

Science and Technology Associations and Social Governance of Britain in the Middle and Late 19th Century

ZHAO Wenyuan

(College of History and Tourism Culture, Inner Mongolia University, Hohhot, Inner Mongolia 010021, China)

Abstract Civil science and technology associations have been widely springing up everywhere in Britain, especially the new industrial towns in the eighteenth and nineteenth centuries. Associations held various academic activities, organized and funded scientific research, which played an important role in promoting the progress of science and technology and the development of industrial society. Based on case study on British Association for the Advancement of Science and Manchester Literary and Philosophical Society by academic circles at home and abroad, development situation of British science and technology associations in the middle and late 19th century is summarized, and a series of activities of associations participating in industrial and agricultural development and environmental health reform are systematically sorted out, while the promoting role of science and technology associations in the social development of Britain in the 19th century is explored.

Keywords Britain, Science and technology societies, Environmental governance, Public health

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British non-governmental scientific and technological societies rose in the early years of the industrial revolution, and the Lunar Society and local literary and philosophical societies have emerged in new industrial towns such as Manchester and Birmingham. Communities frequently held lectures and other activities, which involved professionals and manufacturers in industrial zones, and gradually established close relationship between science and industry. In the middle and late 19th century, non-governmental scientific and technological associations continued to flourish, which not only promoted the development of industry and agriculture but also generated important impact on environmental governance and public health reform process in industrial cities. Foreign academic circles have made a detailed investigation on influential scientific and technological groups such as the British Association for the Advancement of Science and the Manchester Literary and Philosophical Society, while Chinese scholars paid little attention to the British scientific and technological community in the middle and late 19th century. The research tries to sort out the activities of scientific and technological societies in the middle and late 19th century, and summarize its role in promoting social development.

1 Situation of science and technology society in the middle and late 19th century

1.1 The rise of science and technology organizations such as Literary and Philosophical Society

In the early 19th century, scientific and

technological groups such as Literary and Philosophical Society have emerged and flourished throughout Britain. Local gentry would join them as a symbol of the social status of the middle class, and societies were once thriving. To the middle 19th century, the development of old-fashioned scientific and technological associations has stagnated. In late industrial revolution, the professional knowledge involved in chemistry and other disciplines was becoming more and more complex, and amateur science enthusiasts withdrew from community activities because they were difficult to understand. With industrial development, it became an urgent problem to be solved to provide education for new skilled workers. But as a society of middle class, Literary and Philosophical Society would not accept “class mixing” and strove to exclude working class from joining in them. To the middle 19th century, technological institutes created by the local working class were flourishing, while some societies of literary and philosophy will be forced to disband or merge into technical institutes under the impact. To survive, other societies included non-scientific issues such as travel, history and so on. But in London, Manchester, Newcastle and other industrial cities, relying on the flourishing local industry and commerce, Literary and Philosophical Society and other associations continued to exist and participate deeply in industrial and social development.

1.2 Rise of professional science and technology organizations

When old-fashioned societies such as Literary and Philosophical Society declined,

a number of new professional scientific and technological organizations have sprung up and developed rapidly, which became main forces to promote the development of science and society. In the middle 19th century, professional societies such as the Manchester Geographical Society, the Newcastle Chemical Society and the North England Institute of Mining Machinery have sprung up in large numbers. According to the statistics by Professor Levis in 1868, there were 45,000 people joining in all kinds of scientific and technological associations in Britain, in which the professional associations of mathematics, physics and chemistry had 3,520 members, and total annual income was 5,380 pounds; biological society had 17,924 members, and total annual income was 54,614 pounds; geographical and archaeological society had 7,352 members, and total annual income was 9,601 pounds^[1]. In 1831, scholar Harcourt *et al.* founded the British Association for the Advancement of Science linking the British scientific community. At Cambridge Annual Meeting of the association in 1833, scholar Whewell firstly used “scientist” to show professional scientists and technicians. In educational circles, the creation of the British Association for the Advancement of Science and the emergence of the term scientist are regarded as important symbols of the specialization of science in Britain in the 19th century^[2].

