

RESEARCH NEEDS ON MOSQUITOES IN RELATION TO AGRICULTURE

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The purpose of this paper is to discuss some of the problems of pest mosquito control as they relate to agriculture. These problems must be considered in the development of a long-range program to reduce the annoyance and economic losses caused by these insect pests. Many of you actively engaged in mosquito research or control activities are much better informed than I on details of the many problems that need to be resolved in our continuing battle with mosquitoes. I will therefore limit my discussion to the broader aspects of the problems, specifically as they relate to agriculture.

Owing to the efforts of a number of members of this Association, the public is beginning to recognize the need for more support for research and control on pest mosquitoes. Several states are giving increased attention to such work, and legislation now before Congress provides for substantial support at the Federal level. Those who have brought this legislation to the current stage are to be commended. The importance of pest mosquitoes in terms of public comfort and health, losses to the livestock grower and other farmers, reduced real-estate values, and the millions spent on control programs justifies such support.

In the past, research on mosquitoes has been concentrated on their relation to public health. The work of Federal and State health departments, State experiment stations, and the U. S. Department of Agriculture, which has been working largely with funds provided by the military departments, has yielded outstanding results. Basic information on the biology, taxonomy, and ecology of most of the species has been obtained. The relationships be-

tween mosquitoes and most of the mosquito-borne diseases have been determined. Much has been accomplished in water-level management, many highly effective insecticides and repellents have been developed, and ways to employ them to achieve mosquito control have been worked out.

These and other developments have made it possible for health agencies to practically eliminate malaria, yellow fever, dengue, and other mosquito-borne diseases as vital factors in human health in this country. The information has also been of great value in controlling pest mosquitoes in urban areas, and control workers have organized many successful abatement areas throughout the country. However, in the research on pest mosquitoes the emphasis has been on their control in urban communities located in coastal or floodwater areas. Much additional research needs to be done on mosquito problems in such areas, and many urban communities need technical assistance in organizing control districts. However, the pest mosquitoes are also a serious problem in rural farming areas, especially those under irrigation. More and more land is being irrigated, and we all know that irrigation projects inevitably bring more pest mosquitoes which in turn may lead to disease outbreaks among man and livestock.

The mosquito problem in relation to livestock production has received very little attention. The need for investigations along this line has been stressed repeatedly by Lindquist (1954, 1955a, b, c). This problem is especially acute in irrigated regions, although it is also important in nonirrigated areas. The expansion of

grassland agriculture and the need for livestock-production practices that will bring greater returns to the farmer must be considered in both current and long-range plans for mosquito research. The lack of progress in the control of pest mosquitoes in rural areas is due to a number of causes. (1) The farmer is a rugged individual, and his demands for a solution to the mosquito problem are not as persistent as those made by people in urban areas. (2) It is more difficult to organize and obtain financial support for control programs in a rural community than in an urban area. (3) On the basis of current knowledge, control programs would add to the cost of running a farm. (4) The losses in productivity of meat, milk, and eggs caused by mosquitoes have not been determined. (5) The insecticides now commonly employed for mosquito control, when applied in agricultural areas, give rise to special problems less frequently encountered when they are applied on marshes and other wasteland areas; for example, their application to pasture lands and to forage crops creates hazards because of their potential toxic effect on farm animals and residues in agricultural products, including meat and milk. (6) The biology, habits, and ecology of mosquitoes that are primarily pests in irrigated areas are not as well known as those of the marsh and flood water species.

The following are some of the major lines of research that need to be initiated or expanded:

1. **BIOLOGY, TAXONOMY, AND ECOLOGY OF MOSQUITOES.** In spite of the knowledge we now have, investigations on these phases of mosquito research need to be intensified. The life history, habits, and relative seasonal abundance of various species in different areas should be determined. Careful study is needed to determine the relationship between mosquito populations and animal populations, livestock-management practices, types of forage and range crops produced, fertilizers employed, and other farming practices.

2. **WATER- AND LAND-MANAGEMENT PRACTICES.** From a long-range standpoint

the proper management of lands and water, especially in irrigated areas, undoubtedly offers the greatest possibilities of reducing mosquito abundance at the lowest cost. Fortunately, proper land conditioning from a topographical standpoint, suitable drainage and irrigation canal systems, construction of farm ponds, and proper utilization of irrigation water are usually profitable from the standpoint of agricultural production as well as mosquito control. Details regarding proper practices in relation to mosquito production in different areas need intensive investigations.

