The history of the pyrethroid insecticides

The synthetic pyrethroid insecticides were developed at Rothamsted Research, which receives strategic funding from BBSRC, in the 1960s and 1970s. Today they account for around one sixth of global insecticide sales, and global annual sales of pyrethroids exceed US$1.4bn. They are also used to impregnate bed nets, which help to reduce the spread of malaria as part of the World Health Organisation’s Global Malaria Programme.

The science of pyrethroids

Natural pyrethrins are derived from Chrysanthemums, the same genus as common daisies, and are an important component of plant defences against insect pests. For thousands of years they have been extracted and used to combat insect pests. However, the natural pyrethrins are not particularly effective when used on fields of crops as they are quite unstable, breaking down quickly when exposed to sunlight. To overcome their limitations, scientists developed synthetic compounds, called pyrethroid insecticides, based on the chemistry of the natural pyrethrins. Both work by targeting sodium channels in the cell membranes of insect nervous systems. By locking these channels open, pyrethroids paralyse the insect and ultimately killing it.

Compared to natural pyrethrins, the synthetic pyrethroids are more stable in direct sunlight. They are also significantly more effective against a wider range of insects, so farmers need to apply less insecticide to their crops. This also means pyrethroids are less likely to build up to dangerous levels in the environment.

However, pyrethroids can harm some beneficial insects such as bees or the parasitic wasps that prey on pests, and they are also toxic to fish and other aquatic organisms. Because humans possess enzymes that quickly break down pyrethroid insecticides, the pyrethroids are only toxic to people in large quantities or over long periods of time.

Early landmarks in the discovery of the synthetic pyrethroids

• Pyrethrin insecticides from pyrethrum daisies (Chrysanthemum cinerariifolium) have been used in various forms for thousands of years. They were originally discovered in China and imported into Europe as ‘Persian powder’.

• Hermann Staudinger and Lavoslav Ružička published a definitive study on the structure of natural pyrethrins in 1924.

• Pest control research at Rothamsted began before the Second World War when other pest control options often relied on arsenic or cyanide. Work on plant breeding near Rothamsted in the 1920s supported the establishment of the pyrethrum industry in Kenya.

1949
The first synthetic pyrethroids, allethrin and bioallethrin, are developed in America by Milton S. Schechter and colleagues. They are around twenty times more effective at killing insects than DDT without the serious environmental or health impacts.

1950s
Milton S. Schechter and colleagues developed bioallethrin, which is around twenty times more effective at killing insects than DDT without the serious environmental or health impacts.

1960s
The development of the synthetic pyrethroids at Rothamsted was led by Michael Elliott. Elliott joined the institute in 1948 to investigate the link between molecular structure and biological activity in the natural pyrethrins. He used this knowledge to create the synthetic pyrethroids. Elliott won numerous awards over the course of his career, and received a CBE in 1982.

1970s
Michael Elliott develops permethrin, the first field-applicable pyrethroid. It is much more suitable for use in agricultural settings as it does not break down so quickly in sunlight.

1980s
Professor Chris Curtis at the London School of Hygiene and Tropical Medicine begins to investigate the potential of insecticide-treated bed nets to control malaria. He compiles reports for aid agencies to distribute the nets for free to communities in affected regions to help reduce mosquito numbers and Wepman.

1990s
An MRC-funded study shows that using insecticide-treated mosquito nets (ITNs) in a rural region of the Gambia can reduce the number of deaths of children under the age of 5 by around one-third. The ITNs used in the study were treated with permethrin.

2000s
Early 1990s
Sakis of synthetic pyrethroids reach US$1.2bn per year.

2003
New long-lasting insecticidal nets (LLINs), which use pyrethroids such as cypermethrin, form one of five pillars to tackle malaria in the World Health Organisation’s international Roll Back Malaria Programme.

2011
The WHO recommends the use of 12 long-lasting insecticidal mosquito nets to tackle malaria. The nets only rely on pyrethroids developed at Rothamsted.
The history of the pyrethroid insecticides

Notes and References
Thanks to Professor John Pickett and Professor Bhupinder Khambay for providing much of the historical information about the work of Dr Michael Elliott at Rothamsted Research, and for their comments on a draft of this case study.


10. Professor Chris Curtis, London School of Hygiene and Tropical Medicine.


18. ‘Demolition of the laboratory where synthetic pyrethroids were invented’.