When new professional societies rose, a new generation of professionals within societies such as the Manchester Literary and Philosophical Society rose and replaced old-fashioned gentleman scientists as group leaders. In the middle 19th century, Dalton and Hodgkin have

successively become chairmen of Manchester Literary and Philosophical Society. After that, almost all the papers published by the association focused on science, and literature was excluded from community issues. In 1862, Gordon, a renowned botanist in Manchester City, applied to join the Literary and Philosophical Society, but he failed to become a member because he was rejected as an amateur scholar. The event indicated the transition of non-governmental science and technology associations from amateur gentry associations to professional associations in the middle 19th century. John Leigh, chairman of the Manchester Literary and Philosophical Society, once declared that almost all the great discoveries and designs of our time come from the middle and lower classes of society^[3]. In the late 19th century, the backbone of scientific and technological societies all came from the middle and lower levels of the middle class. Different from Thomas Henry and other gentleman scientists in the end 18th century and early 19th century, professional technicians did not have independent gentleman status, but they generally received professional science education and lived on full-time scientific and technological work such as scientific lectures, professional chemical analysis or university faculty, and science was an important way for them to gain social identity. The new generation of professional scientists and technicians were also deeply influenced by utilitarianism, and their own experience made them clearly realize that science is essential to economic and social development, and pay more attention to the application of science. Under their leadership, science and technology societies not only disseminated science but also were dedicated to the application of scientific and technological knowledge in industrial and agricultural production, and established closer links between science and industry.

1.3 Scientific and technological societies using their income to fund scientific research

Among many scientific and technological societies, the British Association for the Advancement of Science had the strongest support for the development of science and industry. The association developed rapidly by obtaining support of science and technology organizations in each county. In eight years since its establishment, it held activities in 37 towns of Britain^[4]. Manchester Annual Conference of 1842 obtained enthusiastic support from local literary and philosophical societies, and more than 200 members from royal institute joined in the society^[3]. Annual meeting held by

the association in each area of Britain provided important platform for exchange of information and personnel in the scientific community, while annual overseas conference and other activities promoted links between the British scientific community and European and even overseas scholars. The association also subsidized scientific research, which made its contribution to science transcend all contemporary and previous knowledge societies^[5]. In 1833, the association raised the first batch of funds for scientific research. During 1851–1855, 25% of annual income was used to fund scientific research. During 1866–1870, 70% of annual income was used to fund scientific research. To the early 20th century, the fund always maintained at 50% of annual income^[2]. In 1872, the journal of *Nature* pointed out that the association invested at least 2,000 pounds to fund science every year. Adding its sought government's scientific research support, it gave valuable financial support to scientific research^[2].

2 Scientific and technological associations and social governance

2.1 Scientific and technological associations promoting the development of industry and agriculture

In the late 19th century, the activities of scientific and technological associations powerfully promoted the development of industry and agriculture. Chemical industry was an important industry in Britain in the 19th century, and rose and developed rapidly in Lancashire and other western industrial zones in the 1860s–1870s. Soda manufacturing and other industries needed professional chemical knowledge to guide production. Although some factory owners have set up small laboratories, it could not meet the demand of output value, and scientific and technological associations provided necessary scientific and technological support. British Association for the Advancement of Science actively provided fund support for chemical research. During 1834–1879, the grant amounted to 1,747 pounds, while it increased to 2,298 pounds during 1880–1914^[2]. National and local chemical professional societies such as the London Chemical Society and the Newcastle Chemical Society have been established one after another. The associations frequently held various academic activities, and studied relevant problems of Leblanc soda production line, which powerfully promoted the prosperity and development of British chemical industry. Scientific and technological associations also promoted the application of Liebig's agrochemistry theory

in Britain, which made contribution to British agricultural improvement and development. Under the support and fund of Association for the Advancement of Science, British scientists have translated the series of works by the famous German organic chemist Liebig into English, and introduced Liebig's opinions that chemical fertilizer compensated soil fertility and improved agricultural yield into Britain. In 1844, British Association for the Advancement of Science specialized funding the application of organic chemistry in agriculture. With successive establishment of professional societies such as the Society of Agricultural Chemistry and the England Royal College of Agriculture, chemical fertilizer industry rose and developed rapidly in Britain, and British agricultural productivity has been greatly improved.

