NOWOTWORY Journal of Oncology • 2006 • volume 56
Number 2 • 147–155

Historia medicinae

Pierre Curie 1859-1906

Richard F. Mould

19 April 2006 is the centenary of Pierre Curie's accidental death when he was killed by a horse-drawn carriage on the rue Dauphine near the Pont Neuf, Paris. This short biography commemorates the life of Pierre Curie. It is appropriate that it is published in Nowotwory Journal of Oncology since this is the journal not only of the Polish Oncology Society and the Polish Society of Surgical Oncology, but also of the Maria Sklodowska-Curie Memorial Cancer Center & Institute of Oncology. Much has been written of Maria Sklodowska-Curie and to a certain extent Pierre Curie has in print been relegated to the background. It is perhaps sometimes forgotten that Pierre made significant contributions to scientific research before meeting Maria in 1894 and before 1898, the year he began concentrating solely on the study of polonium, radium and radon. Only a single biography of Pierre Curie has ever been written. This was in 1923 by Marie Curie [1] and it has been reprinted a few times, the latest being a Polish edition in 2004 [2].

Key words: Pierre Curie, Maria Sklodowska-Curie, history of physics, radioactivity, radium

Introduction

It is interesting to speculate on 'What if Pierre had not died in 1906 when he was only 47 years old?'. His elder brother Jacques died at 85 years of age and if Pierre had attained the same age he would have died in 1944 almost at the end of World War II. His life would therefore have spanned the discovery of artificial radioactivity by Irène and Frédéric Joliot-Curie in 1934 and their award of the Nobel Prize in 1935. Would he have been involved in this discovery? Almost certainly the answer is 'Yes' if we remember that Marie Curie retained her interest in this work right until her death.

Would the Institut du Radium still have been built? Again, almost certainly 'Yes' since the Sorbonne had in 1904, specifically for Pierre Curie, funded and built a pavilion to house the Laboratoire Curie at 12, rue Cuvier, Figures 1-2.

Would Marie Curie have been appointed to a Chair by the Sorbonne at the age of 39 years old, in 1906? With the then male dominated climate in science in France this would virtually have been impossible. Pierre would most likely have remained as the Chief of the Laboratory/Institute until he wished to retire, but obviously continuing to work with Marie as his first assistant.

They only published seven joint papers [3-9]. These spanned the years 1898-1902, Figure 3. Thereafter Pierre concentrated on the physics of radioactivity whereas Marie concentrated on its chemistry. 1902 may therefore still have been the last year they published together. However, all this is idle speculation about a future which was sadly curtailed by Pierre Curie's early accidental death in the rue Dauphine, Figure 4.

A scientific family

The Curie family originated from Mulhouse in Alsace before the German annexation of Alsace and Lorraine at the end of the 19th century. Pierre Curie's grandfather, Paul Étienne François Gustave, and father, Eugène, were physicians. Eugène was brought up in Paris and studied natural sciences and medicine at the Musée d'Histoire Naturelle at 47, rue Cuvier where later, Henri Becquerel was to be professor of physics and to discover radioactivity. It was also in a house in the rue Cuvier, number 16, that Pierre Curie was born. At 12, rue Cuvier the Laboratoire Curie was established by the Sorbonne in 1904 and remained on this site until 1914 when the Institut du Radium was built in the rue Pierre Curie.

Of the first three generations only Eugène Curie never published. Paul became an established physician in England working at the London Homeopathic Infirmary [10-14] having previously worked as a surgeon in the Military Hospital of Paris. Jacques and Pierre published three joint papers [15-17] and two years after his death, Pierre Curie's papers were republished by the Société Française de Physique [18]. The most recent listing of the publications of Marie Curie will be given in full by *Nowotwory* later this year, including a translation to English of all French, German and Polish titles [19].

Scientific Consultant
Sanderstead, South Croydon
Surrey
United Kingdom

Figure 1. No. 12 rue Cuvier in October 2004. Instead of being referred to as an annex of the Sorbonne it is now called 'Université Pierre et Marie Curie Paris & Centre Cuvier'. (Photograph RF Mould)

Figure 2. Interior of one of the small rooms inside the rue Cuvier in October 2004. The original white-tiled bench is clearly seen. The pavilion was built inside an existing courtyard with two of its sides close up against existing walls: one of which is seen through the windows. (Photograph RF Mould)

Figure 3. Signed photograph of Pierre Curie in 1902

Piezoelectricity and crystallography

Pierre received his early education at home before entering the Faculty of Sciences at the Sorbonne and obtaining his Licence in Physics in 1878, Figure 6. He then continued as a demonstrator in the Sorbonne's physics laboratory where he worked with his brother Jacques, Figure 7, who in 1883 left to take up the head lectureship in mineralogy at the University of Montpellier. With Montpellier being in the south of France and very distant from Paris, this ended the scientific collaboration of the brothers, but not before they had completed important studies on the electric properties of crystals and made the discovery of piezoelectricity [15-17].

