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Public Health Advantages of Biological Insect Controls

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Biological control is not new, it is simply newly appreciated. This renewed appreciation stems from the widespread insecticide treadmill which is largely a product of insecticide disruption of the balance of insect communities. Biological control is a natural phenomenon; the regulation of plant and animal numbers by natural enemies. In this broad sense, biological control is vital to public health because it keeps the myriad insect species from out-competing us. It also has direct public health advantages as where natural enemies are manipulated to control disease vectoring insects. Insecticide distruption of biological control by insecticides and the resulting pesticide treadmill have serious public health implications. One is the increased pesticide load in the environment. The other is the acceleration of pesticide resistance in disease vectoring insects. The treadmill and its associated hazards will not abate so long as chemical control dominates our pest management strategy.

Some years ago, in 1968 to be exact, I was invited to speak at the 1st Rochester Conference on Toxicology, an affair largely concerned with environmental and public health impacts of pesticides (*1*). It was a new experience for me, an applied insect ecologist, to be invited to one of those big hand-wringing affairs generated by the pesticide crisis. In fact it was unusual for any entomologist to be invited to such a conference. I mentioned this in my speech and pointed out the irony of the situation wherein entomologists whose insect control programs were responsible for the pesticide mess were rarely, if ever, invited to discuss its causes, consequences and possible solutions. Instead, the conferences invariably involved endless dronings by chemists, toxicologists, physiologists, and public health scientists over molecular configurations, chemical modes of action, metabolic pathways, chemical half lives, LD_{50} values, toxic lesions, residue analysis, and the like. Once in a while a wildlife specialist would be trotted on stage to groan a bit about the unhappy state of such creatures as the coho salmon, the bald eagle, or the peregrine falcon, but this was just to give a semblance of balance to the discussions.

What especially struck me about these sessions was that they were invariably concerned with the consequences of pesticide usage; they never asked the question, "Is there a better way to manage pest populations in order to minimize chemical usage and therefore chemical impacts" The answer is, "Yes, through integrated control," but since the typical conference rarely, if ever, included pest management ecologists (integrated control specialists), there was no one on hand to raise the question, let alone answer it.

As a colleague once remarked, "the science of entomology advances by creeps," and so with the passage of time we entomologists are beginning to creep into the hand-wringing sessions. In this connection, it is noteworthy that this conference includes at least four of us with extensive experience in that aspect of applied ecology termed pest management.

I welcome this opportunity to communicate with elegant scientists of biochemical, physiological and medical callings and sincerely feel that the kind of dialogue developed here will eventually help alleviate the pesticide problem. I am especially pleased to note that in this conference biological control is considered to be one of the key tactics in a "new approach" to insect pest control. This is heady stuff to a biological control specialist fledged at the outset of the synthetic-organic insecticide era, who endured two and a half decades when his

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tactic very nearly vanished from the pest management arsenal.

In reality biological control is not new; in fact, it is as old as the balance of nature which, as most of you know, goes back a few years. What has happened is that there is a new appreciation for and understanding of biological control and the vital role it must play in modern pest control strategy. Ironically, it was the modern synthetic organic insecticides which led to this renaissance, for by interfering with the balance of nature (particularly the balance of insect populations), these biocides created a global pesticide treadmill of such grave ecological, economic and sociological consequences that biological control could no longer be ignored.

Knowledgeable pest control specialists accept the significance of biological control and seek to include it in their pest management strategies. As a result, virtually every integrated control program in use or under development entails a major biological control component. In other words, in modern pest management rationale, biological control is automatically included in program planning and implementation.

Biological Control Defined

Biological control, as considered here, is the regulation of plant and animal numbers by natural enemies (parasites, predators, and pathogens). In other words, biological control is a natural phenomenon, a major element of natural control. With no other group of organisms is biological control so important as with the insects, earth's most diverse, adaptable and prolific animals. With an estimated 1.5 million species occupying an incredible range of habitats, it takes little imagination to visualize the chaos which would ensue were there even a moderate disruption of overall insect biological control. Insight into this chaos is given by the global pesticide treadmill which, as I will presently relate, is largely a product of disturbed biological control.

The definition I have just given may be confusing to some who consider biological control to be a man-manipulated tactic. Indeed, biological control does have its applied aspects, as in the classical introduction of exotic natural enemies against invader pests, mass culture and release of parasitic or predaceous species into croplands, artificial augmentation of natural enemy populations in the field, etc. But these applied aspects are simply human manipulations of nature's creatures and as such are fully consistent with the naturalistic definition of biological control.

