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Technical Session - Panel Discussion and Questions

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Editor's note: The following is an edited transcript of the question session/panel discussion that followed the presentation of H.B. Tordoff, R.D. Moon, T.A. Lajiness, J.W. Washburn, M.V. Meisch, A.H. Mason, and C.E. Reed at the Technical Session. The questions were generated by members of the audience and presented to the panel by Robert Binger.

MODERATOR: Robert Binger, Burlington Northern, President of Natural Resource Division, retired.

PANEL MEMBERS: Charles Reed, M.D. Allergist, Mayo Clinic; **John Washburn,** Director, Minnesota Mosquito Research Program, Minnesota Dept. of Health; **Max Meisch,** Ph.D., University of Arkansas, Dept. of Entomology; **Roger Moon,** Ph.D., University of Minnesota, Dept. of Entomology; **Arthur Mason,** Minnesota Dept. of Agriculture, Division of Plant Industry; **Harrison Tordoff,** Ph.D., University of Minnesota, Dept. of Ecology and Behavioral Biology; **Paul Pentel,** M.D., Hennepin County Medical Center.

Binger: *Considering the 1983 data presented on Western Equine encephalitis, does the virus necessarily constitute a threat of epidemic proportions to humans? Does the threat warrant mosquito control on a statewide basis?*

Washburn: For the first part of the question, up until 1983 the indicator that we were using was the presence of the virus as a threat to the public health. Quite to the amazement of not only those of us here in Minnesota but also to a number of national experts, the presence of a virus may not necessarily indicate that there is a threat to human health. Despite all the red dots [virus isolations] on the map, there was only one human case of Western encephalitis reported in Minnesota, and where that person was exposed remains a bit of a mystery to us even now. Clearly, the presence of the virus had nothing to do with risk of disease at that time, and that raises some pretty serious questions. For the second part of the question, in 1983 we went on the knowledge that we had available to us at that time. The spraying program was a justified attempt at an adulticide knock-down program to eliminate transmission of the virus. It's our belief now, based on that experience in 1983 and also based on the fact that we no longer have a really accurate indicator, that statewide spraying should probably not be the first line of defense in preventing cases of Western encephalitis. The time and the money would be better spent on intensified public health education — use of personal repellents and other modes. The other is that it's such a vast land area that even with that large-scale spraying program we barely offered protection on a very short-term basis to less than half the population exposed.

Binger: *Are juvenile hormone-based controls species specific or family specific, and what effect do these hormones have on larval fish and amphibians?*

Meisch: The most commonly used juvenile hormone mimic is a chemical called Methoprene.... There's some evidence that this is indeed interfering with the life processes of various crustaceans. This is data generated in Louisianna by Dr. David Steelman. I'm not sure about the [specific] effects on shrimps, crabs, so forth. My knowledge is that it's pretty specific for Diptera....

Moon: Two things pop into my mind. One is the Chironomids, which are midges. They are apparently making a sizable contribution to the nutrition of dabbling ducks and other animals. They're all in the order Diptera — flies, two wings. I suspect it's toxic to others. I would like to raise the issue of dose, though, and formulation. Those are two mechanisms whereby we can impart selectivity regardless of the biological generality or specificity of the target factor ingredient we're working with. By putting it in precise places at precise times, we can be functionally specific with material that is not very specific. It's an option that we have. I think we're using much more elegant sorts of formulations for getting at our best species.

Binger: *This questioner requests more specific information on which natural predators, especially invertebrates, are most important in restraining larval populations.*

Moon: I'm not aware of any cases where it's been demonstrated that an invertebrate predator maintains mosquito populations. I might point out that it's not well established that any biological agent maintains (in the sense that we would like to see) mosquito populations; and it seems to get worse the farther north we go.

Binger: *How does the current use of insecticides for mosquitoes compare in abundance to that used for agriculture in Minnesota?*

Mason: I don't have any figures on that, but my guess is it would be almost minuscule....I think the pesticide use by urban dwellers may even exceed that used by agriculture. That may be a surprise to many people, but with the advent of liquified lawn care (herbicides, germicides, and all those sorts of things are pesticides), the urban dwellers may be exceeding in the use of all pesticides. Most of the mosquito control that we're aware of in cities and towns may only involve one or two sprayings a year at the most — over an agricultural fair or during a time when there may be a heavy brood of [*A.*] *vexans* — and then it's sprayed over the populated areas of communities. So basically it would be a very small amount in comparison with agriculture in general.

