry; he does not pose the conjunction of science and ideology and their reciprocal determination. Thus there can be no 'eternal truths' that are not relative to a 'current past', indeed to select elements (sanctioned and errors) from their particular problematic is to fall into empiricism.[41] For the recurrent judgement must conflate the epistemological break that originates the science with the

reorganization of the problematic of the science - thus removing the concept of the epistemological break from the corpus of the concepts of history insofar that it is continually shifted forward.[42]

"Scientific knowledge only exists in opposition to, by overcoming, epistemological obstacles. But to theorise epistemological obstacles, i.e. what prevents the existence of science, a theory of something other than science is required; a theory of ideology - i.e. a theory of the ideological instance in the social formation. Hence a theory of the history of a science cannot entirely be independent of the theory of history in general, historical materialism."[43]

In thinking the problem of epistemological obstacles solely from the side of science and the scientist Bachelard turns to psychologism - epistemological obstacles have no historical location; they are assumed to be universal and natural products of the human mind.[44] Thus the natural tendencies of the mind are anti-scientific, and science is a constant struggle against the psychological traps lying in wait for each scientific concept, the epistemological obstacles.

This concept of the 'scientific mind' explains the nature of Bachelard's polemic, that of philosophy secreted in the development of each science against the claims of other philosophies over the sciences; these latter lodge in the niches provided by the ideological obstacles that the mind creates for the concepts of science, forming the philosophical spectrum.[45] Thus there is no positive role for philosophy, it has no history; the true epistemology of the science in question has only a fleeting existence in the science's rejection of the claims of these philosophical hangers-on.

This shows no internal inconsistency.[46] However, the anhistorical nature of the psychological obstacles to be overcome in the establishment of a science has its converse side - a necessary set of stages, a hierarchy of rationalities in the constitution of scientific concepts - the epistemological profile. Three consequences follow:

(1) This demands an evolutionist conception of the history of the sciences - but what then of recurrence and the double history of the sciences? (c.f. n38).

(2) Each science is seen in isolation according to its place in the evolutionary scheme, and each science is essentially similar in kind - but what then of the histories of the sciencies?

(3) A general theory of scientific rationality is set up corresponding to the last phase - that of discursive reason; but what then of the attack on philosophy for attempting to prefound the truth of scientific statements?

Another contradiction arises from the individualism of this psychology of errors. Although Bachelard correctly sees scientific knowledge as a collective activity - uniting collective rational activity and collectively controlled experimentation - he conceives error as individual, for although archetypal, it manifests itself in the individual scientist. Thus the role of the 'city of science' is to guard against the aberrations of the individual psyche, and to guarantee the progressive sequence of the epistemological profile. The 'evolutionism' of the epistemological profile is accompanied by a historicism of the social conditions of existence of the historical mind.[47]

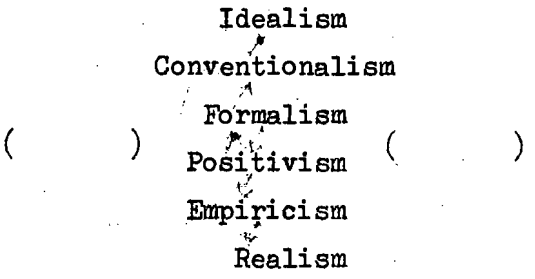
Thus the philosophy of knowledge re-enters by the back-door of psychology, and it can do this because Bachelard can only make general statements from a position outside particular sciences,[48] and, lacking any theory of the outside of science, he lapses into a traditional philosophy of knowledge with its categories of subject and object.[49]

This contradiction can only be resolved by situating science with respect to the ideologies with which it breaks - i.e. by a theory of 'epistemological obstacles' as part of the ideological instance of the social formation.

Tim Jenkins.

