1

Aspects of the development of the history of science

Although the history of science as an autonomous academic discipline only developed in the 20th century, activities that might justifiably be described as early forms of history of science have been taking place for centuries. Historical descriptions and analyses have always followed the development of science. Indeed, even a superficial consideration of the history of science in former times reveals that many of the central historiographical problems discussed in modern history of science can also be encountered in earlier centuries.

Throughout most of the period in which science developed, it was learnt and cultivated as part of a historical tradition that was indistinguishable from science proper. In Classical times and in the Middle Ages in particular, the usual form of cultivation of science involved relating to earlier thinkers. Critical commentaries and analyses of the Classical works were made and these were used as a point of departure for new thought and contributions of current interest. When Aristotle wished to say something about atoms and the void, he reproduced parts of the history of atomism and embarked on a discussion with the long-departed Democritus. When a Greek mathematician wanted to solve a problem, the natural way to proceed was to begin by giving an account of the history of that particular subject, which was regarded as an integral part of the problem.

Classical historians were interested first and foremost in contemporary history and did not consider it of much value to consider earlier events or developments in a historical perspective. This topical, and therefore in one sense, ahistorical attitude was based on the Greeks' perception of critical historical method: the only reliable sources were believed to be eye-witnesses, people who had personally been present at the event under discussion and as such

could be cross-questioned about the event by the historian. As a result of this approach, Greek historical perspective was, for the main part, limited to a single generation.

Another factor that contributed to the absence of a real historical perspective was the prevailing view of time and the uncertain chronology. It was usual for the Greeks to regard time as cyclic or, as far as short periods of time were concerned, as static. This notion of time does not support the fundamental idea of historical development, according to which modern ideas and events are seen as the results of the dynamics of the past. The Greeks had no tradition for, or interest in, dating events and often made do with dating them as having happened 'long ago'. Precise dating and the placement of events in chronological order are largely bound up with a linear concept of time. A linear and dynamic view of time derives especially from Judeo–Christian thought and did not become widespread until the Middle Ages in Europe.

Our knowledge of the Classical form of history of science is greatly limited by the almost total absence of original source material. Thus, we know that Eudemus, who lived in the 4th century BC, wrote both a history of astronomy and a history of mathematics, but these works have disappeared. The knowlege that we do have comes mainly from later commentators working at the end of the Classical period or at the beginning of the Middle Ages. One example of these is Proclus (*c.* 420–485) who wrote a historical account of Euclid's mathematics. Simplicius (*c.* 540), who wrote detailed commentaries of Aristotle's works on natural philosophy and, in connection with these, also gave an account of the ideas held by earlier natural philosophers, is another example. The commentaries written by Proclus, Simplicius and others can reasonably be regarded as late-Classical history of science.

In the 16th and 17th centuries, when the new science came into being, history was still regarded as an integral part of scientific knowledge. History, especially Classical history, was regarded by pioneers from Copernicus to Harvey as definitely present and relevant to the current progress of science. During the scientific revolution the Classical authorities were often used as opponents in ideological arguments. At the same time, history served as legitimation for the new science. By referring to the great philosophers in the past, a tinge of respectability could be lent to science.

From the end of the 17th century the attitude towards the Clas-

sical authorities changed. It became common to highlight the modern world's knowledge at the expense of that of antiquity. Many of the pioneers of the new science were strongly influenced by protestant religious views: they critisized Classical Greek scholarship for being heathen, and wanted to trace science back to a Biblical knowledge dating from before the time of the Greeks. Wherever such knowledge was not known, it was constructed from the Bible. Sennert, Boyle and Newton were among the many who thought that Moses had possessed a divine insight into the laws of nature.[1] Atomism, in their view, did not owe its existence to the heathen and atheist Democritus, but to the prophet Moses. This view helped to invest atomism with social authority in the 17th century. Gradually, as science became authorized as worthy in its own right, age became unnecessary as a means of legitimation and references to the great ancestors seemed superfluous.

