the flexibility of the enabling statutes, that, among other things allows boundaries to be established to realistically encompass the problem area.

A realistic and practical solution to the problems of vector control funding in California should begin with the recognition that vector control in California has been delivered, for the most part, by Special Districts and that the districts are uniquely suited to effectively provide vector control for the citizens of California.

# UTILIZATION OF A MICROCOMPUTER IN A VECTOR CONTROL PROGRAM – ALAMEDA COUNTY MOSQUITO ABATEMENT DISTRICT

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Information is required in order to accomplish vector control. It is routinely collected, processed and interpreted to provide guidance to vector control programs. It follows logically, that to process the information more efficiently is to increase the efficiency of the programs. It can provide savings in money, and result in increased effectiveness of vector control.

In recent years the costs of automatic data processing have been declining rapidly. A recent article in Science magazine, called "Information - the New Frontier", pointed out that if costs of computers continued to decline at the current rate, a computer would cost 3/10 of a cent 100 years from now. The projection is absured of course, but was intended to indicate the rate of which computer costs are now crashing.

The Alameda County Mosquito Abatement District is currently processing data automatically by means of a TRS-80 microcomputer system. A comparison of the automatic data processing system to the previous punch card system has indicated that we should expect a long-term savings of about $2,400 per year in paper and labor costs. One time costs of hardware and software were not included in the analysis, but the savings should pay for the system in about two years.

The installation of automatic data processing in the District required that we look at the flow of information in the District from the point of view of a computer scientist. The approach is called systems analysis. When the systems analysis is accomplished in the broadest perspective, it provides a logical and practical frameworks for vector management programs. It is relatively easy to accomplish a systems analysis in vector control for a couple of reasons. First, the basic concepts of integrated pest management are compatible with the systems approach. Secondly, vector ecologists have published information in the past that is usable in the systems analysis. Both published and unpublished articles by Richard Husbands, formerly of the California State Vector Biology and Control Section, were quite useful in accomplishing the analysis.

A valuable by-product of the analysis was that before the data processing system could be designed the goals and objectives of the District's programs had to be clearly defined. The analysis also provided rather startling information about the amount of time utilized to gather and process information prior to the installation of the computer system.

The data processing system has been designed to measure the mosquito problem and to determine the impact the control program has on the problem. The basic input data are the same data used in most all vector programs - - light trap data, biting counts, larval sampling data, service request data. The output data are also the same kinds of familiar information - - lineal feet of ditches excavated, number of fish plants, pounds of insecticide per source, pounds of insecticide per species, etc.

Objectives of The System.--The specific objectives to be accomplished by the automatic data processing in the District are the following:

1. To efficiently process data that will measure the effectiveness of the program.
2. To efficiently generate required reports.
3. To develop and utilize models to predict levels of mosquitoes and thereby assist in making treatment decisions.
4. To quantify the work performed by the District.
5. To define "high priority" sources through cost-evaluation and set appropriate work schedules for the physical control program.
6. To measure the insecticide pressure on any given species and avoid resistance problems.
7. To determine the costs of specific program elements and enhance program budgeting.
8. To check current inspection and treatment schedules with those of the past and modify the schedule as required.

The District has already gone a long ways toward meeting the objectives. The "core" program currently in use processes data from the employees' daily reports and generates the monthly reports of the District. The program includes one relatively simple yet informative model that predicts levels of adult *Culex pipiens*. The program can easily be upgraded as the "pipiens" model is elaborated upon and as additional models are developed for other species.

The use of the computer in the District should also provide benefits beyond that of our current stated objectives. The flexibility of the system enables data to be retrieved in a variety of combinations by simple program additions. Other programs could be developed to increase the efficiency of the bookkeeping systems. Existing programs can also be utilized to do statistical analysis if required. In truth, as we gain knowledge of how increasing amounts of data can be processed rapidly and efficiently, it only increases our expectations of the system.

In summary, automatic data processing has been installed in Alameda County Mosquito Control District at a relatively low cost with long-term savings projected. The system is designed to increase the efficiency of the existing data processing system, to process more data at less cost, and to increase the effectiveness of the vector control program by providing appropriate and timely data to support decision making.

