involved in: (1) preventing the scattered human rural cases of plague, and (2) lessening the danger of urban populations from plague of wild rodent origin. To assist in obtaining answers to these problems, an intensive ecological study of wild rodents in a single area is to be undertaken.

This study is under the supervision of a mammalian ecologist and will utilize an entomologist and four rodent survey aids. The study will be established in a known plague area and will function throughout the year. The testing of ectoparasites and rodent tissue for plague for the ecology study as well as for several cooperating agencies will, as in the past, be done at the Laboratory headquarters in San Francisco.

One of the objectives of the unit will be to illustrate fluctuations in the rodent populations and the factors responsible for them. With such information, it may be possible to predict when conditions will be ideal for epizootics. Another objective will be to determine the principal reservoir host and the principal vectors; this determination may elucidate how and when the disease spreads from one species of rodent to another. A further objective will be to learn how plague is maintained over the winter period and how and when it is practical to control rodent epizootics.

The study will be based on an extensive live-trapping program in which the captured animals will be observed while alive; each will be given a suitable permanent distinctive mark and then will be released for future recapture. The lives of known individuals will be followed to learn the length of the life span, reproductive activities, changes in ectoparasite species, and numbers of ectoparasites harbored at various times and how they are affected by such factors as changes in climate.

Immediate spectacular results undoubtedly will not be produced by the type of investigation contemplated; but sound control measures can be founded only on the type of basic information that will be provided by the proposed study of the ecological interrelationships between the various mammals and their ectoparasites. It is believed that only through such a study can the complexities of plague be solved, provided such a study is undertaken in a limited carefully chosen area and is conducted on a year-in, year-out basis.

The Development of Local Mosquito Control Districts in Virginia

R. E. DORER*

The 1940 session of the Virginia Legislature passed an act providing for the creation of mosquito control districts. Under this law, a district could be created in Tidewater Virginia, to include a town, city, or county, or any portion or combination thereof. Two members were to be appointed locally to serve on a commission that would conduct the affairs of the mosquito control district. The Virginia State Health Commissioner was designated to serve on all commissions as chairman ex officio. The State health department was empowered to contribute State funds in an amount equal to 25 percent of the funds collected locally, not to exceed $5,000. Local funds could come from a direct tax, an appropriation, or contributions. Subsequent legislatures have amended the law allowing any community in the State to create a mosquito control district and raising the maximum State contribution to $10,000. On July 1, 1940, a mosquito control district was established under this law at Virginia Beach. No doubt, more districts would have been created at that time except for the gathering war clouds.

With the advent of World War II, the Hampton Roads section of Virginia became very important from a military standpoint. The U. S. Public Health Service working in cooperation with the State health department inaugurated the Malaria Control in War Areas program. Under this program, operated largely throughout the Southeastern States,

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Federal funds were made available for malaria control in the vicinity of military and war establishments. Large sums of Federal money were expended in Virginia for control in the 1-mile zones around military establishments. In the Hampton Roads area, war establishments are so close together that the 1-mile zones intersected, resulting in control measures being carried on in the entire area. While the program was designed to control only the malaria-carrying mosquito, it was unavoidable that other species would be controlled also. The local officials, while not contributing to the Malaria Control in War Areas program, were kept fully informed of the progress being made. This was purposely done because the day could be foreseen when they would have to take over operations.

Two facts have been used in forming the policy for mosquito control in Virginia. First, the local people who receive the benefits from mosquito control must bear the burden of the cost. Second, mosquito control to be economically sound must provide protection to sufficient people so that the cost will not be prohibitive. Working on this policy and using the Malaria Control in War Areas program to further the effort, it became necessary only to create in the local citizenry the desire for mosquito control and a willingness to pay for it.

The Malaria Control in War Areas program served to demonstrate to the local people what they could expect from mosquito control. Mosquito workers were trained to take over local programs when the time came. In addition, equipment assigned to the State could in some instances be loaned for short periods to the local programs, thus allowing all of their local funds to be spent largely for labor.

With the end of the war came the end of the Malaria Control in War Areas. Federal funds were curtailed as expected. Virginia did not participate in the extended malaria control program because locally transmitted malaria had practically disappeared in the State. Now was the time to develop local mosquito control districts. Using the momentum gained through the MCWA and capitalizing on the ground work that had been done with the local authorities, it was not too difficult to sell the district idea.