The historical form that decked much of earlier science is well illustrated by Joseph Priestley's *The History and Present State of Electricity* (1767) and *History and Present State of Discoveries Relating to Vision, Light and Colours* (1772). These were pioneering works of what was then front research, but they were nevertheless presented as 'histories'. Priestley was one of the many who regarded the historical development as a natural part of their science, a stocktaking of what had been achieved and of the problems that were still unresolved. In this way history was given a role in the sciences of the day. In full agreement with Priestley, the French astronomer and historian of astronomy Jean–Sylvain Bailly regarded the history of science as a report on 'what we have done and what we can do.'[2]

For Priestley and his contemporaries the history of science was primarily a tool, the value of which was bound up with the progress of the research being carried out at that time.[3]

> Great conquerors, we read, have been both animated, and also, in a great measure, formed by reading the exploits of former conquerors. Why not may the same effect be expected from the history of philosophy to philosophers? May not even more be expected in this case? . . . In this case, an intimate knowledge of what has been done before us cannot but greatly facilitate our future progress, if it be not absolutely necessary to it. These histories are evidently much more necessary in an advanced state of science, than in the infancy of it. At present philosophical discoveries are so many, and

> the accounts of them are so dispersed, that it is not in the power of any man to come at the knowledge of all that has been done, as a foundation for his own inquiries. And this circumstance appears to me to have very much retarded the progress of discoveries.

As a natural consequence of this attitude and the period's general belief in progress, the history of science was unequivocally depicted as the history of progress.[4]

> I made it a rule to myself, and I think I have constantly adhered to it, to take no notice of the mistakes, misapprehensions, and altercations of electricians; . . . All the disputes which have no way contributed to the discovery of truth, I would gladly consign to eternal oblivion. Did it depend upon me, it should never be known to posterity, that there had ever been any such thing as envy, jealousy, or cavilling among the admirers of my favourite study.

While Priestley used the history of science in the service of contemporary science, others used it as a contribution to the debate about the correct methodology and policy of the new science. An early, classical example of this is Thomas Sprat's *History of the Royal Society* from 1667. The most important aim of this work was not to give an objective, historical account of the Royal Society's foundation, but to play a polemical and political role. In 1667, the Royal Society was only five years old as an official institution, but it had come into being as a result of the work and visions of a series of informal groups dating from about 1640. The methods, ideals and forms of organization to be pursued by the new science were the subject of much discussion around 1670. Sprat's *History* was a contribution to this debate, directed at the future rather than the past. Since Sprat identified some sources (Wilkins, Boyle, Bacon and others) as the Royal Society's spiritual ancestors and ruled out the significance of others (Descartes and Gassendi, in particular), and since Sprat's work achieved an authoritative status, it laid down the view of science to be followed by the Royal Society in the future. The Royal Society, and the activities organized in connection with it, were to be based on an empirical view of science and not on the more deductivist ideas adopted by such continental thinkers as Descartes.

One should note that the word 'historical' in the 17th and 18th centuries was often used in a different sense to that in which it is used today. A 'historical phenomenon' frequently meant a concrete, factual phenomenon and a 'history' merely an account of the factual

conditions without it being necessary for these to belong to the past. For example, Bacon's references to 'histories' that must be researched by the future science were about concrete subjects or areas of research. We have kept this meaning of the word history in the term natural history.

The truly historical perspective that the study of the past is of value in itself and therefore not in need of legitimation with regard to the present, barely existed before the 19th century. There were, admittedly, individual thinkers, in particular the Italian philosopher Giambattista Vico (1668–1744), who emphasized the value of the historical perspective. But Vico's thoughts remained isolated throughout the 18th century which, instead, was characterized by a tendency that must be described as anti-historical. The Age of Enlightenment saw history as an instrument for progress in the battle against the old feudal order. Only the recent development was worthy of interest while the past was generally regarded as irrational and inferior. Leibniz was one of the many who believed that the study of the history of science could contribute towards an increased recognition of how scientific ideas come into existence. He viewed history of science as a contribution to the formulation of the *ars inveniendi* of which he and many others dreamt:[5]

> It is of great advantage to get to know the real sources of great discoveries, in particular of those that were made not by chance but by reflection. The result of this is not only that the history of science acknowledges what each individual has contributed (i.e. the establishing of objective historical facts) and that others are thus encouraged to acquire a similar reputation (i.e. a great model serving as an incentive), but also that the *art of discovery (ars inveniendi)* expands when one finds the path of research in outstanding examples.

Although the idea of a logic of discovery was gradually discredited, the exemplary function of the history of science – that modern research can learn from the historical elucidation of the successes and failures of earlier research – remained an important theme. A century later, William Whewell dissociated himself from the idea of a logic of discovery as understood by Leibniz. But Whewell, too, regarded the study of the history of science as justified for similar reasons. In 1837 he wrote as follows:[6]

> The examination of the steps by which our ancestors acquired our intellectual estate . . . may teach us how to improve and increase

> our store . . . and afford us some indication of the most promising mode of directing our future efforts to add to its extent and completeness. To deduce such lessons from the past history of human knowledge, was the intention which originally gave rise to the present work.

