PUBLIC HEALTH ASPECTS OF PEST MOSQUITO CONTROL

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At the turn of the century a new era in vector control began with the first successful demonstrations for the control of mosquito-borne diseases: first, Watson's malaria control work in Malaya, then Gorgas' yellow fever epic in Havana, followed by the control of malaria in Panama by Gorgas and LePrince. In the more than 60 years that have elapsed since those historic projects, mosquito control has been employed on many occasions to check epidemics throughout the world.

When such a program is undertaken at the time of an epidemic, or in a situation where the disease is endemic, it is possible to obtain some measurement of the benefits through careful interpretation of morbidity data. But how does one evaluate the public health benefits of a control program in an area where there are no infectious diseases of mosquito origin? It is unlikely that we will ever have a comprehensive answer to this question based on experimental procedure. We can perhaps profit, however, by organizing some of our subjective observations and conclusions.

Referring again to the Panama incident, the results were obtained mainly by an attack against the mosquito at the source, by drainage, filling, grading, and some use of oil larvicides. Residual insecticides and chemotherapeutic drugs had not yet become available. It is apparent, therefore, that the early Panama program was based upon nonspecific mosquito control. The old reports show that there were few mosquitoes of any kind left in the areas subjected to organized control, although both pest and vector species were abundant in the uncontrolled areas nearby. The people living within the Canal Zone were

thus receiving the benefits of pest mosquito control as an adjunct to vector suppression. This fact was important, for the Panama experience was used frequently as an example of an effective mosquito control program, and doubtlessly aided in securing acceptance of new mosquito abatement programs for communities which had only pest mosquitoes.

Historical reports of mosquito control in New Jersey, the first state to organize an intensive program of mosquito control (Headlee, 1945), reveal that malaria was prevalent at the time of the first comprehensive mosquito study, which was begun in 1900 (Smith, 1904). The control program, however, was directed mainly against pest mosquitoes from the salt marshes, with but minor attention given to *Anopheles* and other freshwater species. Nevertheless, the number of *Anopheles* mosquitoes in residential areas declined rapidly and there was a sharp reduction in malaria morbidity, even though the vector species could still be found in the natural swamps and ponds. Localized epidemics were also recorded in 1914 and 1935; both were apparently checked as a result of intensified mosquito control operations. Although some anophelines can still be collected, transmission of malaria does not occur and it is generally agreed that the pest mosquito control operations have been one of the factors in eliminating this disease.

California was an area of high malaria endemicity a hundred years ago and, in fact, well into the 20th century. The earliest local mosquito control programs (1903–04) were, however, directed toward pest mosquitoes from tidal marshes of the San Francisco Bay. Malaria control activities were not started until 1910. California's Mosquito Abatement Act, passed in 1915, received its primary support, however, from real estate interests around the San Francisco Bay, where malaria was not a factor. The important point here is that mosquito control for public comfort reasons often precedes, and may lay the foundation for, mosquito-borne disease control programs.

Anophelines are still present in California, probably in increased numbers in the Sacramento Valley where rice is now grown extensively, but indigenous malaria is now virtually nonexistent.

Pest mosquito control is rarely selective. In our area, operations directed toward pest species are often responsible for reducing numbers of anophelines as well as the encephalitis vector, *Culex tarsalis*. *C. tarsalis* is, of course, an important vector species, considering California's history of endemic encephalitis, not forgetting the epidemic of 1952.

It is axiomatic that if mosquito control were not practiced in areas having a high potential for the production of mosquitoes near populated areas, the incidence of vector-borne diseases would be greater. However, the broad public health benefits inferred here are of a different nature. Pest mosquito control programs are designed to bring about conditions conducive to comfort and general well-being by allowing full utilization of residential, agricultural, industrial, recreational, and wilderness areas, free of the discomfort and frustrations which characterize mosquito-infested localities.

It is common for mosquito control agencies engaged primarily in the control of nuisance mosquitoes to maintain surveillance over the ecological and epidemiological factors which could contribute to the occurrence of mosquito-borne disease. Thus, when there is an apparent hazard, emergency measures can be employed in a meaningful manner. As an indication of how such a state of preparedness pays off, epidemics did not materialize at the end of World War II when malarious servicemen returned to civilian communities, some of which were formerly endemic areas.

The president of the California Mosquito Control Association recently called for an evaluation of the potential hazard due to the failure of anti-malarial drugs in Vietnam and elsewhere, in order to determine if an emergency protective program should be undertaken by the mosquito abatement districts. He pointed

out that there are many agencies throughout the country presently engaged primarily in pest mosquito control work, which have well-trained personnel, specialized equipment, and the versatility necessary in case there were a reason for their being diverted to malaria control activities.