# EFFECTIVENESS OF THE BACTERIAL PATHOGEN *BACILLUS THURINGIENSIS* SEROTYPE H-14 AGAINST MOSQUITO LARVAE

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INTRODUCTION.--During the past two decades numerous studies have been conducted on the activity and efficacy of entomogenic bacteria against mosquito larvae. Most of these studies have dealt with laboratory evaluation of strains of *Bacillus thuringiensis* and other pathogenic bacteria recovered from mosquito breeding sources or infected larvae. The activity and potency of a number of bacterial species and strains have been reported by numerous researchers (Davidson et al. 1975, Hall et al. 1977, Kellen et al. 1965, Liles and Dunn 1959, Shaikh and Morrison 1966). Most of these studies dealt with the evaluation of *B. thuringiensis* varieties or strains in laboratory where they were shown to have marginal activity. A few field studies were also implemented on commercial formulations and other strains of this pathogen, and these were all found to show little or no activity at practical rates (Kellen and Lewallen 1960, Liles and Dunn 1959, Shaikh and Morrison 1966). These investigators employed concentrations as high as 200-500 ppm in laboratory evaluations, and rates as high as 0.5-1.0 lb/acre of BT preparations under field conditions without obtaining significant mortality in the treated larvae of several species of mosquitoes.

Evaluation of a BT isolate (designated as BA-068) from dead and moribund *Culex tarsalis* Coquillett larvae from California, showed good activity in laboratory studies (Reeves 1970, Reeves and Garcia 1971). This same isolate was later designated at *B. t.* var. *thuringiensis* (serotype H-1) and was found (preparation HD225/531C) to have an $LC_{50}$ of 0.3 ppm against 2nd instars *Ae. aegypti* (Hall et al. 1977). In the same study, these authors evaluated some 127 strains of *B. thuringiensis* (consisting of 18 varieties/serotypes) against *Aedes* and *Culex* species. Most of the strains showed little or no activity, but some preparations (HD-169/R-567B and HD-96/R574D) in addition to the above possessed good activity, showing an $LC_{50}$ of 0.04-0.06 ppm against 2nd instar *Ae. triseriatus* a most susceptible species as compared to *Culex* and *Anopheles* species.

Recently, Goldberg and Margalit (1977) isolated a strain of *Bacillus thuringiensis* (designated as ONR-60A or WHO CCBC 1897) from mosquito larvae and this isolate showed good larvicidal activity against several species of mosquitoes. This strain was typed by de Barjac (1978) of Institute Pasteur as serotype H-14 and designated as *B. thuringiensis* var. *israelensis* (BT Ser H-14). This strain has been found to be quite effective against *Aedes* and *Culex* species under laboratory conditions, and appears to be the most effective entomopathogenic bacterium studied to date. Its activity against mosquitoes under indoor and outdoor conditions was studied in California by Garcia and Desrochers (1979).

Our current studies were aimed at the laboratory and field evaluation of BT (H-14) against several species of colonized mosquitoes and also a number of species collected from the field. Additionally, field evaluations of semi-commercial preparations of this entomopathogen were conducted in a variety of habitats supporting species of 3 genera of mosquitoes.

METHODS AND MATERIALS.--In the laboratory, 4th instar larvae of *Aedes aegypti* (L.), *Aedes nigromaculis* (Ludlow), *Ae. taeniorhynchus* (Wiedmann), *Anopheles quadrimaculatus* Say, *Culex tarsalis* Coquillett, *Cx. peus* Speiser, *Cx. quinquefasciatus* Say, and *Psorophora columbiae* (Dyar and Knab) were employed. The standard procedures and techniques as reported by Mulla et al. (1966) were utilized. In brief, the procedures used are as follows:

Twenty mosquito larvae were placed in 100 ml tap water (pH 8.0 ± 0.1) in a 160 ml (4 oz squat waxed ice cream) cup. Each treatment was replicated 3 times and run on 2 - 3 different occasions, yielding 6 - 9 replicates per treatment. The treated and control cups were kept at 26°F ± 0.5 and mortality was read after 24 hours of continuous exposure to the bacterial preparations. On account of the short-term exposure period (24 hrs) the larvae were not provided with food.

To determine the range of activity, the bacterial preparations were run at 3 - 4 concentrations, each replicated 3 - 4 times. The average mortality for each concentration was plotted on log probit paper and the $LC_{50}$ and $LC_{90}$ concentrations in ppm were read off the concentration response lines fitted and established through the points. There was little or no mortality in the control larvae, therefore no correction for check mortality was deemed necessary.

Several preparations of H-14 consisting of WP, waxy solid and fluid suspension formulations were evaluated. The solid formulations were suspended in water by the addition of Tween 20 (wetting agent) and blending at moderate speed in