

## PROCEEDINGS OF THE NUTRITION SOCIETY

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### SYMPOSIUM ON 'THE APPLICATION OF HUMAN AND ANIMAL CALORIMETRY'

#### Adair Crawford and calorimetry

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It is 200 years ago this year that Antoine Laurent Lavoisier published in the *Mémoires de l'Académie de Sciences* his experiments on respiration in animals. Three years later with the mathematical physicist, Marquis Pierre Simon de Laplace, he published the '*Mémoire sur le Chaleur*' in which they described their calorimeter and the methods used to calibrate it. In 1783 the detailed results of his experiments on the respiratory metabolism and heat production of the guinea pig using a calorimeter were published. Lavoisier was executed during the Reign of Terror and the remarks made on that occasion are well known. Laplace survived largely because he was conscripted to compute trajectories for cannon. Indeed, Laplace rose to become Minister of the Interior. Napoleon wrote of him: 'A mathematician of the first rank Laplace quickly revealed himself as only a mediocre administrator . . . he sought subtleties everywhere, had only doubtful ideas and finally carried the spirit of the infinitely small into administration.'

Lavoisier is the one man to whom we owe the beginning of the study of the relation between metabolism and the production of heat. Another man, however, has been credited with being the first to measure the heat production of an animal, Adair Crawford of Edinburgh. His book entitled '*Experiments and observations on animal heat and the inflammation of combustible bodies being an attempt to resolve these phenomena into a general law of nature*' was first published in 1779, that is a year before the *Mémoire* of Lavoisier and Laplace, and certainly before the classic work of Lavoisier and Berthollet. The Officers of the Scottish Group of Nutrition Society, knowing of this claim, thought that it would be appropriate to hold a symposium in Scotland on calorimetry and to link it to the name of Adair Crawford, no doubt having in mind the very successful symposium held to commemorate James Lind and the causation of scurvy. The title of the

symposium, as you will note, does not include Crawford's name, because we are not sure about the validity of the claims made for him.

Max Kleiber in his book 'The Fire of Life' wrote: 'Adam (not Adair) Crawford (1778) a pupil of Joseph Black is said to have been the first to measure animal heat. Crawford writes that he constructed his first combustion calorimeter at the suggestion of Priestley.' Kleiber's reference to Crawford in his reference list is, however, to the second edition of the book published with the same title as the first in 1788. This book was very different from its predecessor of 1779. The first was a slim volume devoted almost entirely to the measurement of specific heats and heats of combustion of biologically interesting materials. Such work was a direct continuation of that which had been pioneered by Joseph Black, Professor of Chemistry in Glasgow, who had developed the concepts of specific and latent heat, and of William Irvine. Crawford had clearly designed apparatus to measure the increase in the temperature of a mass of water, that is a calorimeter, but there is no mention whatever of any measurements of the heat produced by living things. The second edition was a very different book. It not only dealt with specific heats but included the work on animal heat. It also included many references to the work of M. Lavoisier. A telling passage after the description of Crawford's guinea-pig experiments reads: 'A series of experiments similar to those now recited have been made by Messrs Lavoisier and De Laplace with a different apparatus.'

It might be thought that this was the end, that the attribution of priority had come from a reading of the second edition without a careful checking of the first, but for one thing. In the advertisement or preface to the copy of the second edition held in the Royal Society's library, Crawford says: 'the experiments were made at Glasgow in the summer of the year 1777. . . . In the beginning of the ensuing session they were made known to many Professors and students in the University of Edinburgh; and in the course of the winter they were explained by the Author in the Royal Medical Society.' This statement by Crawford might suggest a priority; even so, it is not clear whether the experiments referred to were those on specific and combustion heats or those on animal heat.

Correspondence with the Royal Medical Society in Edinburgh has not so far resolved the matter. Minutes of their meetings date back to 28th March 1778, and the address was according to Crawford given in the winter of 1777-78. Crawford was proposed as an honorary member of the Society in 1780, and the bound volumes of papers of the Society do not include any given by Crawford. There are, however, references to his work in papers by others, but none of these suggest that his work with guinea pigs was done before 1784. This would be well after the measurements made by Lavoisier. There is still a doubt; the papers of the Royal Medical Society are incomplete, and there appears to be no record of Crawford's communications to the students and Professors at Edinburgh. What is, however, certain is that Crawford built the first calorimeter which employed the principle of measurement of the temperature rise of a mass of material of known specific heat. His conclusion 'the quantity of heat produced when a given portion of pure air is altered by the respiration of an animal is nearly equal to that which is

produced when the same quantity of air is altered by the combustion of wax or charcoal' is perhaps the forerunner of the approximation that roughly oxygen consumption is proportional to heat production.

In the short biography of Adair Crawford by Robert Hunt in the Dictionary of National Biography it is recorded that it was said that Crawford was 'a man who possessed a heart replete with goodness and benevolence and a mind ardent in the pursuit of science'. That, perhaps, is where we should leave matters, for individual priorities are less important than the advance of knowledge. It is a pity none the less that we do not remember him in the title of our symposium.

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