The Cambridge History of Philosophy 1870–1945

edited by

THOMAS BALDWIN
University of York

CAMBRIDGE
UNIVERSITY PRESS

published by the press syndicate of the university of cambridge
The Pitt Building, Trumpington Street, Cambridge, United Kingdom

cambridge university press
The Edinburgh Building, Cambridge, cb2 2ru, UK
40 West 20th Street, New York, ny 10011-4211, USA
477 Williamstown Road, Port Melbourne, vic 3207, Australia
Ruiz de Alarcón 13, 28014 Madrid, Spain
Dock House, The Waterfront, Cape Town 8001, South Africa

http://www.cambridge.org

First published 2003

Printed in the United Kingdom at the University Press, Cambridge

Typeface Bembo 10.25/12.5 pt. *System* LaTeX 2_ε [tb]

A catalogue record for this book is available from the British Library

isbn 0 521 59104 x hardback

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POSITIVIST THOUGHT IN THE NINETEENTH CENTURY

ROM HARRÉ

INTRODUCTION

The positivist impulse, to accept only what is certain and to reject anything in any degree speculative, from its earliest intimations in classical Greece to its most recent revival in contemporary anti-realist philosophy of science, expresses itself in two main ways. It appears as a doctrine about the limits of what human beings can legitimately claim to know, displayed as an austere epistemological attitude. This leads to a foundationalism according to which only what is immediately given by the senses can be known for certain. It also appears as a doctrine about what can legitimately be taken to exist, displayed as an austere ontological attitude. This leads to a scepticism about the existence of unobservables of all sorts, from God to the material substance thought by many philosophers and scientists to account for common experience. Positivism is at root driven by an impulse, attitude, or frame of mind, which expresses itself in a variety of philosophical theses and arguments. That positivistic arguments and analyses are found convincing has perhaps more to do with an attitude of austerity and scepticism, than with their intrinsic worth. Always ready to wield Ockham's Razor against the proliferation of kinds of entities which people are tempted to believe in, positivists could be said to hold that it is better to accept less than one perhaps could, for fear of believing more than perhaps one should.

The topic of this chapter, the rise of positivism in the nineteenth century, picks out just one of the high points of a repeated cycle of waxing and waning enthusiasm for positivist austerity. Harsher and more relaxed attitudes to what one should reasonably believe have come and gone since antiquity. In the sixteenth century the debates about astronomy turned on an opposition between positivism and realism in science. Should one believe in the reality of the heliocentric theory or was it just a convenient calculating device for predicting the comings and goings of 'lights in the sky'? Considerations rather like those canvassed in the contemporary controversies in philosophy of science were advanced by the protagonists of each position, such as the positivist Osiander and the realist Kepler. In the eighteenth century the positivist impulse led some authors, especially Berkeley, to a kind of idealism, at least with respect to our knowledge of the material world. Only that which was perceptible should be held to exist. But in the nineteenth century positivism stood in opposition to idealism, yet in paradoxical ways. Its most powerful and influential nineteenth-century advocate, Ernst Mach, seemed to share a great deal with Berkeley. Both thought that the human senses provided not only the only proper grounding for claims about material reality, but also exhausted the realm of the real. Berkeley's hypothesis of a spiritual, that is, non-material, power to account for what people experience, might have been anathema to Mach, but was revived by another influential nineteenth-century adherent to the positivist attitude, Herbert Spencer.

For expository purposes one can divide the dramatis personae of the philosophical advocacy of positivism into three national groups. In Germany a form of positivism developed among physical scientists, consciously in opposition to the prevailing idealism of German philosophy. To some extent these overtly academic debates reflected important disputes about the hegemony of disciplines in the German universities. The positivist philosophers, such as Mach, were professional scientists. For them such Hegelian definitions as 'This *vanishing* and *self-generation* of space in time and time in space, a process in which time posits itself spatially as *place*, but in which place too, as indifferent spatiality, is immediately posited as temporal: this is *Motion*' (Hegel 1830 [1970]: 41) were not far short of insulting. In France the positivists were part of the anti-clerical movement which was expressed in the revolution of the late eighteenth century. Auguste Comte formulated positivism in the context of a history of the emancipation of the intellect from the superstition and myth he found in the institutionalised religion of his time. The scientific roots of French positivism were in the human sciences. In England the authors who advocated and defended something like positivism were united only by their positions in certain methodological controversies in the philosophy of science. William Whewell's Kantian defence of the priority of concepts over facts was famously disputed by J. S. Mill in a defence of a strong empiricism which had affinities to Comtian thought, and seemed to anticipate much that was argued for by the German physicists of the last half of the century. But there was no political commonality among English positivists. Mill was a man of the left, while Pearson held views that in our times would have been thought close to fascism.