Notes

1. "of the recrystallization of concepts in modern physics and chemistry associated with the name of Einstein."
2. "Agnostic idealism" against the previous "mechanical materialism."
3. In the 'La Philosophie du Non', (1940), tr. as 'Philosophy of No', (1968).
4. The 'new philosophy' will fill the blank spaces in the 'philosophical spectrum' - from 'Le Rationalisme Appliqué', (1949):



"Bachelard seeks in the use of the 'philosophical spectrum' to demonstrate the hierarchization of philosophical doctrines - 'inner' submitted to 'outer' doctrines in the unity of both sides of the spectrum. The blanks, situated on a different plane, indicate the philosophy adequate to think the sciences, which is thus conceived of as partaking of none of the ideological invariants of the philosophy of Idealism-Realism." - Lecourt in "L'Epistemologie historique de Gaston Bachelard", (1970).

5. Lecourt ibid.
6. "It will be the consciousness of a mind that founds itself by working on the unknown." 'Philosophie du Non', p.9.
7. "There cannot be any unitary epistemology - it is at the level of each concept that the precise tasks of the philosophy of the sciences are posed." ibid. p. 14.
8. Lecourt op. cit.
9. This 'historicity' enables Bachelard's epistemology to comprehend the invariance of the discourse of ideological philosophy. In this (latter) the invariant of knowledge "is the comprehending subject confronting the entity which has the character of a given empirical reality." - Bachelard.
10. equals: "comprehension/entity."

11. Thus there is no philosophically defined world of things in themselves which empirical science appropriates either asymptotically or piecemeal. Nor is there any philosophically defined consciousness to which all scientific statements can be reduced.

12. Brewster, 'Theoretical Practise' 3-4, (1971), pp. 25-37.

13. Under this definition the concept of the dialectic does not coincide with any in traditional philosophy - nor could it given the situation of Bachelard's philosophy with respect to traditional/previous philosophy. (See Canguilhem (1970) - 'Etudes d'Histoire et de Philosophie des Sciences').

14. It is worth noting here that this dialectic operates after the epistemological break that constitutes an open science from a previous ideology, and therefore the historicity of Bachelard's epistemology only operates within this openness. Science is therefore a given. This will be returned to below.

15. "It is not a matter of considering external obstacles such as the complexity and fleetingness of phenomena, nor of blaming the weakness of the human senses and mind: delays and disturbances occur intimately in the very act of knowing, by a kind of necessity."

16. "Over-familiar scientific ideas become charged with too much psychological concreteness, they collect too many analogies, images and metaphors, and lose little by little their abstract vector, their fine abstract tuning."

17. Philosophies are produced as a result of scientific advance with the aim of reuniting the world of knowledge and experience which each new science and each new scientific advance shatters. Hence the philosophies can be defined in a spectrum around ongoing science in terms of their displacement from science. - Brewster op.cit.

18. Thus a science is not the exhaustive investigation of a closed domain defined a priori (by sensory experience, philosophical fiat or scientific hypothesis). Once it has made its break with common sense experience and the theoretical modes of thought anchored in common sense experience by an epistemological break, its future is completely open.

19. See 'Le Rationalisme Appliqué'.

20. Thus "Phenomenotechnics extends phenomenology. - A concept has become scientific in so far as it has become technical, i.e. that it is accompanied by a realizatory technique," in 'La Formation de l'Esprit Scientifique', p.61 (1947).

21. 'Le Nouvel Esprit Scientifique', (1934), p.13.

22. ibid. p.9.

23. "The meson, at the junction of the most abstract theory and of the most painstaking technical research, is now a particle with that double ontological status required of all the objects of modern physics." - 'L'Activité Rationaliste de la Physique Contemporaine', (1951).

24. ibid.

25. This distinction devalues the notion of 'method' - "the Cartesian notion of 'general scientific method' is vacuous, lacking the real movement of knowledge."

26. In 'Le Rationalisme Appliqué'.

To elaborate-"Compared with the Cartesian method; if one admits the existence of a general method of scientific knowledge, the doubt which is the first moment of that general method can never achieve specificity -

it's purely formal, not allowing the production of any correction and hence of any knowledge". (All this depends in the last analysis on the philosophical idea of looking outside knowledge for an object to serve as its foundation. - Lecourt, op.cit.).