3. **DEVELOPMENT OF EFFECTIVE, ECONOMIC, AND SAFE INSECTICIDES AND METHODS OF USE.** Insecticides for mosquito control in agricultural areas must be low in toxicity to animals at applied rates and must not contaminate forage, meat, and milk with excessive residues. Recent passage of Public Law 518 (Miller Amendment) makes it necessary to conduct costly studies to assure that the residues will not exceed tolerance limits, before a new insecticide can be registered for interstate commerce and recommended for use where agricultural products might become contaminated. Such studies are already an important phase of programs under way by Federal and State agencies engaged in research on the control of insects on forage and other crops consumed by livestock.

The equipment used to apply insecticides in wasteland areas may not be the most satisfactory in farming areas. Studies on various methods of application are therefore desirable. For example, more intensive work on highly effective insecticides soluble or miscible in water and methods of dispersing them might materially reduce the cost and safety of mosquito control in irrigated areas.

The requirements for suitable insecticides for mosquito control in farming areas may necessitate a search for substitute insecticides.

4. **EFFECT OF MOSQUITOES ON LIVESTOCK.** Relatively little is known about the effect of mosquitoes on the weight

gains of beef animals, milk yields of dairy cattle and egg production in poultry. Such information at various mosquito-population levels and with different species is needed. Such investigations might well show losses to the livestock grower in a mosquito-problem area to be a major factor in his production costs and consequent reduced income. The benefit from the standpoint of animal production and health could be a vital factor in selling the need for community-wide mosquito-control programs even in areas where the primary purpose would be to protect humans from annoyance and disease.

5. DEVELOPMENT OF REPELLENTS OR INSECTICIDES FOR DIRECT APPLICATION TO LIVESTOCK. The most practical way to protect livestock from mosquito attack in areas where community-wide programs are not feasible or have not been organized is through the use of repellents or insecticides applied directly on livestock. Intensive studies along this line are urgently needed. The studies that have been conducted in the past and now under way on repellents for use by military personnel will complement similar investigations on livestock. Investigations on livestock must include the usual costly toxicological and residue studies in meat and milk now necessary in connection with the control of other external parasites. The adaptation of available military repellents for use by farm workers should also be provided for in any expanded research program.

6. BENEFICIAL ORGANISMS IN RELATION TO MOSQUITO ABUNDANCE. An investigation on the natural enemies of mosquitoes should be undertaken as a basis for utilizing them to the maximum extent possible in limiting mosquito production. The possibility of finding insect pathogens that can be used to destroy mosquitoes should be given special attention. It has been shown in recent years that a number of agricultural pests can be controlled by disseminating cultured disease organisms in the same manner as insecticides. This approach to mosquito control offers such

great advantages over insecticides that a thorough exploration is warranted.

7. ROLE OF MOSQUITOES IN THE TRANSMISSION OF ANIMALS' DISEASES. Mosquitoes are vectors, or may be implicated in the transmission, of several diseases of livestock and poultry. Their importance in relation to anaplasmosis in cattle, blue tongue in sheep, leucocytozoon in poultry, fowl pox, filariasis in dogs, and other animal diseases should be investigated.

8. MODE OF ACTION OF INSECTICIDES AND MECHANISM OF RESISTANCE. The number of insects that are becoming resistant to insecticides and the number of insecticides involved are steadily increasing. The seriousness of this problem merits careful study to determine what materials and how they should be used to avoid or delay resistance.

In the development of a broad and comprehensive research program on the many facets of the mosquito problem, it will be advantageous to have the cooperation not only of investigators in many phases of entomology but also of specialists in other fields of science. The day that an individual researcher can successfully investigate all aspects of an important problem is past. We need specialists in entomology, chemistry, physiology, animal toxicology, engineering, soil and water management, and other fields to study the various aspects of the problem.

As the research progresses, mosquito workers should hold national or regional conferences of a round-table type to discuss the results of their work, new ideas, and future plans. Such conferences will fill gaps in an over-all research program, avoid duplication of effort, develop supplementary research programs when indicated, and often lead to more uniform control recommendations. Regular conferences of this nature are being held by Federal and State workers in several fields of entomology, with great benefit to all. For a number of years the Public Health Service, the Tennessee Valley Authority, and the Entomology Research Branch have held an-

nual meetings of this nature to discuss the various activities under way in the medical entomology field.

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