Pierre left the Sorbonne in 1878 to be in charge of all the practical work (Chef de traveaux pratique and eventually to become Professor de physique générale et electricité theorie) at the École Supérieure de Physique et de Chimie Industrielles (ESPCI) which until 1946 was called the École Municipale de Physique et de Chimie Industrielles, Figure 8. He was to remain there for 22 years, obtaining his Doctor of Science degree in 1895 [21]. In 1900, he returned to the Sorbonne as a Professor in the Faculty of Sciences.

As early as the 18th century, crystals of some minerals were known to generate an electric charge when heated: the phenomenon of pyroelectricity. The phenomenon discovered by the Curie brothers was piezoelectricity (named after the Greek piezein meaning to squeeze or press). They showed that crystals of tourmaline, quartz, topaz, cane sugar and Rochelle salt generated electrical polarisation from mechanical stress. Piezoelectricity was the basis for the Curie electrometer using a thin slice of quartz, Figure 9 [22] and Figure 10 [1].

The first practical application (after the measurement of radioactivity) was a sonar piezoelectric device. This was an ultrasonic submarine detector developed during World War I in 1917 by Paul Langevin, who had been one of Pierre's students at ESPCI. It consisted of a transducer made of thin quartz crystals carefully glued between two steel plates and a hydrophone to detect the returning echo. With the emission of a high frequency sound note from the transducer and by measuring the time taken to hear the echo from the

Figure 4. Artist's impression of the fatal accident. This was published on 20 April 1906 in the French newspaper *Le Matin* with the headline 'M. Pierre CURIE, le savant qui découvrit le radium, a été écrasé dans la rue et tué net par un camion'. Then …….. 'M. Curie traversait la rue Dauphine, près du Pont-Neuf, à deux heures et demie, se tenant derrière un flacre. A ce moment arrivait du Pont-Neuf un camion attelé de deux chevaux et chargé d'équipments militaires, conduit par le charretier Louis Manin …….'.

sound waves returning from an object, the distance to that object can be calculated.

Pierre Curie's name is not only commemorated by the Curie piezoelectrometer but also by the Curie point (or Curie temperature) of a ferromagnetic material. This is the temperature above which the material loses its characteristic ferromagnetidc ability. In an analogy to ferromagnetism, the Curie temperature is also used in