Meisch: The dosages involved in insecticides for mosquito control are so reduced compared to what agricultural insecticides usually require, that in terms of pounds, I would think they'd be much, much [lower]. As far as dollars spent, pest control operations are a high item. [Use is high] not so much in terms of amount, but in dollars spent.

Binger: *Could immunity to mosquito bites be induced or managed?*

Reed: That was one of the things I'd hoped to find when I reviewed the literature on mosquito allergy and unfortunately there simply hasn't been enough scientific study to know. The problem is that the antigen we're interested in is in the saliva, and there's no easy way to collect saliva from mosquitoes. It can be done in a research mode, but to get enough of it for clinical trials is simply not possible. We do have pretty good information about perhaps an analogous situation — the allergy to the bee sting. Here it is necessary to collect the venom specifically. If you try to get venom simply by collecting the whole insect and grinding it, enzymes of the body of the bee quickly denature the antigen that's in the venom sac and it becomes inactive. So it's necessary to collect the venom separately. Whether it's necessary to collect the saliva of the mosquito separately I don't know, but I suspect it would probably turn out to be necessary.

Binger: *How much land area and what percent of the population is under mosquito abatement in the U.S.? What are the demonstrated negative aspects of these programs on the environment?*

Mason: My own feeling is that, even though we've had mosquito abatement districts in this country for many years, they're refining their techniques and [are able to reduce their environmental impact] perhaps better than they did years ago, simply because they have more technologies available to them. I don't believe that there's an abatement district out there that hasn't by now been made aware of the environmental concerns of what they're doing. For them to survive, if you will, or for them to do their job, they have to be more refined in what they're doing. Some of the problems [have involved] permanent "ditching" done years and years ago in some marshes along the seacoast. But those marshes, before the ditching was done, were permanently altered by highways going along the coasts, which altered the marshes themselves — they restricted the flow of water in and out — so the ditches followed that first disruption in an attempt to solve another problem.

Tordoff: One example of the negative environmental effects, of course, comes from the bad old days of the use of DDT. If you remember, it was used for mosquito control among other things. The negative effects are probably well known to everyone in this audience and include near-extermination of birds like the peregrine falcon and reduced reproduction of things like bald eagles and so on. That was dramatic, but we did something about it and we're not doing that sort of thing anymore. I think that what we need to do now is be sure that before we install new control programs, we get the kind of baseline monitoring of presumed or likely target species — find out what's out there — so we can make some before-and-after comparisons. The problem is that once you set a control program in place then you've lost the opportunity to make the measurements you need at the outset in order to measure the effect of the program. My apprehension about a suggested statewide program is that we might launch into the same sort of thing again on a statewide basis, or at least on an expanded basis from what we have now, without taking advantage of the opportunity this time to find out what we're really doing. We don't really know.

Meisch: I agree with what you're saying and I think Minnesota really has the chance to do it right. I think this is good and I would laud the approaches toward this control effort in that research has been mandated. I don't know of any mosquito abatement district that was ever [later] voted in that was voted out. Mosquito abatement historically comes about by the people that benefit from it — the people who pay the local taxes. It's a grassroots type of thing. There are emergency programs where the government might step in and abate mosquitoes, but, by and large, it's a community type program. I think that some abatement districts in California have almost worked themselves out of a job; they're having to branch out into other things such as rodent control, etc. But once abatement is voted in, I guess it's testimony that people have demanded it and [usually it stayed there].

Binger: *What is the screening process, if any, to determine the toxicity to humans of chemicals and hormones used in mosquito control? Do the results of these tests have any impact on product use?*

Pentel: That's a very broad question and a very controversial one in terms of the stance of regulatory agencies. In general, when looking at a chemical that will be used in the environment, there are a number of aspects of toxicity that are looked at. One, of course, is the acute toxicity tested in animals in terms of what the dose is that kills the animals [or causes any other acute effects]. Perhaps of more concern is what is their chronic or long-term toxicity, and this may be specific damage to organ systems. For example, some of the organophosphates (not the ones used for mosquito control but others) can cause damage to nerves. The biggest questions are in terms of damage to genes. Are these chemicals mutagenic? Do they cause cancer? Do they have reproductive effects? Any number of tests can be done. These range from tests on cells, or bacteria, all the way up to tests on organisms themselves. We can look at whether chemicals cause mutations or damage chromosomes and try to use that as predictors of whether they might damage genes or chromosomes in higher animals. To some extent these same things can be looked at [directly] in higher animals. One can give [a test] animal some drug then remove specific cells and look at the chromosomes and see if they're damaged. That's somewhat of a predictor.