In the nineteenth century the positivist attitude appeared first in France (Comte's *Cours de Philosophie Positive* began to be published in 1830), then in England (Mill's *A System of Logic* appeared in 1843) and finally in Germany

(Mach's *Science of Mechanics* appeared in 1883). Not surprisingly it was the writings of Mach that, in hindsight, can be seen as having the most influence in the twentieth century.

POSITIVISM IN FRANCE: REINVENTING MORALITY IN A SECULAR WORLD

While there is no doubt that French positivism grew out of the critical philosophies and anti-clerical sentiments of the eighteenth century (Comte himself professed Saint Simon as his mentor), as Charlton (1959) points out in his comprehensive study of French thought in the middle of the century, those we might lump together as positivists, in their reliance on the senses as the exclusive sources of knowledge, held rather diverse views on how moral and political principles were to be created to replace those which their criticisms of religion would have eliminated. Yet, unlike the arrogant 'puritanical' reductionism of Ernst Mach, most acknowledged the existence of irresolvable mysteries, *inconnaissables*, and all recognised the difficulties of constructing a plausible and satisfying positivist ethics.

Auguste Comte (1798–1857), very much in the manner of his times, built his philosophy on the idea of a three-phase development of ways of understanding. Rather than describe these phases or styles as stages, he prefers to call them states or attitudes of mind, since he saw around him examples of people thinking in all three of the main ways he discusses. In the 'theological state of mind' a person looks for explanations in terms of the 'continuous and arbitrary actions of supernatural agents' (Comte 1830–42 [1864]: 5). The next, more advanced, state of mind is only a modification of the first, replacing supernatural agents by 'abstract forces . . . capable of giving rise by themselves to all the phenomena observed' (p. 5). In the third or positive state the human mind 'endeavours now to discover by a well-combined use of reasoning and observation, the actual *laws* of phenomena . . . that is to say, their invariable relations of succession and likeness'.

In a striking passage (Comte 1830–42 [1864]: I, 23) Comte slips from a repudiation of the search for first or final causes to a rejection of an interest in causes at all: 'we do not pretend to explain the real causes of phenomena, as this would merely throw the difficulty further back' (p. 23). All that Newton's Law of Gravity can do is to show us a great variety of phenomena as 'only a single fact looked at from different points of view . . . the weight of a body at the earth's surface' (p. 26). So stringent was Comte's empiricism that he famously and unwisely chose the chemical composition of the stars as a prime example of unattainable knowledge.

A historian would see much of Hume in Comte's writings on the positive philosophy when applied to the natural sciences. But on psychology Comte was quite opposed to the Humean project of psychology as the study of the relations of ideas. He denied that we 'can discover the fundamental laws of the human mind, by contemplating it in itself'. The way forward was the 'physiological study of our intellectual organs'. French positivism was fiercely materialist. Not only were explanations to be reduced to laws of correlation of phenomena, but the phenomena too were exclusively material.

The laws of society ought to be discoverable by exactly the same methods as those by which the laws of material nature had been arrived at. It should be possible to devise a scientific sociology. By the four methods of Observation, Experiment, Comparison, and History we could arrive at laws of society without positing any unobservable causes. But these too will only be available to those whose 'state of mind' has passed from the theological through the metaphysical to the positive, seeking only correlations among social phenomena. Since not everyone can aspire to this degree of perfection Comte advocated the fabrication of a suitable religion to take the place of superstitious faiths of the time. But how was this to engender a morality? As Charlton (1959: 49) puts it: how can one be a positivist and yet provide an 'objective, authoritative ethical system'? If we are confined to phenomena how can we make the passage to such a system? From whence comes an 'ought' from a world of 'is'? Progress, according to the threefold scheme of 'states of mind', must pass from the theological to the positive, and this will of itself engender the new social morality. In the positive state of mind the true decency and generosity of human nature will come to dominate social relations. This is the 'law of progress'. Sociology is like a medicine for the ills of the state, letting natural health shine through. Since the main bar to progress is the persistence of primitive attitudes of mind, the cure is at hand – change the attitudes. But Comte certainly respected the role that religion had had in supporting morality, and he published a catechism for those who would 'take instruction' in the new religion (Comte 1852).