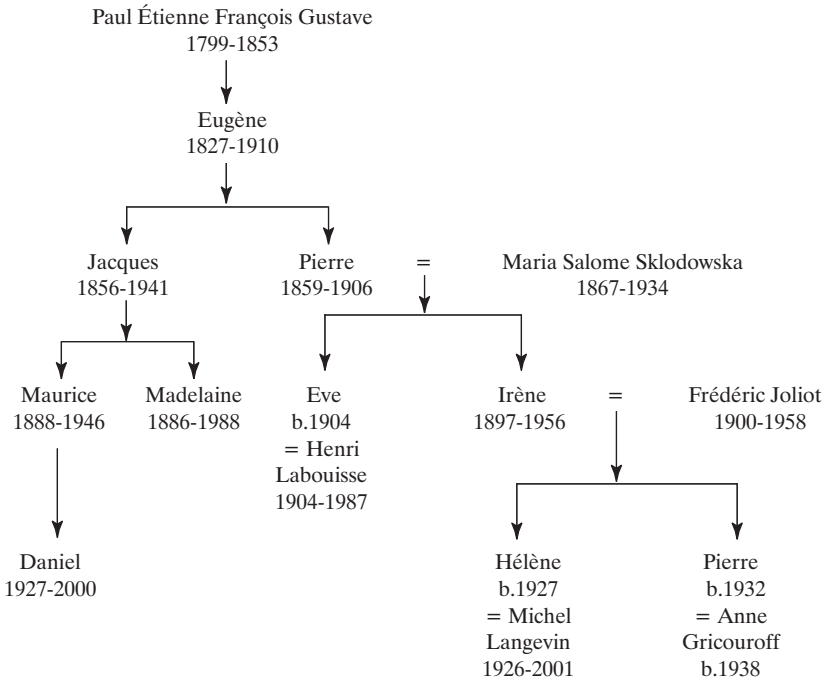

Figure 5. The Curie family tree. Of those included, Eve Curie was a not a scientist but was the author of the first biography of Marie Curie [20]. Both Maurice and Daniel were physicists. Hélène is a nuclear physicist and Pierre a biochemist. In 1903 Pierre & Marie with Henri Becquerel were awarded the Nobel Prize for Physics. In 1911 Marie was awarded the Nobel Prize for Chemistry. In 1935 Irène & Frédéric were awarded the Nobel Prize for Chemistry. In 1965 Henri Labouisse received the Nobel Peace Prize on behalf of UNICEF

Figure 6. Pierre Curie in 1876, age 17 and a physics student at the Sorbonne

piezoelectric materials to describe the temperature above which the material loses its spontaneous polarisation and piezoelectric characteristics.

Research undertaken by Pierre Curie without any collaboration with his brother for the period 1880-1995 included that relating to piezoelectricity, crystal symmetry and the Curie temperature [23-26].

Radioactivity

Pierre Curie in 1898 ceased his studies on piezoelectricity and crystallography to be able to concentrate solely on working with Marie Curie, which culminated in the discovery of polonium and radium [3, 4]. This phase of his life is very well documented not only in scientific

Figure 7. Pierre (left) and Jacques Curie circa 1880

Figure 8. Staff members of the ESPCI in the rue Lhomond 1894. Centre in the front row is Paul Schutzenberger the Director of ESPCI with Pierre Curie sitting next to him. The school was founded in 1882 to replace the Chemistry School of Mulhouse which at that time was the premier school of chemistry in France

Figure 9. Piezoelectric quarts (right) and electrometer. The name plate towards the base of the instrument (left) states 'Electrometre. P. Curie. Atelliers Louis Deffez. 26 rue Boulard, Paris' [22]

Figure 10. Pierre Curie using a quartz piezoelectrometer. This photograph is one of the few published in the biography of Pierre by Marie Curie. It is probably the only now existing side-view image of Pierre using this device [1]. All others, such as Figure 11, are frontal views

publications but also in popular magazines and journals. Invariably the latter were illustrated with not very good representations of Pierre and Marie working in their rue Lhomond laboratory. Figure 12 is one such example from the 10 January 1904 issue of *Le Petit Parisien*. This was probably to celebrate the 1903 Nobel Prize for Physics. It was in the Nobel address given by Pierre Curie [27] that he made the following statement.

"It is possible to conceive that in criminal hands radium might prove very dangerous, and the question therefore arises whether it be to the advantage of humanity to know the secrets of nature, whether we will be sufficiently mature to profit by them, or whether that knowledge may not prove harmful. Take for instance the discoveries of Nobel: powerful explosives have made it possible to achieve admirable things, but they are also a terrible means of destruction in the hands of those great criminals who draw nations into war. I am among those who believe with Nobel that humanity will obtain more good than evil from future discoveries".

During the year 1900-1906 Pierre Curie published 21 papers, Table I, either alone or with co-authors other than Marie Curie. Only one of these was with Henri Becquerel, in 1901 [28] and in this paper the self-exposure experiments made by Pierre Curie were reported, including follow-up of the skin reaction. This in turn led Pierre Curie to loan some radium to Henri Danlos, a dermatologist at the St. Louis Hospital, Paris, for the first radium treatment in France of (non-malignant) skin disease [29]. A second paper on the physiological action of radon (radium emanation) was published in 1904 [30] demonstrating Pierre Curie's continued interest in radium/radon therapy. His final paper [31] was published on 25 June 1906, some two months after his death.