In the end, though, the real test is to take animals and give them large amounts of the chemical and see if they develop cancer. There are inherent limitations in this. Most cancers that are caused by chemicals [occur infrequently] so that a chemical that causes cancer in humans might do that in only one in a million individuals. In a country of 300 million, that's a lot of cancers.... [However] it's not feasible to take millions of animals and give them the chemical. Furthermore, most chemicals cause cancer with a latent period; that is, it may be 10, 20, or 30 years before the cancer actually shows up. In experimental animals, it certainly is not feasible to carry on these experiments for 20 or 30 years. So what has to be done is to extrapolate, and usually animals are given much higher doses of the chemical than humans would ever be exposed to, and they're given it for very prolonged periods of time to see if [we] can magnify the chance of getting these very infrequent events. That necessarily means [we] have to extrapolate from animals to humans, and it's always very difficullt to do that and to know if it's a reasonable step. Most regulatory agencies now have a set number of tests for looking at other chemicals. In the past, when rats [were] given [a certain amount of a] chemical for [a certain] length of time, [and] it caused cancer, [it was considered] predictive of causing cancer in humans. If a new chemical is tested in those animals and it does the same things, it's presumed that it may have the same effect in humans. It's not the same as getting that data [directly from] humans, but sometimes that's very hard to do. The other [possibility] is to do epidemiologic studies in humans, but that can only be done for certain chemicals. It's a very complex process. It involves extrapolation and it requires, to some extent, assuming that a chemical is toxic until it's shown by reasonable tests that it isn't.

Meisch: Regarding insecticides, specifically those used for mosquito control, to acquire labeling, at least a 6- or 8-year research period is necessary at a cost of millions of dollars. Right alongside the efficacy of a compound against a target species, there are toxicological trials going on of maybe 4,000 candidate insecticides and any one will reach the market. The point I want to make is that mosquitoes are really a minor-use item. There are not many companies that can afford the millions of dollars [needed] for mosquito insecticide that's going to be used strictly in that area. They're going to put their dollars into something like cotton or corn insecticides or pesticides that are used over wide areas so they can [make] a profit. I think we're in danger of losing some of the tools that we use in our fight with the mosquito simply because new and promising products [aimed] specifically at mosquitoes are not going to come about [because of] the cost aspect.

Binger: *How are mosquito flight patterns and distances determined accurately?*

Meisch: One of the most sure-fire techniques would be an island out from the coast. If there is no mosquito breeding on the island and mosquitoes are captured there, you can be sure they came from somewhere but the closest land is 40-50 miles away. There all sorts of marked-recapture type studies and things of this nature. It's a very difficult thing to prove. We're trying some of this in Arkansas now.

Moon: The only other technique that's used is logic. You could look at historical records and notice areas where rainfall has been extraordinary and might account for a local, fairly focused hatch of adults. [You could] in turn look at wind movement patterns and deduce where a plasma of mosquitoes would be moving in the air and see if that corresponds at all with what you've observed someplace downwind....You can...run into trouble but that is a technique that's used. In fact, Horsfall used it to argue that mosquitoes from St. Louis came from much farther south [because of] wind trajectory patterns. It's very indirect.

Binger: *My experience indicates mosquitoes go into vegetation to avoid being blown away. Are there differences among species in Minnesota that retreat to vegetation to avoid wind?*

Moon: I suspect there is but it's not documented. There seems to be some relationship between a mosquitoe's interest in flying and its age. It seems that mosquitoes that have just emerged are much more inclined to take wing and fly while others that have just fed are very inclined to sit it out, regardless of what the weather is like. We have good experimental and field evidence that mosquitoes are going through these gonotrophic cycles where their interest in feeding would likely coincide with dispersion and inclination to move, and once they've fed, they become fairly sedentary.

Binger: *Comment on the Jamestown Canyon virus' mosquito vector [and] relationship to white-tailed deer. Are cattail mosquitoes carriers of any disease or are they just a nuisance?*

Washburn: Jamestown Canyon virus is a California group virus. You find fair evidence of it in white-tailed deer populations, though we don't know precisely what the vector is — certainly *Aedes triseriatus* is one but there may be others.... There's not a great body of knowledge on Jamestown Canyon.... Dr. Thompson in Wisconsin [looked at] kids in summer youth camps who were working in the woods. There were seropositivity rates...as high as 17%, in groups of kids with what they thought was an observed increase of febrile headaches. These would be subclinical cases. There is some suggestion that there's illness associated with the disease. Clearly, this is just scratching the surface.

As far as I know, *Coquilettidia pertubans* — the cattail mosquito — is not a vector of anything [in Minnesota.]...[It may carry] Eastern Equine encephalitis, but that's not of public health importance here.