Public Health Advantages of Biological Control

The most obvious of the public health advantages of biological insect control is its tremendously important role in helping to keep the myriad insect species in a state of restraint. Without this naturally occurring biological control, insects would erupt to unimaginable abundance and literally strip the earth of its vegetation. In this state of affairs man could not cultivate crops or even gather roots and berries and in short order, most humans would starve or revert to entomophagy. So, in a very broad sense, biological control is vital to public health because it prevents the insects from ripping the food from our mouths and of course, it keeps us from being harrassed to death or distraction by them or suffocated by an overwhelming insectan tide.

Biological control has other direct public health advantages, as where natural enemies control disease vectors, either in naturally occurring relationships or through human manipulation (e.g., *Gambusia* vs. mosquitoes, parasitic wasps vs. filth flies). An additional advantage here is that the natural enemies have no environmental impact, nor are they a hazard to human health.

Having made these few observations on the direct advantages of biological control, I would like to pass on to a discussion of the prevailing chemical control strategy and how its disruption of biological control has led to a global pesticide treadmill that is a serious hazard to public health, not to mention human economy and the environment in general.

Many will argue the existence of a pesticide treadmill, but the insect ecologists invited to speak at this conference can attest to its reality. These same ecologists also know that the treadmill has its roots in the chemical disruption of biological control. Smith and Reynolds have documented the global tribulations of cotton (*2*); McMurtry et al., the pesticide-assisted rise of spider mites to world supremacy as arthropod pests of crops (*3*); my colleagues and I have studied and documented the biological bases of the pesticide treadmill in California (*4,5*). General discussions of this phenomenon can be found in the volumes edited or authored by Huffaker (*6*), van den Bosch and Messenger (*7*), DeBach (*8*), and Farvar and Milton (*9*).

There are two bioecological bases involved in creating the treadmill. First, chemical disruption of biological control creates a biotic vacuum, wherein target pests rapidly resurge following treatment and previously suppressed species erupt to damag-

ing abundance. These resurgences and secondary pest outbreaks necessitate chemical retreatments which contribute directly to the second basic element of the treadmill, i.e., genetic selection for pest resistance to the control chemicals.

The significance of the treadmill is that it leads to the massive use of pesticides and thus an increased public health hazard. But this is only one side of the coin, for there is another highly disturbing aspect to the problem, the contribution of the treadmill to pesticide resistance in disease-transmitting insects. Here, the resistance of the malaria vector *Anopheles albimanus* Wied. to several insecticides in Central America comes to mind. With *A. albimanus*, resistance appears to be clearly aggravated by intensive use of pesticides in cotton (one of the world's most severe pesticide treadmills occurs in cotton on Central America's Pacific Coast)(*10*).

There is another possible case of this sort in California's central valley where the encephalitis vector *Culex tarsalis* Coq. has become resistant to a wide range of insecticides. In this case, heavy and extended direct use of insecticides against *C. tarsalis* has unquestionably been the major contributor to resistance, but some entomologists familiar with the problem also feel that agricultural pesticides too have played a role. This would not be surprising, since agricultural plantings in California's central valley are among the most intensively sprayed in the world. Indeed, there are times when the valley lies under a virtual blanket of crop sprays which must enforce the selective pressure for resistance in *C. tarsalis*.

Whatever the case, the documented or suspected role of agricultural pest control in contributing to pesticide resistance in disease transmitting insects, is a disturbing development which has very direct ties to the adverse effects of the control chemicals on entomophagous insects.

Conclusion

Why then do we continue to rely on this strategy? There is no easy answer to this question, for it involves technological, economic, psychological, and political considerations. However, what it all boils down to is that the forces wanting change do not yet have the power to override those who support the *status quo*. Unfortunately, as long as the *status quo* prevails, the full public health advantages of biological control will not be realized.

The public health advantages of biological insect controls are so obvious that they do not require detailed elaboration. This is the reason why I have talked in generalities rather than specifics. In doing this it has been my intention to point out the shocking inconsistency of the prevailing chemical control strategy which not only fails to take advantage of biological control but, in fact, inhibits it. The chemical control strategy is a disaster, first because it cannot possibly cope with such a diverse and adaptable group as the insects and second because of its basic incompatibility with biological control, one of nature's major insect regulating mechanisms.

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