Table I. Topics of Pierre Curie's papers 1900-1906

Action of a magnetic field on Becquerel rays
Induced radioactivity and radon
Secondary rays produced by X-rays
Physiological action of radium rays [28, 30]
Conductivity of liquid dialetrics
Decay of radon
Heat released by radium salts
Radioactivity of gases emitted from thermal water sources [31]

There was much early interest in the first two topics in Table I. For the first, there were initially considered to be two types of Becquerel rays, deviable and non-deviable. The former were the beta rays and the latter the alpha rays. However, the reason that they were non-

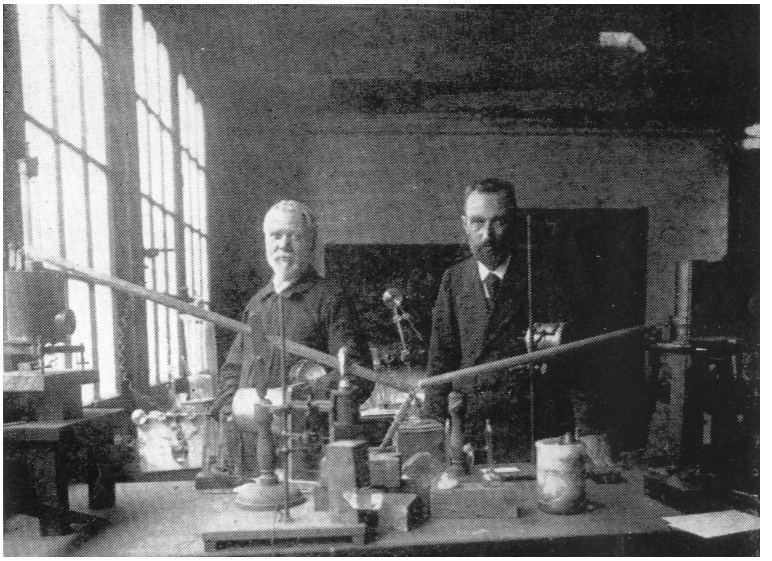

Figure 11. Pierre Curie in the 'shed' at ESPCI in the rue Lhomond, circa 1898. Pierre's laboratory assistant Monsieur Petit is seen left. He is sometimes mistaken for Gustave Bémont the chief chemist at EPSCI who was the third co-author of the paper announcing the discovery of radium [4]. He did not follow the Curies to the Sorbonne but remained at ESPCI where in 2005 there is still a Salle Bémont lecture theatre to commemorate his name. Some Parisian streets have been renamed since the end of the 19th century and for example part of the original rue Lhomond is now the rue Vacquelin where number 10 is the current address of EPSCI.

Figure 12. Journalist illustration of Pierre and Marie Curie in their laboratory in 1904

deviable was only because the magnetic field was not of sufficient strength for any deviation to be detected. The second referred to reports that radium could induce radioactivity in other materials. However, it was later demonstrated, by Ernest Rutherford, that the phenomenon which was common to thorium & thoron and radium & radon, was due to an active deposit.

In conclusion, for comparison with Table I, Table II lists the topics on which Marie Curie published during 1900-1906. There were a total of 13 papers, in all of which she was the sole author [19]. This period also included the publication of her doctoral thesis in both French [32] and English [33].

Table II. Topics of Marie Curie's papers 1900-1906.

Penetration of Becquerel rays undeflected by a magnetic field.
Atomic weight of radium.
Reviews of work on radioactive substances.
Decay of polonium

Acknowledgements

I am most grateful to Mme Hélène Langevin-Joliot for providing names and dates in Figure 5, and also to Mme Andrée Dutreix and Professor Jean Dutreix. Their assistance has been invaluable.

Richard F. Mould MSc, PhD
Scientific Consultant
41, Ewhurst Avenue
Sanderstead, South Croydon
Surrey CR2 0DH
United Kingdom