The next generation of positivistically oriented philosophers in France is typified by Hippolyte Taine (1828–93). In his own time Taine was famous, perhaps one could say notorious, for his attack upon the characters and the motives of the main figures of the French Revolution. His philosophical writings were also uncompromisingly critical of received opinion, in particular on those aspects of human life where spiritual or non-material entities and processes had been given a central role. Along with his criticisms of the revolutionaries went a reductionist treatment of moral qualities. In his *D'Intelligence* (1870) he set out an account of those aspects of human life that had been assigned to a mental substance, especially by Descartes, wholly in terms of the contents of conscious experience. He declared that both the 'self' (*le moi*) and material 'substance' were illusions. 'There is nothing of reality in the self but a stream of events' (quoted in Charlton 1959: 137). His metaphysical austerity is very much in the Comtian style. 'All reality', he declared, 'is perceived experientially by man'.

But his critical account of Mill's philosophy, *Le positivisme Anglais* (Taine 1864), shows how much his positivism differed from the strictly empiricist 'archetype', according to which natural regularities might have been otherwise, and hence their expression in empirical generalisations must be contingent. Causality was not a natural necessity, but merely a psychological product of the constant experience of experiential regularities. However, according to Taine, laws of nature and of psychology were indeed discovered by abstraction from catalogues of facts, but they were necessary causal truths. This allies him with the 'Kantians' like Whewell and Helmholtz, both of whom played important parts in the English and German versions of positivism.

In applying his positivist psychology, Taine was especially critical of the idea that works of art were the product of a special faculty, an individual spiritual teleology, and in his *Philosophie de l'art* (1865) he offered a systematic account of artistic excellence in the same manner as he had earlier dealt with other intellectual, mental, and moral qualities of human beings. The circumstances, not the artist, were responsible for the production of works of art. In the first place a work of art was an imitation of its model, but not too much. To understand a work of art 'it is necessary that it represents exactly the general spirit and customs (*moeurs*) of the time at which it appears' (Taine 1865: 7). He remarks that these constitute the primitive cause that determines all the rest. But there are secondary conditions, and these amount to the existence of a cultivated public who can recognise the work as according with the spirit of the times. Furthermore a work of art expressing a certain emotion will affect only those who have already experienced such an emotion. Culture is like the geographical conditions that determine what sorts of plants will grow in a certain place and time. This account is worth a fairly detailed exposition since it brings out another strand in positivist thought, the tendency to look for the sources of psychological phenomena in the environment rather than in the workings of an individual mind.

In summary, we can see that French positivism was anti-theoretical, strongly empiricist in the sense that the only legitimate source of knowledge was human sensory experience. However, the writings of Comte and Taine illustrate the extent to which French philosophers of the period were well aware that the sensationalism and environmentalism that they favoured in psychology left questions of great moment still unanswered. Above all they pondered the question 'How to live?'

POSITIVISM IN ENGLAND: WHAT IS SCIENTIFIC KNOWLEDGE?

The positivist quest for a firm basis for knowledge led back always to what could be discerned by the use of the five senses. Yet data derived in this fundamental way were local and particular. The known laws of nature and the anticipated laws of human thought and social action were evidently universal and general in scope. How could the one be related to the other? Two answers had been proposed in the late eighteenth century. According to Hume the generalisation of patterns of concomitance in experience were at best guides to practical action, but, from the limited evidence available, they could not be certified as necessary truths. According to Kant the basic laws of nature were synthetic a priori propositions expressing the forms within which human experience had to be framed. Comte took the Humean stance while Taine's views were Kantian. The same opposition characterised English philosophy of science in the nineteenth century.

John Stuart Mill (1806–73) published his *System of Logic* in 1843. Its influence was immediate and long lasting. It became a standard textbook in the universities and was generally taken to be a definitive account of scientific method for the rest of the century. In Book III Mill presented a set of principles by the use of which reliable knowledge of material causes could be arrived at. Mill's philosophical outlook owed a great deal to his youthful enthusiasm for the ideas of Saint Simon and, from these, to the writings of Comte. The principles upon which Mill proposed to found an Inductive Logic, to set alongside Deductive Logic as a method of proof for the empirical sciences, are the famous Canons of Induction. Clearly influenced by Bacon's *Novum Organon* (1620), Mill based his system on the distinction between ephemeral and permanent causes (Mill 1843 [1862: 258]). Finding a regular concomitance between paired types of events gives us a hint that the one might be the cause or part of the cause of the other. This hint is confirmed, usually by deliberate experiment, if it is found that in the absence of the putative cause no event of the correlated type occurs. For permanent causes like gravity one must look to see if variations in the one are correlated (or anti-correlated) with variations in the other. Mill describes his Canons as 'the only possible modes of experimental enquiry – of direct induction *a posteriori*, as distinguished from deduction' (Mill 1843 [1862: 266]). Not only were the laws of physics and chemistry arrived at by induction, but so were the laws of arithmetic and geometry. The laws of logic were the laws of thought. This was a thoroughgoing empiricism. To the objection that all this was based on data that were local in both space and time Mill answered that the Uniformity of Nature upon which the formal validity of his 'inductions' depended was itself a 'complex fact' arrived at by the same methods (Mill 1843 [1862: 206]), an application of the 'boot-strap principle'.