27. 'Le Rationalisme Appliqué', p.51.

28. e.g. Bachelard points to the standardized chemical reagent.

29. It is here that Bachelard attempts (in 'Le Rationnalisme Applique') to found the apodicity of scientific values in a psychologistic vocabulary.

30. Michel Fichant: 'L'Idée d'une Historie des Sciences' in 'Sur l'Historie des Sciences', ed. M. Fichant and M. Pêcheux, (1969).

31. Althusser.

32. 'L'Activité Rationnaliste de la Physique Contemporaine', p.24.

33. 'L'Actualité de l'Historie des Sciences', (1951), p.6.

34. ibid. p. 10.

35. 'L'Activité Rationaliste de la Physique Contemporaine', p.26.

36. ibid. p. 25.

37. 'L'Actualité de l'Histoire des Sciences', p.9.

38. "Recurrence is then substituted for teleology - the concern for sources, ancestries etc.
(1) Teleological analysis treats the statements of sciencs as things. It dissociates them, separates and reduces them, links them together as container to content, or cause to effect. This reduction makes two confusions:
(a) that of the statements of the sciences with the object to which they refer.
(b) that of this object (the object of science) with things offered to perception, whereas the object of science is a theoretical, constructed object, an object 'in thought' and not a concrete thing given as the support of its perceivable properties.

(2) Teleological analysis rests finally on the confusion of the real and knowledge, in an empiricist mode which confers the properties of the real onto knowledge. Science is the disclosure and the formulation of the real. - This empiricism reduces the concept to the word (nominalism) - also to a formalism - it conceives the statements of science not as the registration and production of a concept, but as the formulation of a pre-existing real - successive formulations only 'translate' this 'real' diversity, without affecting it in itself". - Fichant op. cit.

39. Brewster op. cit.

40. Cutler 'Theoretical Practise' 3-4, (1971), 'The Concept of the Epistemological Break', 63-81.

41. ibid.

42. ibid.

43. Brewster op. cit.

44. e.g. the 'Psychoanalysis of Fire', (1938), tr. 1964. - Psychoanalysis develops into a general 'poetics of revery' - close to Jung's theory of archetypal images.

45. Lecourt points out that the 'city of science' stands in for the 'Reason' of philosophers, but says of the psychologistic vocabulary in 'Le Rationalisme Appliqué' - "It is as if Bachelard hoped in this way to resolve a problem whose very terms were forbidden to him ever since he broke with the conception of a norm-producing Reason like the one constituted by the philosophical problematic" - he (weakly) attributes this to 'philosophical guilt', and claims (wrongly) that it is marginal.

46. Nor is it incompatible with a certain conception of Marxism, which similarly refuses philosophy anything more than an imaginary reality, reducing knowledge to a psycho-physiological faculty of the human brain - cf Godelier, 'Myth and History', New Left Review 69 (1971), 93-112.

47. c.f. "Founding the objectivity of rational knowledge on the union of experimental workers and the validity of rationalism on the consistency of a co-rationalism; founding the fertility of my learning on the division of the ego into an ego of existence and an ego of super-existence i.e. of co-existence within a cogitamus, is on the whole an ingenious attempt...but not wholly convincing." Canguilhem, Etudes p.205.

48. The way Bachelard uses examples demonstrates this. In the concrete example Bachelard takes up a position on a particular scientific development from within the science in which it takes place. Whenever he makes a general statement about the sciences he substitutes a constitutive subject in place of the concepts term in the couple used in the example, a subject which first appears in negative form as the psychological subject of error, but then positively as the scientific 'mind' of the advanced phases of the epistemological profile. - Brewster. op. cit.

49. For the theme of the impossibility of philosophical abolitions of philosophy, see Jacques Derrida 'De La Garmmatologie', (1969). Also Althusser in 'Lenin and Philosophy', (1971), pp.59-60.