SCIENTIFIC REVOLUTIONARIES CAUGHT IN POLITICAL REVOLUTION: PRIESTLEY AND LAVOISIER

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This symposium rightfully focuses on Antoine Lavoisier's contributions to the establishment of modern chemistry, but other aspects of his career also are worthy of our attention. Dr. Donovan already has described many of Lavoisier's activities as an administrator (1). It is informative and interesting to compare Lavoisier's career to that of his English contemporary and sometime chemical adversary, Joseph Priestley. Priestley's discovery of oxygen not only helped Lavoisier toward a new explanation of chemistry but, combined with his other work on gases, helped to earn him a reputation as a chemist. These two were considered by their contemporaries to be the outstanding scientists of their countries, if not the world. Their activities, interests, and honors were similar in many respects, although Lavoisier worked in business, political, and social environments, whereas Priestley's were religious and academic.

The trial of Lavoisier and the Tax Farm, a 19th century reconstruction from the 1874 edition of L. Fuguier's *Vies des Savants Illustres.*

Lavoisier was on the inside. Wealthy and with social position, he served on committees of the Academy of Sciences and of the government and was appointed to increasingly important positions. Rapidly, however, the situation in France reversed, and he was executed. Priestley, on the other hand, was always on the outside, always opposing the "Establishment," whether church or government, in his preaching and in his writing. Eventually, his situation in England became so unpleasant that he voluntarily took himself into exile.

Today neither Lavoisier nor Priestley is considered by historians to be a major figure of this period; they were not involved in significant events that would get their names in the typical histories. Their contributions to society are not the kind made by kings, generals, and statesmen. At the time, however, each was widely known and respected for his scientific reputation and his considerable contributions in other areas. Although neither was directly involved in revolutionary activities, both were brought down by the political upheaval in France and the attendant mob actions.

A summary of the areas of interest of these versatile men (Table 1) brings out the similarities and the differences. Both were well educated, had a consuming interest in chemistry, made innovative proposals for improving the educational systems of their countries, and were active members of their national scientific societies. Lavoisier earned his major income from the Tax Farm, was concerned about economic matters, including scientific farming, and was a public servant in the French tradition at that time. Priestley worked as preacher and teacher, wrote textbooks on electricity, grammar, history, and perspective in drawing (several going through many editions), contributed as critic and theoretician of government, and wrote theological treatises.

A chronological list of the major events in their lives (Table 2) is useful for making comparisons. We see, for example, that, although Priestley was ten years older than Lavoisier, they were admitted to their respective scientific societies at about the same time and started chemical investigations in the same year. Reference to Table 2 will help to keep straight the sequence of events to be described, which will cover the period of almost 21 years from 1774 to 1794.

Three events make 1774 significant: on 9 May, Louis XV died; on 1 August, Priestley discovered oxygen, and in October he visited Lavoisier and described his results. France was on the brink of disaster. She was nearly bankrupt, and there was a great gulf between the privileged and the common people. The nobility and the church were not prepared to give up any of their perquisites, especially their freedom from taxation. The death of the King marked the beginning of change. Louis XVI was only 20 years old and was not strong enough to stand up to the entrenched supporters of the status quo. He tried to achieve reform by appointing Turgot to the post of Controller General, but Turgot's changes were popular only with the common people. In two years, he was ousted and his reforms were erased. This was the start of inevitable deterioration in France.

Table 1. A Comparison of the Careers of Lavoisier and Priestley.

Lavoisier	*Priestley*
Lawyer	Minister
Businessman	Teacher
Chemist	Chemist
Economist	Grammarian
Educational Theorist	Educational Theorist
Experimental Farmer	Historian
Public Servant	Political Theorist

For our two heroes, however, 1774 was the start of a 15-year period of successes. Both rose in position and in public recognition during this time. Lavoisier was appointed head of the Powder Commission and moved to the Arsenal, where he had space to set up the well-equipped laboratory described by Dr. Schwartz (2). He became Director of the Academy of Sciences, receiving intellectual stimulation there as well as from visitors to his famous laboratory. It is remarkable that nearly everything he did was creative, well-thought-out, and useful. Some examples are:

* As Farmer-General, he had many assignments over the years. Some achievements were abolishment in his district of a tax on Jews, proposal of a wall around Paris to stop smuggling (it was constructed), and preparation of an instruction manual for officials of the organization. He thought the system was wasteful, and he tried to achieve equity and to reduce the burden on the lower classes.
* As Powder Commissioner, he improved the quality of the gun powder and the system of manufacturing it. France changed from an importer to an exporter of powder and, therefore, was able to supply the American colonies during their conflict. The greater range of French guns is given credit for the defeat of the Prussians and for Napoleon's success.
* As member and Director of the Academy of Sciences, he served on many committees which produced over 200 reports (usually written by him) on topics assigned by the government. Significant ones are those on prison reform, hot-air balloon flights, and Mesmerism (this committee included Benjamin Franklin and Joseph Guillotin).
* As farmer, he tried new methods of cultivation and fertilization, kept careful records for ten years, and helped found the Royal Society of Agriculture.
* As elected official, he represented the Third Estate at the Provisional Assembly of Orléanais, 6 September 1787. According to L. de Lavergne, "It was Lavoisier who did everything, who inspired everything, who was everywhere" (3). As usual, he wrote most of the committee reports. His innovative proposals concerning tax reform, forced labor on roads, agriculture, social security, and a Savings Bank were passed, but nothing ever came of them.