The dominant figure in British philosophy of science at the time Mill published his *System of Logic* was William Whewell, Master of Trinity College, Cambridge, friend and mentor of Michael Faraday, and of whom it was said 'his foible was omniscience'. Whewell had argued, with a multitude of examples, that facts could only be discovered by the application of prior hypotheses to inchoate experience. Such hypotheses were initially relative to their immediate applications, but refined as a kind of dialectic between ideas and facts unfolded through the pursuit of experimental programmes, driven by the newly revised ideas (Whewell 1847: I, 42). Hence, Whewell declared, Mill's four methods or canons were not and need not be employed in the process of discovery.

Mill, granting that his four methods might not be methods of discovery, insisted that they were the indispensable methods of proof. For Whewell new facts brought forth new hypotheses leading to a gradual refinement of hypotheses. For Mill something like proof was called for. According to Mill it is modes of thought that produce errors. 'Hence it is that, while the thoughts of mankind have on many subjects worked themselves practically right, the thinking power remains as weak as ever . . . in what relates to the invisible world . . . and to the planetary regions, men of the greatest scientific achievement argue as pitiably as the merest ignoramus' (Mill 1843 [1862: 285]). Of course what they need is Mill's Canons, a strict method of proof. 'The business of Inductive Logic is to provide rules and models . . . to which, if inductive arguments conform, those arguments are conclusive, and not otherwise' (Mill 1843 [1862: 283]).

It seems that Mill was not seriously troubled by the problem that had been much in the minds of the French philosophers of the positivist frame of mind: namely, how is it that from a basis of the sensations of individual human beings, we, those human beings collectively, arrive at a common material world, a commonality obvious in even the simplest activities that we engage in, individually and collectively? The methods Mill advocated were not techniques for bridging the gap between sensation and reality, but for bridging the gap between local and general facts about that common world.

Despite the success of Mill's point of view with many scientists, and the popularity of a strict empiricism with chemists, many of whom rejected the reality of chemical atoms, the necessity for some a priori principles in science was still felt by some positivists, in particular Karl Pearson (1857–1936). Pearson virtually created the modern mathematical science of statistics. His enthusiasm for it led him into both philosophy of science and politics. In the latter he became the academic leader of the eugenics movement. From his eponymous Galtonian chair in the University of London he advocated the state control of human breeding. In philosophy of science his rejection of the idea of any real uniformities behind observable variations led him to a kind of positivism. The idea of natural homogeneities is a metaphysical conceit. Pearsonian statistical curves were mental constructs summing up the data and no uniform underlying causes could be inferred from them. His book, *The Grammar of Science* (Pearson 1892), coming decades after Mill's empiricism, served to boost the positivistic point of view against the rising tide of British idealism. Since all we have are simple sensory experiences, how could the complex material world, as we perceive it and as the natural sciences seem to reveal it, be possible objects of a common discourse? Here again is the same problem that troubled the French positivists. Pearson resorted to a Kantian solution.

> such an [external] object [for example a blackboard] must be recognised as largely constructed by ourselves; we add to a greater or lesser store of immediate sense-impressions an associated group of stored sense-impressions. (Pearson 1892: 41)

> But the things-in-themselves which the sense-impressions symbolise, the 'reality' as the metaphysicians wish to call it, at the other end of the [sensory] nerve, remain unknown and unknowable. (Pearson 1892: 63)

> The fact that the human reflective faculty is able to express in mental formulas the routine of perceptions may be due to this routine being a product of the perceptive faculty itself. (Pearson 1892: 112)

Indeed Pearson's views were described by Peirce (1892) as 'Kantian nominalism'. The laws of nature were not just generalisations or abstractions from catalogues of simple experiential facts. They were 'products of the perceptive faculty'. 'The logic man finds in the universe', said Pearson, 'is nothing but the reflection of his own reasoning faculty.' There is no knowable reality (in both senses of 'know', *savoir* and *connaître*) other than the sensations of the individual consciousness. The motivation for science as the abstraction of statistical regularities is 'economy of thought'. There was a shared common world only because each mind was furnished with the same a priori principles.

The influence of Hume can surely be discerned in Pearson's remark that 'what I term "myself" is only a small subdivision of the vast world of sense-impressions' (Pearson 1892: 66). Significantly Pearson reproduced Mach's famous drawing of his own field of vision, looking down his lounging body to his feet. It is not surprising that Pearson remarked that matter, force, and action at a distance 'do not express real problems of the phenomenal world'.