2.2 Scientific and technological associations supporting environmental governance and public health improvement in industrial cities

Emerging scientific and technological societies were extremely concerned about the serious environmental pollution faced by British society in the middle and late 19th century, and gave important support for environmental governance and public health reform in industrial cities. As the first industrialized country, environmental pollution has emerged in Britain in the middle 19th century. Population grew rapidly in emerging industrial cities, and Manchester, Birmingham and Bristol all had more than 50,000 people in the early 19th century, while population abruptly increased to 400,000 in Manchester in the middle 19th century. Emerging industrial cities were vibrant but messy. Although Manchester was the heart of British industrial revolution, there were no parks, orchestras, universities and any other cultural facilities in the city. The city was surrounded by factories of all sizes, and the smoke and dust from these factories covered the city all the year round. Tourists inviting Manchester in the middle 19th century vividly recorded the scene of city. In 1835, French politician and historian Tocqueville wrote that "huge buildings rise above people's houses, which is isolated from air and sunlight, and they wrap people like a thick fog. Slaves live on one side of the city and lords live on the other. That side belongs to the wealthy minority, and this side belongs to the poor majority. Here human nature has achieved the fullest and most brutal development. Here the miracle of civilization has been created, but the civilized people have almost fallen back to the barbarian situation"^[3]. The visiting King of Saxon had a similar impression of Manchester City in 1844: "I couldn't help

but be amazed by the dense smoke over the city, which gushes from the hundreds of factory chimneys that works around me. The atmosphere here is neither fog nor dust nor smoke, but a mixture of these three substances, and it's getting thicker because of the chemical exhaust from the city"^[3]. Besides air pollution, water pollution was also very serious in industrial cities. Textile mills densely distributed in Manchester continued to discharge industrial waste water, and quick population growth made discharge of municipal domestic sewage increase, which greatly exceeded self-purification abilities of rivers and land, and formed increasingly serious water pollution, and three rivers flowing through Manchester were all contaminated seriously. In the *Condition of the Working Class in England*, Engels depicted the seriously polluted Erkk River: "it is a narrow, dark, and smelly river full of sludge and waste, and the river shakes these things on the flatter bank on the right. In dry weather, there is a long series of dirty, dark green mud pits on this shore, and stench bubbles often come up from the bottom of the pit, spreading stench, and even it is unbearable on a bridge four or fifty feet above the water"^[3].

In industrial cities with serious environmental pollution, the living conditions of the ordinary laborers were extremely bad. Workers in Manchester and other cities were unable to afford better housing and had to choose back-to-back row houses. The house was crowded and lacked ventilation, with extremely bad hygienic condition. Moreover, residential areas of labors were often not far from urban industrial areas, and they were heavily polluted by smoke, dust and noise. In the 19th century, a lady who went through the labors' housing district recorded the bad environment: "a group of workers live together in crowds, and every room is full of machine noise, which is mixed with the sound of passing vehicles. It could smell odor and steam from factories and coke ovens in the room, and it will be a little better if the wind changes"^[4]. Poor public health conditions led to epidemics. During 1831–1832, large-scale cholera firstly outbreaked in Manchester, and then the epidemic broke out again in 1848–1849 and 1854–1867. Adding the invasion of other diseases such as typhus, it made that the average life expectancy of the population in industrial cities such as Manchester and Leeds was much lower than that in the countryside.

In the 1840s–1850s, it became urgent problem to be solved to control pollution of industrial cities and improve public health. Public health reformer Chadwick called on scientists to participate in the reform, and hoped science to

save the environment. He pointed out that Britain was leading in applied science, but knowledge in these areas has not been applied to public services, while improvements in urban health can only be achieved if relevant scientific knowledge was respected, accepted by the public and properly applied. The appeal of social reformers received a positive response from the British scientific and technological community, and scientists in manufacturing cities such as Manchester were particularly enthusiastic. The pollution of alkali production in chemical industry was very serious. The British Association for the Advancement of Science took the lead in funding Playfair, a chemist, to investigate chemical pollution in Lancashire. After Chadwick's report was published, societies such as the Royal Institute have also sponsored and organized scientists to investigate environmental hygiene in industrial cities. At Glasgow Annual Conference of the Society for the Advancement of Science in 1840, Playfair introduced Liebig's views on health and disease to Britain, and pointed out that industrial waste gas and polluted water damaged health, in which harmful substances would also damage soil, crops and the whole environment. The investigation by Playfair gave strong support for Chadwick's health reform from a scientific point of view.