Priestley became librarian for the Earl of Shelburne, moved to Calne, and had time to do his work on gases at Bowood. In a few years, he left, probably because he was becoming a political liability to Shelburne, but, in Birmingham and the Lunar Society, he found intellectual stimulation and wrote his best theological works.

Probably this was the happiest and most satisfying time of both their lives, but, on 14 July 1789, came the fall of the Bastille. This was the beginning of the end for both men, because each had become quite involved in public affairs. Lavoisier was on the inside, active on many committees set up by the government to report on assigned problems. Priestley, on the outside, had supported the American colonies in their revolt and had gained notoriety from his polemical writings on matters of church and state and his role as a leader of the Dissenters.

The situation grew worse in both France and England with

Table 2. Comparison of Significant Dates in the Lives of Lavoiser and Priestley.

Lavoisier	Year	*Priestley*
	1733	Birth, 13 March
Birth, 26 August	1743	
	1761	Warrington Academy
	1766	Royal Society
Academy of Sciences; Tax Farm	1768	
Diamonds	1772	Soda Water
	1773	Copley Medal; Lord Shelburne
Ascension of Louis XVI; Entertained Priestley	1774	Oxygen; Visited Paris
Powder Commission; Arsenal	1775	
	1780	Move to Birmingham; Lunar Society
Director, Academy of Sciences	1785	
Nomenclature Report	1787	"Honest Heretic"
Traité Élémentaire; Bastille, 14 July	1789	
Weights and Measures	1790	Response to Burke
National Treasury	1791	Birmingham Riot; Pastor at Hackney
Public Instruction	1792	
Arrest of Members of the Tax Farm	1793	
Death, 8 May	1794	Emigration to U.S.
	1804	Death, 6 February

the fall of the Bastille, only a few months after the event celebrated by this symposium: the publication of Lavoisier's book describing the new system of chemistry. Soon, each man was being attacked and abused in the press. For Priestley, the critical episode was his response to a speech by Edmund Burke in opposition to the French Revolution. Burke had supported the American Revolution, so he seemed to Priestley to be a turncoat. Characteristically, Priestley fired off a vigorous attack, his "Letters to Burke." This and other writings made him the target of cartoonists, such as Gillray, whose "Birmingham Toast" shows Priestley calling for the King's head on a platter. "Dr. Phlogiston" shows Priestley as a firebrand, setting the flames of revolution. In 1791, a mob burned his church and house during the Birmingham riot. Lavoisier and others sent expressions of sympathy, and Priestley was made an honorary citizen of France, which did not help him at home. He wrote from his new home in Hackney that "On the 14th of July, 1792, it was taken for granted by many of the neighbors, that my house was to come down, just as at Birmingham the year before" (4). He received many threatening letters and was burned in effigy many times. Also, he was "much restricted with respect to my philosophical acquaintance; most of the members of the Royal Society shunning me" (5).

For Lavoisier, the critical factor was the shift in power; anything from the Old Regime came under attack, often not fairly. He was criticized for the tax wall as early as 1784, "... M. Lavoisier ... is the beneficent patriot to whom we owe this ingenious and solitary imprisonment of the capital of France" (6). In 1790, Lavoisier still had hope that a constitutional monarchy might result; he wrote optimistically to Franklin, "We regard the Revolution as finished, irrevocably ... There is a weak royalist party ... the constitutional party ... is numerous, including among its numbers the intelligent and enlightened citizens" (7). The attacks became more vicious, "I denounce to you the coryphaeus of charlatans, the sieur Lavoisier, son of a land-grabber, pupil of the Geneva stock-jobber, Farmer-General, controller of gunpowder and saltpeter, governor of the Discount Bank, secretary to the King, member of the Academy of Sciences ..." (8). This came in 1791 from Marat, who hated Lavoisier because Lavoisier had ridiculed publicly a paper submitted by Marat and had prevented his admission to the Academy of Sciences. Apparently Lavoisier lost the hope expressed to Franklin; he began to resign from positions and to refuse new appointments, trying to separate himself from the Old Regime. In 1792, he moved from the Arsenal. He did hold on to the directorship of the Academy, trying to save it as an institution. When funds were withheld, he used his own. Late in 1793, all the Farmers-General were arrested, and, after several months in prison, they were given a farcical trial and were executed on 8 May 1794.