POSITIVISM IN GERMANY: PHYSICISTS AS PHILOSOPHERS

In the German story we have a grand opposition between claims to knowledge based on scientific research, positive science, and what were seen as not much short of mystery mongerings, claims to knowledge based on Neo-Kantian philosophical speculation. Here we have German positivism in conflict with German idealism. But within the German-speaking scientific community another division appeared. On the one hand were those scientists who adopted a strong reductive empiricism, such as Mach, and on the other those who took theory to be a source of reliable knowledge, as good as or better than experiment and observation, physicists such as Hertz and Boltzmann. Here we have a more tightly defined kind of positivism in opposition to scientific realism. To make the 'internalist' history of the movement even more complicated one of the major figures, Herman Helmholtz (1821–94), developed a strongly Kantian account not only of the natural sciences, but also of the very possibility of perception. But at the same time, and almost within the same breath, he eschewed any projection of the conceptual basis of physics onto the material world.

The breadth of Helmholtz's contributions to science is astonishing (Turner 1980). He contributed not only to the physiology of both visual and auditory perception, but also to hydrodynamics and to electromagnetism. He was sceptical of metaphysics and committed to a theory of science according to which the mathematical generalisation of empirical observations and experimental results was the ultimate aim of research. Laws of nature were summaries of facts and their utility was practical. So far he would seem to have been more or less of the same opinion as Mach and Mill. But his neurophysiological work, developing Müller's law of specific energies – that it was the perceptual organ that determined how a stimulus would be experienced – was strongly Kantian. Indeed, he claimed that his work on the neurophysiology of perception confirmed Kant's general thesis as to priority of concepts, in particular the concept of causality. The causal order in experience was imposed by the human mind. His empiricism was very unlike that of Mill. Indeed, had he been asked, he would probably have sided with Whewell in the great controversy.

Helmholtz was well aware of the problem that has dogged positivism in all its various manifestations. If the ultimate source of reliable knowledge is immediate sensory experience of individual people, how can it give rise to impersonal knowledge of the kind the natural sciences seem to provide? Helmholtz's solution invoked the a priori law of causality. Everyone believes that external objects are the cause of our perceptions. Why? The experiential ground is that they change without our volition. But we do not pause, as it were, and try to work out why this might be so. Rather we make instantaneous 'unconscious inferences' (*unbewusste Schlusse*) so that our sensory experience is taken to be of a real, material world. These inferences are driven by the a priori law of causality. But, unlike Kant, Helmholtz held that space and time, as empirical givens, were constructions, the result of unconscious inferences under the influence of the law of causality of the same sort that gave us material things.

Of all the positivistically inclined writers of the nineteenth century there is no doubt that Ernst Mach (1838–1916) was the most influential on subsequent generations of philosophers and scientists. His three most influential works, *The Science of Mechanics* (1883), *The Analysis of Sensations* (5th edition, 1906) and *Popular Scientific Lectures* (1894) were widely read, quickly translated, and often quoted in the decades that followed. Many of the most characteristic theses of the Logical positivists of the Vienna Circle can be found explicitly formulated in Mach's writings.

Mach's positivism did not emerge from philosophical reflections on epistemology, but from his long-running programme to rework the foundations of physics in such a way as to eliminate the unobservable domain from the ontology of the natural sciences, and particularly to eliminate any traces of reference to absolutes. He described his project very clearly:

> My definition [of 'mass'] is the outcome of an endeavour to establish the interdependence of phenomena and to remove all metaphysical obscurity, without accomplishing on this account less than other definitions have done. (Mach 1883 [1893: 267])

His method was simple. He set out to show that all concepts in physics that purported to refer to unobservable properties, entities, or relations, including 'quantity of electricity' and 'temperature', could be defined in terms of observable properties of material set-ups, such as the mutual accelerations of visible and tangible bodies. Newtonian mass, as the quantity of matter in a body, was not only an absolute, but also, in Mach's terms, metaphysical since unobservable.

Perhaps his best known 'reduction' of absolutes is his criticism of Newton's famous thought experiments – the rotating globes and the spinning bucket – which seemed to show that there could be an experimental proof of the existence of absolute space and time. The arguments turned on the principle that if the relevant *concept* can be parsed out of the discourse then that to which it seems to refer is redundant. The concept of 'mass' can be eliminated from the discourse of mechanics, so mass as quantity of matter can be dropped from our ontology. Similarly with absolute space and time. It is a mistake, so he claimed, to substitute a 'mechanical mythology' for the 'old . . . metaphysical scheme'. 'The atom must remain a tool for representing phenomena, like the functions of mathematics' (Mach 1894: 205).

