Chemhistory: phosphorus

The curious poisoning of her employer by Mrs Merrifield presented a chemical mystery that for many years piqued the interest of Professor Alan Dronsfield.

In July 1953 I was eight years old, living in Blackpool, and an avid reader of anything I could get my hands on. For regional daily newspapers in those days a local murder trial would be a god-send, and it would be covered day after day, complete with page after page of gory details. Thus the Blackpool Gazette reported the trial of Louisa Merrifield and her husband Alfred for the poisoning of Sarah Ricketts, a wealthy elderly widow for whom they kept house.

Poisoning had always been a popular way of disposing of unwanted wives, husbands, bosses and, well, anyone. In the 19th century arsenic had been the fashionable choice. Its symptoms mimicked the prevalent disease cholera, so acquiring a death certificate was a reasonable certainty, at least if the doctor had been well set-up beforehand. Moreover, it was easy to get hold of. Perhaps the least suspicious method was to buy "fly-papers" from the grocers, chemists or iron-mongers, steep them in warm water and dispense the nearly-tasteless lethal solution of arsenious oxide to the victim in his/her drink or food.

During the 20th century, however, getting hold of poisons was more and more difficult. Fly-papers were no longer arsenic-based, but became the non-toxic sticky variety we know today. True, you could still get strychnine on the pretense of killing garden moles, but even inquiring after it would sow seeds of suspicion.

However, there was one agent that was widely available and highly toxic: a phosphorus-based rat and mouse killer called Rodine. In Mrs Merrifield's case, the prosecution alleged she used this material to murder her employer. Traces of the poison were found in Sarah Rickett's organs and Merrifield had recently purchased a tin of the bait. It was suggested that either the Rodine had been mixed with jam, which Ricketts liked to eat by the spoonful, direct from the jar, or administered in strong drink such as rum, to which she was also partial.

Merrifield was found guilty and hanged on 18th September 1953. The jury could not agree on the guilt of her husband. In fact, he inherited a half-share in the late Mrs. Ricketts' bungalow and died in 1962, aged 80.

Now to the chemistry. Probably about the time of the trial my parents had bought me a home chemistry set and this started off a fascination with the subject that persists today. Over the years I was troubled by the Merrifield case – not really in connection with the verdict, but in the precise identity of the chemical she used. To the lay public, phosphorus is phosphorus.

However we chemists know that the element comes predominantly in two forms (called allotropes, as with carbon). One allotrope is a very deep red powder, insoluble in water. It is hardly toxic – perhaps 15g per kilogram of body mass for a lethal dose. Thus a typical individual of weight 70kg would need to eat a kilogram of the stuff: the size of a large bag of sugar. Unlikely.

The second allotrope of the phosphorus is the "yellow" variety, which if pure is in fact an almost white solid with the consistency of candle wax. This yellow phosphorus is toxic, with lethal doses for rats being about 3mg per kilogram of body mass. Our 70kg victim would only need 210 mg for dispatch – somewhat less in mass than the average aspirin tablet.

But there's a problem even with this. Yellow phosphorus fumes in air at room temperature and catches fire (in air) spontaneously at temperatures typical of a warm day. How then could yellow phosphorus be used in rat poison? Even opening the tin, at least in summer, would risk a spontaneous fire. For years I remained perplexed about the type of phosphorus Merrifield had used to see off her employer.

In the trial reports there were many references to the yellow variety and thanks to the Science Museum archives I was recently able to track down a packet of the Rodine, of approximately the right vintage. It cost 1/6 (then 7p) and the box clearly states “Yellow Phosphorus 2%: Inert Ingredients 98%”. The latter was a bulking mixture of bran and molasses, an impure type of syrup, and would encourage the rats to eat the poison.

Rickett’s death was viewed as suspicious and an autopsy was performed. Her stomach contents revealed a small quantity of bran and a minute amount of phosphorus (0.042 grains, 2.7mg) and a little more in her intestines (0.099 grains, 6.4mg). Elemental phosphorus was not detected elsewhere in the body.

The prosecution found an expert witness who asserted that the phosphorus was the cause of death and she had been poisoned. More than 9.3mg would have been administered, but on absorption (and whilst doing its lethal work) it would have been oxidized to phosphate, which occurs naturally within the body.

The defence, however, was able to call another expert witness, of equal standing to that appearing for the prosecution. Whilst not disputing the analytical data, he held that the absence of phosphorus in the intestinal walls showed that it had not penetrated into the major organs. Moreover he was able to advance another theory for Merrifield’s death. He held that she had died from “natural causes” as he had found evidence for “fatty necrosis of the liver”.

Faced with the conflicting views of the two expert witnesses, a deal of circumstantial evidence, the jury had to make its decision. And it found Merrifield guilty of murder.

I wonder if, had her defence counsel had been more of a chemist, enough doubt would have been sown in the jurors' minds to get her acquitted? Merrifield never confessed so we will never know the precise means she allegedly used to murder her victim.

As it was, Merrifield may have been her own worst enemy. A loose tongue saw her boast to her friends that she had worked for an old woman who had died and left her a bungalow worth £3,000 (£180,000 today). When asked who had died, Louisa Merrifield’s reply secured the noose around her own neck: *"Well, she's not dead yet, but she soon will be."*

Author: Alan Dronsfield . Professor Alan Dronsfield is chair of the Royal Society of Chemistry Historical Group.