References

1. M. Curie. *Pierre Curie.* Translated by Charlotte & Vernon Kellogg. New York: Macmillan; 1923.
2. M. Curie. *Autobiografia i wspomnienia o Piotrze Curie*. Warszawa: Wydawniczo-Promocyjny GAL; 2004.
3. Curie P, Curie M. Sur une substance nouvelle radio-active contenue dans la pechblende. *Comptes Rendus de l'Académie des Sciences* 1898; 127: 175-8.
4. Curie P, Curie M, Bémont G. Sur une nouvelle substance fortement radio-active contenue dans la pechblende. *Comptes Rendus de l'Académie des Sciences* 1898; 127: 1215-8.
5. Curie P. Curie M. Effets chimiques produits par les rayons de Becquerel. *Comptes Rendus de l'Académie des Sciences* 1899; 129: 823-5.
6. Curie P, Curie M. Sur la radioactivité provoquée par les rayons de Becquerel. *Comptes Rendus de l'Académie des Sciences* 1899; 129: 714-6.
7. Curie P, Curie M. Les nouvelles substances radioactives et les rayons qu'elles émettent. Report presented at the 1900 International Congress of Physics, Paris, organised by the French Physical Society. Guillaume CE, Poincaré H, (eds). Paris: Gauthier-Villars, 1900; 3: 79-114.
8. Curie P, Curie M. Sur la charge électrique des rayons déviables du radium. *Comptes Rendus de l'Académie des Sciences* 1900; 130: 647-50.
9. Curie P, Curie M. Sur les corps radioactifs. *Comptes Rendus de l'Académie des Sciences* 1902; 134: 85-7.
10. Curie PEFG. *Essai sur les évacuations sanguines dans les maladies inflammatoires*. Thèse. Paris: Gauthier-Villars, 1824, [26 pp].
11. Curie PEFG. Exposition de la religion Saint-Simonienne. Mulhouse, 1832, [23 pp].
12. Curie PEFG. *Practice of homeopathy*. London: JB Baillière & Thomas Hurst, 1838, [366 pp].
13. Curie PEFG. *Verdicts of Coroner's juries. The case of the late Mr Cordwell*. London: Samuel Highley; 1845, [86 pp].
14. Curie PEFG. *A treatise on cholera, English and Asiatic, with directions for the homeopathic treatment*. William Headland & JB Baillière, 1849, [48 pp].
15. Curie J, Curie P. Développement, par pression, de l'électricité polaire dans les cristaux hémièdres à faces inclinées. *Comptes Rendus de l'Académie des Sciences* 1880; 91: 294-5.
16. Curie J, Curie P Sur l'électricité polaire dans les cristaux hémièdres à faces inclinées. *Comptes Rendus de l'Académie des Sciences* 1880; 91: 383-6.
17. Curie J, Curie P. Contractions et dilatations produites par des tensions dans les cristaux hémièdres à faces inclinées. *Comptes Rendus de l'Académie des Sciences* 1880; 93: 1137-40.
18. Curie P. *Oeuvres de Pierre Curie*. Publiées par les soins de la Société Française de Physique. Paris: Gauthier-Villars, 1908.
19. Mould RF. Radium history mosaic. Warsaw: *Nowotwory J Oncol* suppl. 2006, in press.
20. Curie E. *Madame Curie*. London: Heinemann, 1938.
21. Curie P. Proprietés magnétiques des corps à diverses températures. Thesis presented to the Faculty of Sciences, University of Paris for the degree of Docteur ès Sciences Physiques. Paris: Gautheir-Villars, 1895.
22. Niemann F. Atom-messgeräte. *Sammeln* 1991; 88: 28-35.
23. Desains P, Curie P. Recherches sur la détermination des longeurs d'onde des rayons calorifiques à basse température. *Comptes Rendus de l'Académie des Sciences* 1880; 90: 1506-10.
24. Curie P. Sur les phénoménes pièzo-électriques. *Bulletin des Séances de la Société Française de Physique* 1887; 47-9.
25. Curie P. Sur la symétrie dans les phénoménes physiques. Symétrie d'un champ électrique d'un champ magnétique. *J Phys* 1894; 3: 393-416.
26. Curie P. Lois expérimentales du magnétisme. Proprietés magnétiques des corps à diverses températures. *Ann Chim Phys* 1895; 5: 289-405. [Reprint of the Thesis]
27. Curie P. Radioactive substances, especially radium. Nobel Conference lecture, Stockholm, 6 June 1905.
28. Becquerel H, Curie P. L'action physiologique des rayons du radium. *Comptes Rendus de l'Académie des Sciences* 1901; 132: 1289-91.
29. Danlos H, Bloch P. Note sur le traitement du lupus erythémateux par des applications de radium. *Ann Dermatolo et Syphilog* 1901; 2: 986-8.
30. Bouchard C, Curie P, Balthazard V. Action physiologique de l'émanation de radium. *Comptes Rendus de l'Académie des Sciences* 1904; 138: 1384-7.
31. Curie P, Laborde A. Sur la radioactivité des gaz qui proviennent de l'eau des sources thermales. *Comptes Rendus de l'Académie des Sciences* 25 June 1906; 142: 1462-5,
32. Curie M. Thèses présentées à La Faculté des Sciences de Paris pour obtenir le grade de Docteur ès Sciences Physiques. Thèse. *Recherches sur les substances radioactives*. Paris: Gauthier-Villars; 1903.
33. Curie M. *Radio-active substances*. Thesis presented to the Faculte des Sciences de Paris. Reprinted from the Chemical News [London] 2nd edn. London & New York: D. van Nostrand Company; 1904.

Paper received and accepted: 22 January 2006