The strong belief in progress and science that was a characteristic trait of 18th century culture was also given expression in writings on the history of science. In the last quarter of the century, many historical works were published, including accounts of the general development of particular sciences, historical biographies and accounts of shorter periods of time. Bailly wrote the history of astronomy in a series of works between 1775 and 1782, and between 1771 and 1788 Haller published a collection of so-called 'libraries' that were historical analyses of the lives and works of earlier scientists and physicians.[7]

History of science in the Age of Enlightenment was marked by a naive scientific and social optimism that was not in a position to recognize science as a proper historical phenomenon. The strong points in that time's history of science lay in chronological details and surveys of the subject and not in historical reflection. The emergence of modern science was regarded as due to the inherited thirst for knowledge of the European race, a quality that could only find scientific expression in connection with the revolt against what was seen as the repressive authority of the Church. Once it had emerged, science could not be held back and would quickly achieve perfection. Many philosophers of the Age of Enlightenment – including notabilities such as Diderot, Turgot and Condorcet – thought that this state of perfection had already been reached in physics and astronomy, with only the details remaining to be filled in. The absence of historical consciousness was also a result of the prevailing view of cognition, in particular of the rationalist ideas of Descartes, which were adopted in many areas by the French philosophers. According to Cartesian epistemology, cognition was purely reflective and rational, a universal and ahistorical abstraction. Reason itself could not be contingent on history, which removed the basis for a proper history of ideas and science.

The romantic current that spread in Northern European natural philosophy at the end of the 18th century also had some influence on historiography of science. Romanticism in general involved a stronger sense of history than was the norm in the 18th and 19th

centuries. Among other things, history was regarded as more relativistic, that is, the particular value and innate reason of each period and culture were recognised. Romantic thinkers often had a clear understanding of what is known as *diachronic historiography*, founded on the idea that the past should be judged on its own premises. This is revealed, for example, in their sympathetic attitude to the Middle Ages and to such unorthodox forms of knowledge as astrology and alchemy. Thus, Ørsted gave an account of medieval natural philosophy that was admittedly critical, but in contrast to the attitude that prevailed in the 18th century it was characterized by a certain amount of sympathy. 'Alchemy,' says Ørsted, 'was no randomly designed, but an absolutely essential element of the prevailing physics. All natural philosophers were searching for the philosophers' stone, for no other physics existed at that time and no other physics could arise . . . .'[8]

However, leading *Naturphilosophen* taught a view of history that was based on an intuitive, speculative insight into the spirit of the time. This was a view that was in opposition to the critical and systematic historiography that was developed at the end of the Romantic period. Accuracy, source critical methods, and responsibility as regards historical facts, were not regarded as virtues by the Romantics. Henrich Steffens (1773–1845) thought that such strivings were destructive to history as an idea. 'There are scholars of history', he wrote, 'who feel they cannot rest until they have pursued the majestic stream of turbulent history all the way to the dirtiest puddles, and this is what they call a study of sources'.[9] A similar critique was advanced in his programmatic *Philosophical Lectures*, in which a holistic approach was recommended to both the historian and the natural scientist. He had this to say about the feeling or intuition that to the true philosopher joins the whole of nature together in time and space:[10]

> Periods of time whose way of thinking, whose external existence was quite different from our own become intelligible to us by means of this. If we give ourselves up to it, we shall be renouncing that intellectual postulate of reason: to make our own age and its way of thinking into a norm for all; it will give us the organs of the times that lie hidden in the past.

As a result of the professionalization and organization of the scientific life that became established in the 19th century, a certain amount of interest arose in the history of science. But it was an

interest that was primarily directed towards technical and specialist matters. The increasingly arrogant natural sciences distanced themselves from the humanities and a corresponding schism appeared between the history of science and such fields as philosophy, history of civilization and theory of history. The feeling that philosophy can learn from the history of science while the latter has nothing to learn from philosophy became widespread. This is exemplified in Whewell, who derided the examples of traditional logic as 'so trifling as to seem a mockery of truth-seeking, and so monotonous as to seem idle variations of the same theme'.[11]

The often arrogant confidence in the methods and possibilities of science that accompanied the positivistic current in the 19th century resulted in a relatively unhistorical form of history of science. By regarding the methods of science as unequivocal and universal, the historical perspective was narrowed down and interest concentrated on contemporary science and its immediate predecessors. This was explicitly stated by Justus Liebig (1803–1873), the great chemist: 'If it is *impossible* to judge *merit* and *guilt* in the field of natural science, then it is not possible in any field, and historical research becomes an idle, empty activity.'[12]

It was usual in the 18th and 19th centuries for scientists to include in their works a 'historical introduction' in which they summarized the pre-history of the subject and placed their own work in that tradition; while, at the same time, emphasizing the originality and significance of their work. One example is Darwin's 'historical survey' which he included in later editions of *The Origin of Species*. In this survey he gave a historical account and evaluation of the concept of evolution from Lamarck up to his own contributions.[13] Historical introductions of this kind are often documents that are of interest to modern historians, but they should, of course, be read critically. They often reveal more about the author than about the history of the subject concerned.

