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Mosquito Wars: Politics, Economics or Science?

Heated debates are going on again in Brandon and Winnipeg about the most effective way to deal with mosquitoes. In thinking about this issue it is useful to begin with the broad historical context of mosquito control, and then to follow with a look at some recent and current research relating to the fundamental questions being asked in both cities about the repeated use of malathion.

Western cultures have long believed that we can dominate nature, and in fact we have come to see such domination as a key part of what we call “development”. As Gladwell (2001) has observed:

Long entangled with not only disease but development, the mosquito has been intimately linked to state power, often becoming both its object and its *raison d'être*. One of the most vivid examples of this process is the anti-malarial project of Italy's Fascist regime in the 1920s, where the malarial-ridden Pontine Marshes served as the ideological “quilting point” for nationalist discourses over the domination of a “wild” nature by modern technology and development”.

Two Approaches

Two fundamentally different approaches emerged historically for dealing with mosquitoes and their impact on humans. The pioneer of chemical-free mosquito source reduction was William C. Gorgas (1854-1920).

He instituted measures to combat mosquitoes such as the drainage of all pools and ditches around a set perimeter of towns and villages; widespread brush removal and the cutting of all grass greater than one foot in height; the window-screening of houses; the quarantining of the sick and the trapping of adult mosquitoes. Preventing any spaces like rain barrels, flower pots and gutters from providing breeding sites was fundamental to his approach. Indeed, householders who did not comply with his prevention program received a \$5 fine.

Gorgas's approach was soon overshadowed by chemical intensive warfare advocated by American doctor Fred L. Soper (1893-1977). Soper was given the authority to use Paris Green, or copper acetoarsenate. Soper's title, “world's insect killer”, emerged when he caused the large-scale industrial production of DDT in the 1940s. As Gladwell put it, “Gorgas, Soper's legendary predecessor, said that to fight malaria, you had to learn to think like a mosquito. Soper disagreed- for him fighting malaria had very little to do with the intricacies of science and biology.”

DDT

Soper's approach led to the worldwide application of DDT in the 1950s and 1960s supported by the United States Agency for International Development (USAID) and the World Health Organization (WHO). It wasn't

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long before mosquitoes developed DDT resistance and insect populations rebounded after aerial spraying. The 1962 release of Rachel Carson's *Silent Spring* and ongoing research on DDT and its breakdown products, indicating detrimental effects on humans and biota, confirmed the wisdom of the banning of DDT in the developed world in the 1970s. It should be noted that this well-studied and clearly very damaging insecticide is still being manufactured and sold by industry and promoted in some countries. This lack of concern on the part of the current manufacturers, despite the scientific and medical literature, is evidence of the lasting power of Soper's doctrine.

The DDT industry is not alone in its disregard of the relevant literature, giving us some measure of the integrity of pesticide manufacturers /distributors in general. Where adulticiding is still practiced, DDT has been replaced by ultra-low-volume (ULV) insecticides like malathion, usually fogged by sprayers on trucks or helicopters. Those communities who favour Soper's dogma have continued to blanket the environment with insecticide from air and road, resulting in negative impacts on various biota, including humans, and most importantly resulting in the development of insects that are resistant to the chemical.

Biological Approaches

A developing concept in general insect control was to identify the most vulnerable and accessible stage of an insect's life cycle. With this addition to the Gorgas approach, the mosquito larval stages were identified as the life cycle stage most accessible to population control. These larvae were found in the standing water in the environment. This approach in the early 1970s led to the use of another organophosphate pesticide, terbuphos (abate), to kill larvae in breeding locations where drainage etc. were not feasible.

By the 1980s resistance to terbuphos was documented and it was replaced by much more specific biological insecticides- *Bacillus thuringiensis israelensis* (*Bti*) and *Bacillus sphaericus* (*Bs*)- and progressive and ecologically aware communities promoted the concept of integrated pest management. Promoting predators by a bioengineering approach that encourages habitats for bats, dragonflies and insectivorous birds has been used in some jurisdictions. The Soper approach, based on chemical use, minimizes these aspects and may reduce predators.

Manitoba Evidence

After hearing presentations from experts from across Canada in hearings held in 1982, the Manitoba Clean Environment Commission concluded that adulticiding mosquitoes was a waste of time and money. So why, given that conclusion, has the City of Winnipeg persisted with continuous fogging with malathion? Has new scientific evidence materialized to support their approach? Do monitoring systems indicate, when critically evaluated, that malathion produces dramatic drops in adult mosquito populations?

A more likely explanation is that recent events in Brandon have led Winnipeg to continue rejecting the approach taken by Canadian cities that do not use malathion. Brandon most years has been effectively managed through larviciding, but cut-backs in staffing and monitoring this very wet year resulted in large nuisance mosquito populations, making conditions there similar to Winnipeg's. Winnipeg is located in a large flood plain that experiences significant flooding most years, and large tracts of land are not accessible, making effective larviciding very expensive. Politics took over as occurs most of the time in Winnipeg and ineffective malathion spraying returned.

There is much evidence showing that the use of Malathion has serious health implications

When challenged on the use of malathion and its impact on human health, its supporters call upon the flawed Health Canada Pest Management Regulation Agency (PMRA) research which gives the green light for use of the chemical. But the agency relies on the industry's own research which states that the public is perfectly safe as long as it doesn't drink it. This is interestingly the stance taken by Crop Life Canada — a trade association representing the manufacturers, developers and distributors of pest control products — that, through its lobbying efforts, has had a huge negative impact on rational evaluation and licensing of pesticides in Canada and elsewhere.