To date, 12 additional districts have been created. No two operate exactly alike, a good argument for having a law flexible enough to allow for local conditions. Several methods have been used in establishing districts: public meetings have been held; public hearings have been held before boards of supervisors; and in one case, a referendum was held. An indication of how well the public had been sold was demonstrated in this election where the special tax for mosquito control was passed by a two to one majority.

Usually, the amount of money available to do mosquito control in a newly formed district has been pitifully small. However, this has not been too discouraging. Every shovel of dirt moved to drain standing water and every gallon of larvicide sprayed on mosquito breeding will do some good. Fortunately, the best results were the first results. A small effort usually was enough to demonstrate what good could be done; and larger appropriations followed. In one district, funds available the first year totaled $6,000; but within 3 years, the budget was up to $20,000. Of course, the important thing was to do a good job and to let the people know that the improvement was due to the work being done. Figure 1 illustrates the development of mosquito control in Virginia from 1942 through 1950.

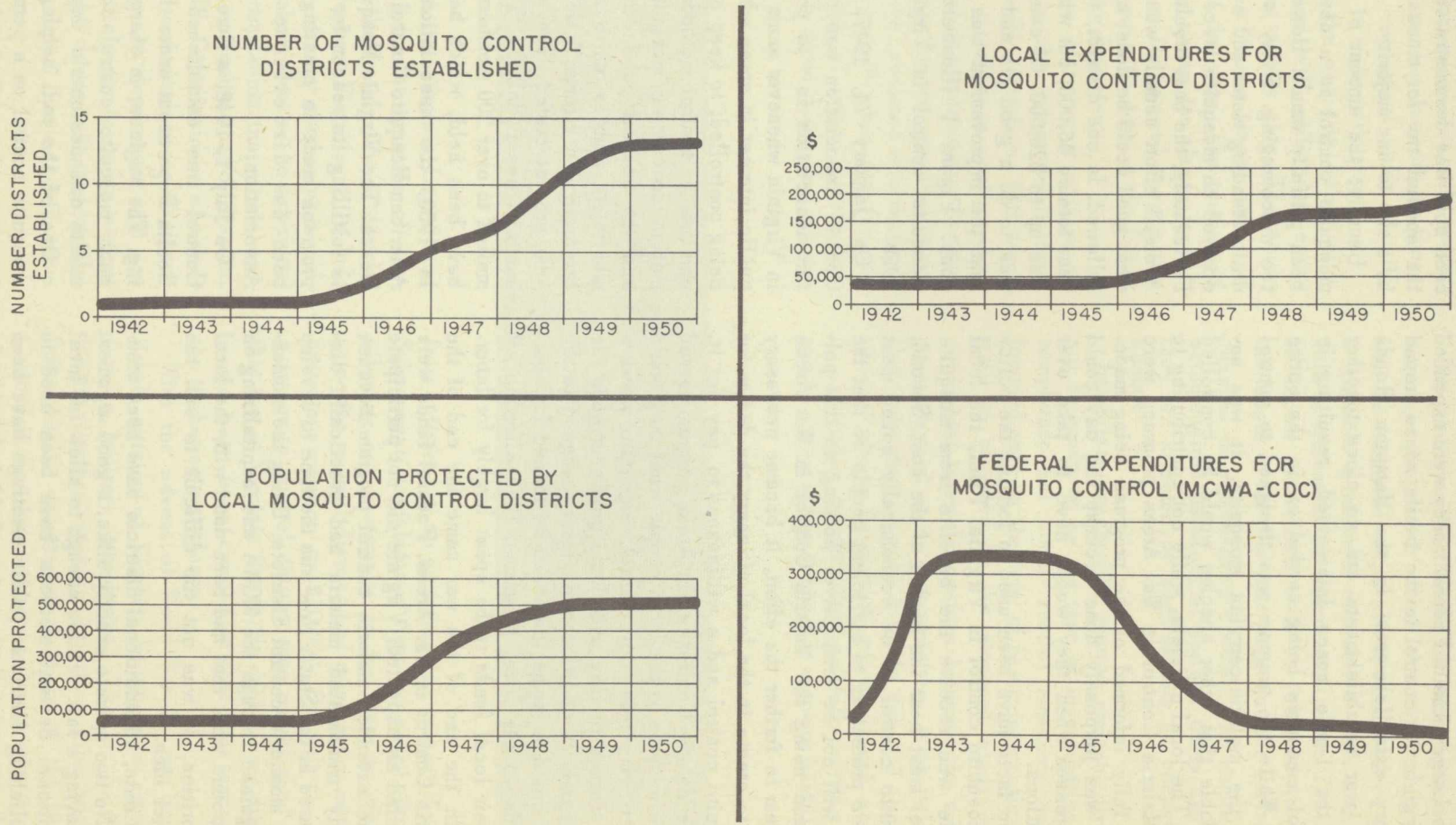
On January 24, 1947, the Virginia Mosquito Control Association was created. The purpose of the association is "to promote mosquito control in Virginia whenever same is feasible; to maintain public interest in areas where mosquitoes are now being controlled; to keep up with the latest developments in control methods; to disseminate information concerning mosquitoes to its membership and the general public through publications and meetings; and to unite and coordinate common interests and efforts." Membership is open to all who are interested. The association publishes a monthly paper called "The Skeeter," which is mailed to over 200 members. Four annual meetings have been held, which have been well attended. In 1950, the association met jointly with the American Mosquito Control Association at Virginia Beach. The Virginia Mosquito Control Association is fulfilling its reason for being; and much of the progress made in creating mosquito districts has been due directly to efforts made by the Association.