Isaac Todhunter (1820–1884), who wrote a series of histories of the mathematical and physical disciplines, may exemplify the specialist historian of science of the 19th century.[14] By virtue of their range and wealth of details alone, these impressive works are still profitably consulted today; but their technical level renders them unreadable for non-mathematicians and they can hardly be regarded as *history* of science according to modern criteria. Todhunter's works are representative of a type of history of science

that has been in existence for almost 200 years: professional scientists who write about the history of their subject with regard to its contemporary status. Most of these works largely ignored (and still ignore) the historical perspective and concentrated one-sidedly on producing an accurate specialist account. Only a few outstanding scholars have been able to combine specialist expertise with a true sense and knowledge of history. Today this happy combination scarcely exists any longer.

William Whewell (1794–1866), sometimes described as the first modern historian of science, attempted to provide a comprehensive stocktaking of the historical development of the inductive sciences.[15] To Whewell, as to his period generally, science was a purely European phenomenon owing nothing to other cultures or times. But Whewell gave no explanation as to why science should be bound up with European thought, or why it arose in the 16th and 17th centuries. His purpose was rather to develop a philosophical understanding of the sciences than to understand them in their historical context. Original historical scholarship, the study of primary sources, for example, lay outside Whewell's programme, which was based on a comprehensive but somewhat random reading of contemporary sources. Instead of merely using the history of science as a collection of examples for philosophical theses, he wished to base on or even derive from history an accurate methodology of science. He maintained that history is the only acceptable source of a philosophical knowledge of science. This view is sometimes referred to as 'historicism' as opposed to the 'logicistic' view according to which logical criteria determine the philosophy of science, while history is in principle irrelevant. Whewell's contemporary, the philosopher John Stuart Mill (1806–1873), maintained a position close to logicism.[16]

Whewell's kind of history of science is representative of the philosophically orientated history that was taken up and developed later in the century, especially by scholars inspired by positivism. Mach, Berthelot, Ostwald and Duhem were all outstanding scientists who combined specialist insight with a philosophically motivated interest in the history of science. Considering the ahistorical view of science that logical positivism later made into a virtue, the extent to which early positivism made active use of the history of science in its argumentation is remarkable. Ostwald's interest in history of science revealed itself in his publication of a series of

reprints of classical contributions to physics and chemistry, the so-called *Ostwald's Classic* series.[17] This series started in 1889 and, so far, comprises more than 250 volumes of original texts in translation. Ostwald's intention in publishing these volumes was to give scientists easy access to their predecessors' original publications, so that they would not be reduced to reading extracts or secondary versions of them. Twenty years later Karl Sudhoff started publishing a corresponding series of medical classics.[18]

The integration of science, philosophy and history is even more marked in Ernst Mach (1838–1916), the Austrian physicist and philosopher. Mach was of the opinion that the historical method was the one best suited to the purpose of gaining insight into scientific method. *Die Mechanik*, possibly Mach's most important work, is characteristic of his view of the history of science.[19] Mach's aim is primarily philosophical since he engages in a dialogue with the scientists of the past, by means of which he criticizes their methods and develops his own epistemology and methodology. Mach's celebrated criticism of the concept of causality and the Newtonian view of space and time is a result of this historio–critical method. The method revealed to Mach that Newtonian mechanics, far from being absolute and complete, is 'an accident of history'. Mach described his view of the function of the history of science as follows:[20]

> We shall recognize also that not only a knowledge of the ideas that have been accepted and cultivated by subsequent teachers is necessary for the historical understanding of a science, but also that the rejected and transient thoughts of the inquirers, nay even apparently erroneous notions, may be very important and very instructive. The historical investigation of the development of a science is most needful, lest the principles treasured up in it become a system of half-understood prescripts, or worse, a system of *prejudices*. Historical investigation not only promotes the understanding of that which now is, but also brings new possibilities before us, by showing that which exists to be in great measure *conventional* and *accidental*. From the higher point of view at which different paths of thought converge we may look about us with freer vision and discover routes before unknown.

A more historically conscious historiography than found in Whewell and Mach slowly began to develop from the middle of the last century. This happened under the influence of such diverse