But medical research shows that concerns are warranted. For example, infants under 6 months do not yet have fully developed acetylcholinesterase systems (the molecular target for malathion) and their immature livers are less able to breakdown malathion, making them and developing mammalian fetuses much more sensitive to malathion. Other persons known

to suffer adverse effects include a small percentage of the population who have an atypical low-level variant of plasma cholinesterase and are therefore more vulnerable to poisoning. Long-distance runners, women in early pregnancy or using birth control pills, and persons who have advanced liver disease, chronic alcoholism, malnutrition, or dermatomyositis also exhibit low plasma cholinesterase levels. Persons who have asthma and are exposed to malathion may be at increased risk because it can cause narrowing of the airways, exacerbating breathing difficulties. Malathion has also been associated with allergic contact dermatitis, and is known to be an endocrine disruptor. The U.S. Environmental Protection Agency (EPA) has identified malathion as a carcinogen in mice and a possible carcinogen in humans.

While the pesticide industry and some ill-informed politicians say repeatedly that malathion is rapidly detoxified and excreted, recent measurements have documented the presence of malathion and its derivatives in the bloodstream of adults in the City of Winnipeg. In the body and in the environment, malathion can be converted from the –thion form to the more toxic –oxon form; rates of conversion vary greatly in the population but are much more rapid in the body than in the environment. Maloxon and commercial grade malathion have been found to cause chromosomal damage in a wide variety of organism cell types including humans.

Commercial versus Pure Pharmaceutical Malathion

It should be particularly noted that the required test results submitted by a malathion manufacturer for registration to PMRA have been carried out with *pure* malathion, not the manufactured or commercial product that has additives. Malathion is now undergoing a further re-evaluation by PMRA and among the new requirements are: data on the formation of impurities in manufacture; impurities of toxicological concern (if applicable); oncogenicity (2 rodent species); long-term studies (if available); acute delayed neurotoxicity (hen); developmental neurotoxicity; foreign reviews of toxicology etc. On enquiring as to the availability of new data provided by the manufacturers, PMRA advise that these data (only available in their library in Ottawa) will not be accessible to independent scientists and the public until the malathion review is completed (no date given).

Since Winnipeg is the only city in Canada carrying out adulticiding and has been doing this for over 40 years, it is unfortunate that Health Canada has not used this as an opportunity —as was done in Florida and California — to have physicians record and assess any health effects in the population. Critics have noted a great reluctance on the part of PMRA to study humans in the real world.

Some U.S. Experience

Several U.S. states carried out extensive and repeated aerial spraying of malathion products in an attempt to eradicate the Mediterranean fruit fly, considered a serious threat to agriculture. The Florida state health department solicited reports of potential adverse health effects. From April 30 to September 30 1998, 230 reports of illness were received and investigated by the Department of Health. The 123 probable or possible cases represented a rate of nine cases per 10,000 residents in the exposed areas.

In California, scientists with varied backgrounds in toxicology raised concerns about contaminants in commercial formulations. Indeed, Dr. Marc Lappe, the author of the state's first risk assessment recommended that *pharmaceutical*, not commercial malathion be used. His recommendation was ignored since the manufacturer advised that they could not make the needed quantity of the pure insecticide. The report also indicated concerns about susceptible people and uncertainties in analysis. For example they ended up with 17 sprayings rather than the 6 used by the Committee to calculate exposures. Recently, the issue of the toxicology of contaminants (isomalathion etc.) in manufacturing led to the EEC's banning malathion as an insecticide in plant protection products.

The last PMRA risk assessment in Canada was done in 2003 and was based on a *single* application event. The exposure of populations to multiple events clearly needs serious study. Two theoretical studies out of Quebec in 2010 conclude that for a significant portion of the population, repeated aerial (advocated by some in Winnipeg) and to a lesser extent, ground sprayings of malathion can generate acute and sub-chronic exposures that may exceed toxicological concern based on the USEPA's reference values. Repeated ground spraying results for acute exposures to infants, toddlers and children were 12.5 percent, 24.2 percent

and 8.8 percent of the individuals and corresponding subchronic exposures were 9.8 percent, 16.5 percent and 7.4 percent.

West Nile Virus

Another stated rationale for adulticiding with malathion in Winnipeg and Brandon relates to fears of infection with West Nile Virus (WNV). Canada had its first confirmed case of WNV in 2002. Health Canada advises that for most Canadians the risk of this illness is low, and the risk of serious health effects is even lower. They advise that one's chance of being bitten by a mosquito capable of spreading WNV is small. However, if there are reports of infected mosquitoes, infected horses or dead birds in your area, the following actions should be taken immediately to minimize risk: limit outdoor time at dawn and dusk; wear light-coloured long-sleeved shirts, long pants and a hat when outdoors; use insect repellants following manufacturers' directions. Also take steps to reduce mosquito populations around your home, namely, remove all standing water. *The Canadian Family Physician* in June 2005 published a "West Nile Primer". The main message was: "While methods for controlling the mosquito population are available, we lack evidence that they reduce infection in the general human population. Indeed all medical and government authorities and research say the best way to protect against any disease linked to mosquitoes is to avoid bites – use repellants." It is also notable that malathion toxicity is a much greater threat to susceptible segments of the Winnipeg population than is West Nile Virus.

It is most unfortunate that, in spite of the evidence described above, Winnipeg is now proposing much more intensive malathion spraying in the provincial capital for nuisance mosquitoes.

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