Earlier in the same year, Priestley stated, "But I see no occasion to expose myself to danger without any prospect of doing good, or to continue any longer in a country in which I am so unjustly become the object of general dislike ..." (9). He decided to join his sons in Pennsylvania and was at sea when Lavoisier died. In New York and Philadelphia, he was welcomed royally, even meeting with President Washington. The lovely home he built in Northampton, PA (now closely associated with the founding of the American Chemical Society), was isolated from the cities but even more so from England. Letters could not replace the give-and-take of the intellectual discussions he loved so much. He did do some chemistry, discovering carbon monoxide. His painting by Rembrandt Peale appears on a postage stamp of the United States, but Great Britain has not honored him in this way. On the other hand, there are several statues of him in England.

"Dr. Phlogiston, The Priestley Politician or the Political Priest". Commentary on Priestley's political and religious activities.

In France, the situation changed so rapidly that, only two years after his death, Lavoisier was commemorated by a ceremony and the issuance of a medal. His head from the portrait by David appears on a stamp of France.

We have looked at the non-scientific aspects of the lives and careers of two men who were active contributors in many

areas of society but are remembered primarily for their scientific contributions. Many parallels appeared, which might be expected for two well-educated and intelligent men of that time. Differences were due largely to the chance of birth: Lavoisier wealthy and "in" socially, Priestley poor and outside the establishment. In summary:

* Both names became household words.
* Both men were visionaries, making proposals that were ahead of their time in the areas of education, economics, government, human rights, and religion.
* Both were scientific revolutionaries, earning recognition as outstanding scientists and making lasting contributions to science.
* Both men were destroyed by political revolution but for opposite reasons: Priestley because he supported it, and Lavoisier because he was seen as a representative of the system against which it was directed.

References and Notes

1. A. L. Donovan, "Lavoisier's Politics", this issue, pp. 10-14.
2. A. T. Schwartz, "Instruments of the Revolution: Lavoisier's Apparatus", this issue, pp. 31-34.
3. D. McKie, *Antoine Lavoisier, Scientist, Economist, Social Reformer*, Schuman, New York, 1952, p. 234.
4. J. T. Boyer, Ed., *The Memoirs of Dr. Joseph Priestley*, Barcroft, Washington, 1964, pp. 114-115.
5. Ibid., p. 98.
6. K. S. Davis, *The Cautionary Scientists: Priestley, Lavoisier, and The Founding of Modern Chemistry*, Putnam, New York, 1966, p. 210.
7. Ibid., p. 204.
8. Ibid., p. 213.
9. Reference 4, p. 127.

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LAVOISIER AND THE CONSERVATION OF WEIGHT PRINCIPLE

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It is generally agreed today that when Antoine Laurent Lavoisier overthrew the phlogiston conception of combustion, he achieved a revolution in chemistry. In its simplest outline the story goes like this. In the phlogistic view that widely prevailed when Lavoisier began his chemical work in the 1760's, substances owed their combustibility to the presence of phlogiston in their make-up. When the body was actually burned, the phlogiston departed, leaving behind the other components - the acid in the cases of sulfur and phosphorus, and the calx in the case of metals. In this view both combustion and calcination were decomposition processes. In this regard, the phlogistic view was an 18th century sophisticated version of a centuries-old tradition of fire analysis, that the application of great heat reduced any body to its simpler components, if not necessarily to its true elements. Thus, in the cases illustrated, the acid was simpler than the sulfur and the calx simpler than the metal.

Lavoisier was able to force the inversion of this compositional relationship by keeping a balance-sheet account of the weights of all the participants in the reactions. For example, when he heated a weighed quantity of mercury in a closed container, he was able to show that the weight gained by the metal in becoming a calx was equal to the weight lost by the air in which the reaction took place. Lavoisier carried out similarly monitored experiments on the combustion of sulfur and phosphorus and again was able to account for the weights of all the participating materials. From these kinds of experiments he was able successfully to argue that combustion was a process whereby something in the air (later named oxygen) combined with the combustible, rather than something leaving it. In Lavoisier's view, appropriately named the "anti-phlogistic chemistry," a metal was simpler than its calx, and sulfur and phosphorus were simpler than their acids. Until Lavoisier made weight a primary criterion for the recording of chemical change, the phlogistic view had been a useful way of organizing a large number of important chemical relationships in a qualitative way. But Lavoisier's persistent application of balance-sheet accounting made the older view untenable, and phlogiston rather quickly disappeared from the chemical scene.

Lavoisier was very conscious of his method in these events and stated the principle quite explicitly in his famous *Traité Élémentaire de Chimie* of 1789, whose bicentennial we are celebrating this year (1):

> We may lay it down as an incontestable axiom, that, in all the operations of art and nature, nothing is created; an equal quantity of matter exists both before and after the experiment ...

With weight as his measure of the "quantity of matter," his persistent and imaginative application established the conservation of weight as the standard principle in chemical investigations, for which he has very properly received full credit.

I have no intention either of challenging that judgment or of further illustrating Lavoisier's systematic use of that principle. Rather, I wish to address the question of why the conservation of weight had not been more vigorously used in chemistry before Lavoisier's time, for the idea of conservation is as old as Western philosophy. As early as the 5th century B.C. Anaxagoras laid it out that, "nothing comes into being or is