Summing up his point of view, Mach claimed that the laws of nature were nothing but devices for 'the communication of scientific knowledge, that is a mimetic reproduction of facts in thought, the object of which is to replace and save the trouble of new experience' (Mach 1894: 192).

But what were the phenomena, the facts? Examining a 'province of facts' 'we discover the simple permanent elements of the mosaic' (Mach 1984: 194).

According to Mach the only positive knowledge one can have is knowledge of one's own sensations. How does this escape a charge of solipsism? This leads him to a strongly reductive account of material objects:

> In mentally separating a body from the changeable environment in which it moves what we really do is to extricate a group of sensations on which our thoughts are fastened and which is of relatively greater stability than the others, from the stream of our sensations . . . It would be better to say that bodies or things are compendious mental symbols for groups of sensations – symbols that do not exist outside of thought. (Mach 1894: 200)

This sounds very much like subjectivism. Mach's escape route from the threat of solipsism is via the concept of uniform 'elements'. Only when considered 'in connection and relation to one's own body' are elements sensations. Considered in relation to each other they are properties of material things. But things are not substances. Substance words simply name groups of elements that remain together in experience.

A parallel path was taken by Richard Avenarius (1843–96). His work added little to the core of Machian positivism. However he did influence one important 'philosopher-king' of the twentieth century, V. I. Lenin. Avenarius introduced the term 'empirio-criticism' to describe his version of positivism and it was against that that Lenin wrote his most important philosophical tract in support of his pragmatist scientific realism (Lenin 1920). Like Mach, Avenarius restricted knowledge to 'pure experience', saw scientific method as driven by the need for economy of thought and argued for the complete elimination of metaphysical categories. He phrased this as a stricture on the process of 'introjection' – the imposition of metaphysics on to experience – which was just the very thing that Helmholtz had required in order to make sense of human experience, of our universal conviction that there was a material world which was other than our individual experiences. Despite the rejection of introjection, Avenarius too needed to find a solution to the threat of solipsism. His 'assumption' was less metaphysical than that of Helmholtz but served the same purpose. Each human being assumed that he or she was confronted by a material world, and that there were other human beings who were making assertions about it.

Here the path from the rejection of German idealism to an extreme anti-theoretical stance to the physical sciences reaches its logical terminus. But there were important dissenting voices in the German-speaking scientific establishment to this slide. Perhaps the two most prominent were Heinrich Hertz and Ludwig Boltzmann.

Heinrich Hertz (1857–94) is best known to philosophers for the preface to his *The Principles of Mechanics* (1894). Adopting an empiricist approach to metaphysics, Hertz was not at all averse to entertaining hypotheses about unobservable realms of the natural world, nor to devising a methodology by the use of which such hypotheses might be assessed for their verisimilitude. He was also the inventor, at least for the physical sciences, of the later-to-be-famous 'picture theory of meaning'. According to Hertz, laws of nature were pictures (*Bilden*) of facts, and it was this that endowed them with meaning. The science of mechanics could be reduced to the laws of interaction of elementary masses. However, when the totality of observable masses did not allow for the creation of an adequate picture, physicists were entitled to add more elementary masses to their scheme to enrich their picture of nature until it was adequate to the laws of phenomena. In the terminology of twentieth-century philosophy of science, physicists were entitled to create realistic models of aspects of reality that were unobservable:

> We become convinced that the manifold of the actual universe must be greater than the manifold of the universe which is directly revealed to us by the senses. (Hertz 1894 [1899]: 25)

Hertz and Mach were roughly contemporaries, but their ways of realising the anti-idealist strand in German thought was very different. Hertz's early death from an infected tooth deprived the German scientific community of an advocate of a 'positivism' which stood in sharp opposition to Machian anti-realism. The contrast between the two was well summed up by Helmholtz in his preface to Hertz's *Principles of Mechanics* (p. xx). Helmholtz says:

> For my part, I must admit that I have adhered to the latter (Machian) mode of representation [of phenomena] and have felt safe in so doing; yet I have no essential objections to raise against a method [modelling unobservable states of nature] which has been adopted by three physicists [Kelvin, Maxwell, and Hertz] of such renown.