When the 1952 encephalitis outbreak in California reached the epidemic threshold, a state of emergency was declared on a Friday. By the following Monday a full-scale emergency anti-*Culex tarsalis* operation was in action. This included such extraordinary features as a $250,000 emergency fund provided by the Governor, 22 specialists flown in by the U.S. Public Health Service from all parts of the country to assist in the operation, and redirection of a major portion of local pest mosquito abatement activities to *Culex tarsalis* control. The lessons of that epidemic have served as a guide for subsequent surveillance, and an early-season warning system was devised and has been employed ever since. This is based on *C. tarsalis* larval counts early in the season, followed by adult mosquito sampling to forecast the possible encephalitis potential for the season. Only twice during the ensuing 13 years has there been a need to call a special alert, but in those instances *C. tarsalis* control efforts were immediately intensified on an emergency basis.

When encephalitis outbreaks have occurred on the east coast, in Florida, Texas and elsewhere, health agencies and mosquito control forces have been able to develop emergency operations in a similar manner. Although it is impossible to say how much greater these outbreaks might have been without these prompt emergency programs, it is certain that the mobilization of local pest mosquito control resources was accomplished in far less time than would have been required to develop a new program.

Though it may be impossible to put a dollar value on the health benefits of mosquito freedom in the outdoor environment, whether for work, play, or relaxation, it is certain that workers subject to severe attack by mosquitoes are less productive and less happy in their work. Similarly there will be little relaxation in a golf game played on a course alongside a salt marsh which has just experienced a large emergence of *Aedes*. Also, if irrigated pastures are permitted to produce mosquitoes at their phenominal capacity, there will be little utilization of the barbecue pits, swimming pools, and back yards at nearby farm and suburban homes.

The removal of barriers to economic development which occurs when areas are freed of mosquitoes has far-reaching implications. In such situations new wealth is created through an added tax base. This, in turn, will provide support for needed governmental activities, including local health facilities and mosquito abatement programs. To appreciate the economic influence of effective mosquito control, one need only visit some of the east coast resort areas which, 50 years ago, were deserted and barren because of mosquitoes. Now you will find a succession of year-round residential and recreational communities, with taxable values in the billions of dollars. Or one may inspect the high-value residential areas which have sprung up in the irrigated pasture belts of California where, before mosquito control was practiced, even the cattle found it difficult to gain weight because of constant attack by hordes of mosquitoes.

Mosquito control officials have an exceptional opportunity to exert leadership in matters relating to the development and utilization of water resources, and the disposal or reclamation of liquid wastes. Since poor design or faulty operation of such facilities can create a mosquito nuisance or a possible health hazard, local mosquito control agencies should review the plans for and the operation of all such facilities, recommending changes necessary for mosquito-free operation.

One of the assigned tasks of inspection personnel in many mosquito abatement districts is to detect faulty residential or industrial sewage disposal facilities; from this they can collaborate with local health departments which have the authority to

correct faulty systems, thus obtaining better sanitation. Similarly, through inspection and treatment programs, and by cooperation with sanitation agencies, mosquito control workers can help to focus public attention on community drainage and sewage facilities which require improvement. In some instances even the sanitary landfills are supervised or operated by the mosquito control agency.

Mosquito control agencies have broad interests in irrigated agricultural areas. By active cooperation with research and extension personnel and agricultural organizations, they may encourage the use and ultimate disposal of water for optimum agricultural benefit with a minimum of mosquito production. Activities of this sort have led to the development and distribution of agricultural publications which encourage mosquito-free farming; they have also been instrumental in bringing about conservation of irrigation water and the elimination of unsanitary dairy drains which had been important sources of mosquitoes and flies.

In recreational areas the cooperation of mosquito control personnel with park officials, fish and wildlife agencies, and commercial interests may lead to integrated activity for the control of the mosquito nuisance, thus enhancing the value and public health benefits of such facilities.

Support of research, and participation in field trials of more effective and more selective chemicals, has led to the adoption of insecticides that are safer for the operator, safer for the public and the livestock in the area, safer for fish and wildlife, and to the adoption of materials which minimize residual contamination of agricultural products. Although agencies which were established for the primary purpose of controlling pest mosquitoes may, in fact, direct the greatest share of their operational efforts against nonvector species, there can be no clear distinction made between "pest mosquito control" and "public health mosquito control." Both contribute to the improvement of man's well-being and the satisfaction of living. Furthermore, as research continues to elucidate epidemiological understanding, we are finding that some of the mosquito species formerly regarded only as nuisances do, in actuality, have the ability to transmit human diseases.

References Cited

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