On July 1, 1948, a Bureau of Insect and Rodent Control was established in the Virginia State Health Department under the Division of Engineering. The engineer in charge serves as chairman of each mosquito control commission as the State health commissioner's deputy.

One of the real helping hands in establishing mosquito control on a permanent basis in Virginia has been the assistance provided by the Public

Figure 1

DIAGRAMMATIC DEVELOPMENT OF LOCAL MOSQUITO CONTROL IN VIRGINIA



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Health Service. In some cases trucks and equipment temporarily loaned to the newly formed districts have allowed them to use their limited local funds for labor and larvicide, thus making it possible for them to show results immediately. Another contribution has been the assistance of trained personnel to get the district off to a good start. A practical fieldman assigned for several days to work with a newly appointed local man and to check back from time to time has been the difference between success and failure. Until recently, the Communicable Disease Center furnished such personnel to Virginia, but recent curtailment of funds has required the lay-off of all the practical fieldmen; and this, no doubt, will hamper the creation of additional districts.

The Potentialities of Biological Warfare Against Man: an Epidemiological Appraisal*

ALEXANDER D. LANGMUIR**

In December 1950 the Executive Office of the President issued a defense manual*** which states categorically, "an enemy could employ..... biological warfare against us effectively." Two major forms of attack are emphasized: (1) the creation of clouds of pathogenic aerosols over cities, and (2) the contamination of water and food supplies or the air of strategic buildings by sabotage. The use of a hypothetical new agent of "super virulence" and the initiation of a "spreading epidemic" are discarded as not based on scientific fact.

The evidence supporting these conclusions may be found in the existing knowledge of the epidemiology of air-borne infections and common vehicle epidemics. These facts form a basis for developing a Theory of Biological Warfare.

Air-borne infection is a serious hazard to research workers in laboratories. Attack rates are high and many fatalities have been recorded. The notorious offenders are the agents causing brucellosis, tularemia, Q fever, typhus fever, yellow fever, psittacosis, coccidioidomycosis, and many others. Until recently, contact was generally thought to be the cause of these infections. Now it is known that many cases result from inhalation of aerial contaminants. Certain procedures such as use of the Waring blender, or the Sharples centrifuge, disperse clouds of fine particles into the air.

Serious epidemics have involved laboratory personnel having no possible contact with the infectious agents. In the Hygienic Laboratory in Washington, 11 cases of psittacosis followed the arrival of infected parrots. At the Michigan State College, 45 cases of brucellosis due to *Brucella melitensis* occurred among students and staff in one laboratory building. A Sharples centrifuge in the basement had been used approximately 1 month prior to the outbreak. Epidemics of Q fever have occurred in many laboratories with attack rates as high as 50 percent. Visitors to laboratories who stayed only a few minutes have been infected. These epidemics have occurred under circumstances that preclude other modes of spread than air-borne infection.

The new Infectious Disease Laboratory at the National Institutes of Health in Bethesda, Md., is a monument to those who have died from laboratory acquired disease. In this building specially designed hoods, controlled ventilation with incineration of exhaust air, and the utilization of properly placed ultraviolet lights indicate the extent to which the hazard of air-borne infection has been appreciated.

Important to the Theory of Biological Warfare is the fact that the respiratory tract is an extraordinarily fine filter. Only small particles less than 5 microns in diameter can reach the alveoli. Larger particles settle or impinge on the mucus overlying ciliated epithelium and are eventually swallowed.

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***Health services and special weapons defense. Executive Office of the President. U. S. Government Printing Office, Washington, D.C. (Dec. 1950).