Both Mach and Ostwald (the most influential chemist of the era) were opponents of realist interpretations of atomic theories in the physical sciences. Though both later abandoned their resistance Boltzmann felt himself to have been personally victimised by the anti-atomism of these influential men. Ludwig Boltzmann (1844–1906), along with James Clark Maxwell, had pushed forward the schematic molecular theories of the behaviour of gases that had been proposed in the late eighteenth century, mainly by mathematical analyses of the possible behaviour of swarms of molecules, relatively elementary bodies great numbers of which were the constituents of gases. Did the overwhelming power of the mathematically developed molecular theory to explain the behaviour of gases justify a belief in the existence of unobservable molecules? A strict Machian would have to say that it did not. A strict Hertzian would have to say that it did. Like Hertz, Boltzmann believed that it was both scientifically fruitful and philosophically respectable to make claims about unobservable states and processes in the material world, on the basis of the explanatory power that hypotheses of this sort gave to the mathematical abstractions from observations and experiments. This attitude did not meet with the approval of the Machian physicists of the Austrian scientific establishment. Boltzmann felt himself, rightly or wrongly, to have been persecuted by the hard-line positivists (Blackmore 1995).

The German physicist-philosophers, while insisting on a strictly empiricist account of the sources of knowledge, were not agreed on the ultimate scope of the materialist view of the world. The positivism of Mach and Avenarius restricted the ontology of physics to persisting clusters of sensations. The scientific realism of Hertz and Boltzmann advanced that ontology into a reality given to experience only in its effects.

BIOLOGISTS AS PHILOSOPHERS: THE NATURE OF LIFE AND THE REINVENTION OF MORALITY

If one thinks of philosophy in the broader sense, reflections on the Nature and Destiny of Man must surely count amongst its proper tasks. Many Victorian scientists, usually actively engaged in research projects in biology, wrote very influential works on these larger themes. In Germany, as Passmore (1957: 31) puts it, philosophically minded biologists like Haeckel, quite as much as the physicists discussed above, stood in opposition to the 'official philosophy' of the German universities, which was 'dedicated to the defence of "the spiritual life" against the inroads of natural science and of the state against radical reform'. This is something of an exaggeration. In Paulsen's (1893 [1895]) account of the German universities he remarks on the unfettered academic freedom of lecturing and research though, he concedes, in the first half of the nineteenth century 'interference was sometimes practised [by the state]; for instance about 1820 in favour of Hegelian philosophy, about 1840 against it'. In England the opposition between established religion and scientific radicalism was more muted. Most scientists, even Darwin himself, went no further than declarations of agnosticism. It is well to remember that most of the writers of the pro-science, positivist persuasion were publicists as much as they were philosophers in their commentaries on and discussions of scientific method.

Two issues commanded attention. On the matter of the origins of life and in particular the origins of the human race, Darwin and other biologists, particularly Thomas Henry Huxley, seemed to have established that the existence of human beings had a naturalistic explanation and required no special creation.

Among physiologists the dominant opinion, especially stemming from Germany, was equally uncompromising. The processes of life were at root 'mechanical' and required no special life force to explain them.

Just as positivism displayed a spectrum of views so too did the naturalistic philosophy of the biologists and those influenced by them. On the key question of the grounds of scientific knowledge, Huxley (1863) argued not only that consciousness was not a material property of the human organism but that one was forced to the epistemological conclusion that 'our one certainty was the existence of the mental world'. How this seemingly 'idealist' principle was to be reconciled with the generally materialist line of scientific thought Huxley never revealed. Huxley had published a book on Hume's philosophy. He seems to have interpreted Hume's sensory impressions as mental. Ernst Haeckel (1834–1919), on the other hand, had no hesitation in taking a strongly monistic position. The universe displays a development towards the complexity and sophistication of human life, but the whole many-layered and hierarchical reality is based firmly on nothing but the 'mechanics of atoms' (Haeckel 1899). He was also uncompromisingly against the agnosticism popular in England. There is no place for God in the story of the origins of the human race (Haeckel 1874 [1905]). Evolution is a 'mathematical necessity of nature'. Haeckel was the first to formulate the famous aphorism 'Ontogeny [individual development] is a recapitulation of phylogeny [the history of the species].' He based his arguments for an evolutionary origin for human beings on a detailed comparison between stages in the development of the human embryo and the anatomy of earlier life forms (Haeckel 1874 [1905]: 2). Haeckel's book on the evolution of the human race caused an uproar in Germany, at least as great as Darwin's *Origin of Species* had raised in England. It was described by one commentator as 'a blot on the escutcheon of Germany'.

At least in the popular mind, the most influential philosopher of the nineteenth century in England, and in the United States, was not J. S. Mill, but Herbert Spencer. His books, mostly published as sections of his enormous *System of Synthetic Philosophy* published in eight volumes between 1862 and 1896, sold tens of thousands of copies. His influence extended into political philosophy (Social Darwinism) and into education. He too drew his inspiration from biology, and in particular the general idea of evolution. This was not Darwin's cautiously phrased conception of development without a teleology of ascending value. Spencer applied the idea of development, in the sense of improvement, to every aspect of the universe, inorganic and organic, cosmic and local.