In Manchester, science and technology societies such as Literary and Philosophical Society were actively involved in environmental investigation and governance. Chemist and physician Lee paid early attention to public health issues, and published the paper *Environmental Factors of Affecting Public Health Status in Manchester* at a meeting of the Royal Institute of Manchester City in October of 1844. He pointed out that air pollution was main cause for poor sanitation in cities, and factory soot harmed vegetables, crops, human beings and livestock. Lee's opinions attracted many audiences and aroused public discussion in Manchester, and the *Guardian* called that his thesis had great significance to the whole society. Despite there was fierce opposition from interest groups, namely representatives of manufacturers in municipal institutions, Lee insisted on submitting the reports on smoke and dust pollution and its hazards to the municipal government during 1845–1846. In 1849, cholera epidemic raged again, and Lee took the lead in the study of urban cholera. His paper *History of Cholera in Manchester* in 1849 pointed out pathway of epidemic disease transmission and possible preventive measures, which was earlier work of British academia using specific data to record the

development of cholera and analyze its causes.

In Manchester Literary and Philosophical Society, Smith, a chemist, has made the greatest contribution to public health reform. He loved British rural life all his life, so he was dissatisfied with the poor urban environment and devoted great energy to health reform. Smith emitted the earliest appeal for "scientific and social progress", required to recognize and give full play to the role of scientists as experts in government and industry, proposed that science was the basis of industry and environmental progress, emphasized the importance of scientific research, and were committed to the application of scientific research results in society, to solve many problems faced by cities. Smith actively studied air pollution problem, and his several papers were published in influential journals in the academic community, making he become national famous hygienic chemist. In the end 1850s, he became membership of the royal society, and was elected as Chairman of Manchester Literary and Philosophical Society, thereby becoming leading figure in Manchester's scientific community. His actions have led many members of the scientific and technological community to participate in the causes of environmental governance and public health reform.

Under the initiative of social reformers and professional scholars, British Parliament has enacted a bill to limit gas emissions from alkali industry in 1863, and the successive promulgation of the new *Alkali Act* during 1881–1892 has expanded the restriction of harmful gases from the caustic soda industry to the whole chemical industry. Meanwhile, water pollution control act was issued. To guarantee the implementation of act, government appointed Lee, Playfair, Smith and other prestigious professionals to serve as inspectors. In 1867, Lee took up the post of chief health officer in Manchester, and was specialized in monitoring urban pollution and plague. Smith also served as the inspector of the *Alkali Act* for a long time, and actively promoted manufacturers to use scientific methods to reduce pollution.

In a word, scientific and technological associations took an active part in environmental and public health governance in the late 19th century. Famous scholars of associations frequently gave speeches at forums such as the Association for the Advancement of Science, submitted research reports to parliaments and municipal bodies, and wrote articles in the *Guardian* and other public media, thereby pointing out serious environmental issues in industrial cities to the public and how to improve

(To be continued in P113)



Fig.1 An ordinary convalescent space of Bad Schallerbach



Fig.2 A nurse station of Bad Schallerbach



Fig.3 Soft lighting in the corridor of Instituut Verbeeten



Fig.4 A consulting room of Instituut Verbeeten



Fig.5 The shared hall of Meander Medical Center



Fig.6 A swimming pool in Bad Schallerbach

design criteria for four main functional spaces of the medical-elderly care buildings, namely the convalescent space, physiotherapy space, medical space, and public space.

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(Continued from P110)

urban health and environment via scientific manner. These research and publicity campaigns have contributed greatly to environmental and public health reform in Britain.

3 Conclusions

To sum up, in the middle and late 19th century, the new professional scientific and technological associations represented by the British Association for the Advancement of Science rose and developed rapidly. Associations not only supported and funded the researches related to chemical production and agricultural improvement, and powerfully promoted the development of industry and agriculture, but also actively joined in social governance of industrial cities, which made great contributions to environmental and public health reform in the 19th century with scientific research and professional knowledge. However by the beginning of the 20th century, Britain's leading position in science and technology was overtaken

by Germany and the United States. The report of the Royal Council for Science and Technology Guidance and the Advancement of Science suggested that the British government should strengthen the management of funding for scientific activities, but it was opposed by many scientific and technological societies. Although the scientific and technological associations hoped to receive the government's funds, they firmly opposed the government's excessive interference in scientific and technological work. British scholars have always been "proud of their free action and independent thinking"^[7], watched out for powerful and centralized power interfering in science, and required full retention of autonomy in the activities of associations. Ultimately, the British government's scientific reform has not been carried out in depth, and scientific and technological societies gradually declined in the first half of the 20th century. The Association for the Advancement of Science was an important promoter of the development of science and society, but the number of

participants declined year by year after the beginning of the 20th century, and scientists no longer used societies as the main platform for communicating ideas and getting fund.

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