But it was a development that was wholly material. Volume II of the *System*, devoted to the Principles of Biology, begins with a firm statement of materialism.

Organic bodies consist almost wholly of four elements: oxygen, nitrogen, hydrogen, and carbon. Evolution, in biology as elsewhere in the natural order, is just the redistribution of Matter and Motion. Philosophy, he thought, sought the most general principles of science, and the principle or law of evolution was the most general of these. This law states that there is constant change 'from a [relatively] indefinite, incoherent homogeneity to a [relatively] definite, coherent inhomogeneity' (Spencer 1862 [1996: 396]). Darwinian application to organic evolution was only a particular case of the general movement of the whole world. And, of course, the same principle applied to human society, which, according to the dictates of the law would improve indefinitely. This optimistic outlook on the world goes some way to explain the enormous popularity of Spencerian philosophy in his own time. It has been suggested that the horrors of the First World War so contradicted the principle that Spencer's philosophical reputation fell with it.

Equally important, perhaps, in explaining that popularity was Spencer's explicit attempt to find a reconciliation between science and religion, and so bring the most tendentious topic of Victorian debate to an end. 'We must find', he says (Spencer 1862 [1996: 22]) 'some fundamental verity in defence of which each [that is, science and religion] will find the other its ally.' It cannot be a specific doctrine or fact of either. The common principle is the inscrutability of the world. From the standpoint of all religions, 'the Power which the Universe manifests to us is utterly inscrutable' (Spencer 1862 [1996: 22]). And 'the ultimate scientific ideas . . . are all representative of realities that cannot be comprehended' (Spencer 1862 [1996: 66]).

Unlike Huxley, Spencer did have an account of the world to experience relation, an account that harks back to Thomas Reid in the previous century, and forward to recent ontological suggestions in attempts to interpret contemporary physics. But it must have seemed thin indeed. Science, says Spencer, leads to the Unknowable. As the sciences progress, for example biology, despite finding an exhaustive catalogue of material substances involved in Life, 'its essence cannot be conceived in physico-chemical terms' (Spencer 1862–96: II, 120). 'The Ultimate Reality behind this manifestation . . . transcends conception . . . even simple forms of existence are in their ultimate natures incomprehensible.' Spencer is very critical of vitalism, the interpretation of the essence of life in terms of primitive animism. We do not know, indeed cannot know what the Ultimate Reality could be. But our sensations must be produced by something. This 'something' can only be, from our point of view a Power, some primordial activity.

Finally it is worth remarking on Spencer's ambitions for Philosophy. 'Science is *partially-unified* knowledge.' The work of Philosophy is to abstract such principles from that level of knowledge as to arrive at '*completely-unified* knowledge' (Spencer, 1862 [1996: 134]). The abstraction of a general law of evolution from chemistry, biology, and human history is just such a work of philosophy.

Some commentators, for instance Passmore (1957), have been scathing in their judgement of the philosophical quality of the scientist-philosophers such as Huxley and Spencer, who so dominated English popular thought in the nineteenth century. It is true that such key concepts as 'Power' were not treated to the kind of analysis that had been popular in the eighteenth century and would be so again in the twentieth. But the style of thinking, centred on scientific insights, raised profound questions ignored, ridiculed or treated quite superficially by the analytical philosophers of the twentieth century.

SUMMARY

Though the scientifically oriented authors in each of the three main centres of philosophical activity were materialists, reductionists, and empiricists by inclination and conviction, few, if any, managed to balance the paradoxes and inconsistencies that quickly emerged. A strict empiricism left them struggling with the problem of how correlations of types of sensations can lead a scientist to reliable and general knowledge of the material universe which is presumably the origin of these very sensations. It was also difficult to account for the strength of the laws of nature if they were nothing but summaries of and abstractions from sensory experience. In many cases recourse was had to some form of the Kantian a priori. Those who resisted this way out, like Mach and Mill, had the traditional 'problem of induction' to deal with, and it cannot be said that either made a good job of resolving it.

It has often been remarked that the five centuries since 1500 have seen a progressive demoting of human beings from a privileged and unique place in the order of things. The biologist-philosophers of the second half of the nineteenth century realised this transformation very well. Having abandoned a transcendental source for morality, they looked for one from within the biological realm itself. Evolution as progress was seized upon as a way of forging a morality not so much for a secular, as for a molecular world. The impressive 'rise of science' in the public regard in this period (one commentator remarked that the locomotive was all that was needed to convince the general public of the authority of physical science) ensured that the influence of authors like Comte, Darwin, Huxley, Mach, and Spencer was very widespread, filtering through to moral, political, and economic attitudes to life itself.