WEATHER AND MOSQUITO CONTROL ACTIVITIES*

IRVING SOLOMON

Headquarters, Air Weather Service, Andrews AFB, Washington, D. C.

Until about two months ago, mosquito control, to me, would have meant using a $1.98 aerosol bomb to kill mosquitoes when they were numerous, a 10¢ flyswatter to kill unsuspecting ones which were resting on a hard surface, or one's palm against that part of the anatomy into which a mosquito was drilling. Since then I have learned of the many projects and fine work done by mosquito control personnel throughout the country and in many parts of the world. The remarks which follow will necessarily be those of a layman, but one who has had experience in handling collectives of data in another field. It is hoped that the suggestions offered can be used, with proper modifications, to increase entomological knowledge and benefit mosquito control work.

About two months ago the Air Surgeon of the Strategic Air Command sent a request for information to the Directorate of Climatology of the USAF Air Weather Service. The Air Surgeon wanted specific weather data to be used in planning a mosquito control program at MacDill Air Force Base, Tampa, Florida. A check with entomologists, primarily those in the Washington, D.C. area, indicated that the information requested would not be of sufficient practical value to warrant the expenditure of time and effort necessary to analyze the data along the lines suggested by the Air Surgeon. It is encouraging to note, however, that individuals are becoming increasingly cognizant of a weather problem, and are trying to solve it, even if their approaches to the solution are not always what the meteorologists would recommend.

An attempt was then made to ascertain from entomologists the effects of various weather elements on mosquito activity. Most of the entomologists did not attempt to estimate the temperatures, wind speeds, etc., which would adversely affect mosquitoes. Those who gave estimates (for salt-marsh mosquitoes, in this case) differed widely enough among themselves to preclude the use of this subjective information. It seemed that quantitative data were needed.

A search of the mosquito literature was then undertaken with the guidance of entomologists, who suggested sources which might yield information on the effects of weather on mosquito activity. Weather was often mentioned as an important factor in mosquito control work, but further consideration of this factor was lacking. Those few studies in which it was actually attempted to use weather left much to be desired from the meteorological standpoint.

Light trap catch data for MacDill Air Force Base were obtained for 1950, 1951, and 1952, together with weather records for the same period. An examination of the data showed that a varying number of traps were operated from one day to another, and that there were numerous gaps in the record. It was quite unusual to have reports for more than 10 consecutive days. The data, however, were painstakingly tabulated by species and by sex.

An analysis of the temperature data for the three years showed no apparent relationship between temperatures and mosquito activity and led to the conclusion that, at MacDill, the temperatures were almost always sufficiently high to be no deterrent to mosquitoes during the periods for which entomological data were available. There were very few mosquito data for the winter months.

Rainfall amounts were then plotted, by

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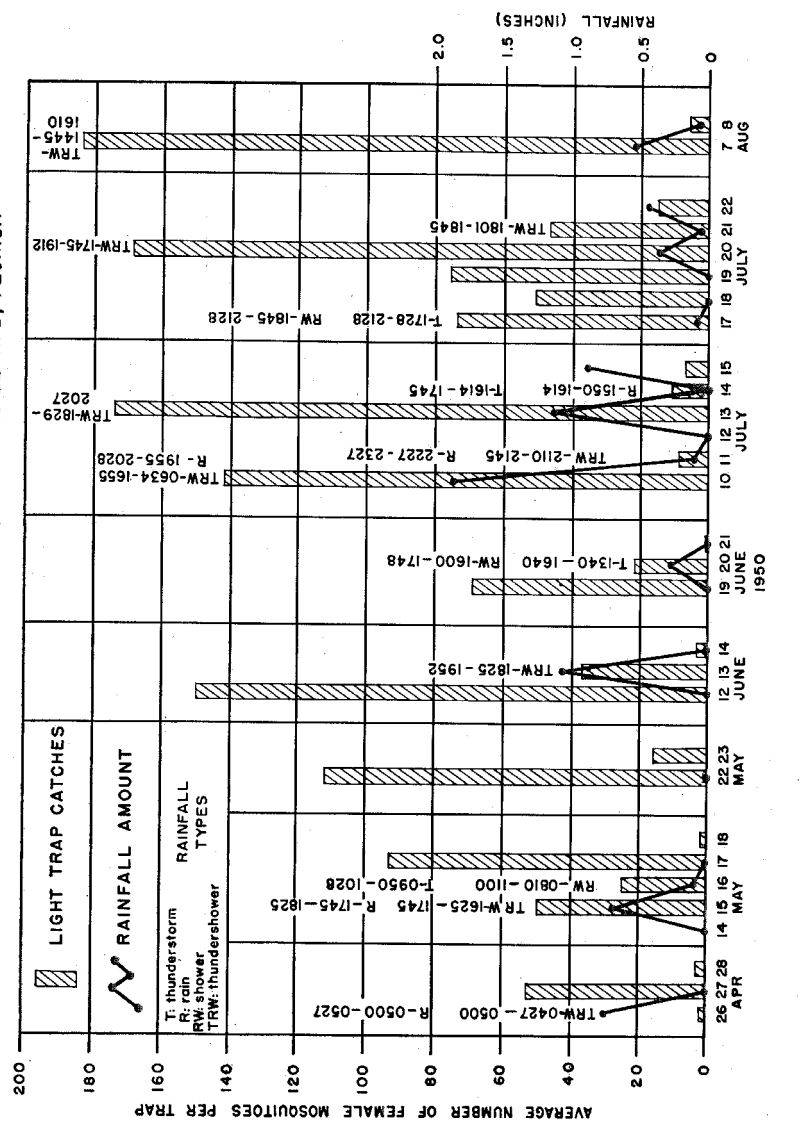
RAINFALL AND MOSQUITO ACTIVITY AT MACDILL AFB, FLORIDA
LIGHT TRAP CATCHES
RAINFALL AMOUNT
RAINFALL TYPES
T: thunderstorm
R: rain
RW: shower
TRW: thundershower
AVERAGE NUMBER OF FEMALE MOSQUITOES PER TRAP
RAINFALL (INCHES)
TRW-0427 - 0500
R-0500 -0527
TRW-1625 - 1745
R-1745 - 1825
RW-0810 -1100
T-0950 - 1028
TRW-1825 - 1952
T-1340 - 1640
RW-1600 - 1748
TRW-2110 - 2145
R-2227 - 2327
TRW-0634 - 1655
R- 1955 - 2028
TRW-1829 - 2027
R-1550 - 1614
T-1614 - 1745
T-1728 - 2128
RW-1845 - 2128
TRW-1801 - 1845
TRW-1745 - 1912
TRW- 1445 - 1610
APR
MAY
JUNE
JUNE 1950
JULY
JULY
AUG

day, on a graph with daily mosquito catches. There appeared to be an inverse relationship between the occurrence of rain and the occurrence of mosquitoes. The hours during which it rained (based on a 24-hour clock) were entered on the graph and the relationship was brought out more clearly. It should be recognized that the mosquito data shown for a particular day are taken from the previous evening through the morning of that day, while the rainfall data apply to that civil day. Of course, other factors, such as adulticiding, winds, etc., could have accounted for a decrease in the number of mosquitoes caught from one day to the next, but it seems more than a coincidence that rain in the late afternoon or night occurred in so many cases. The cases shown in the accompanying figure were taken chronologically and include those with marked variation in mosquito activity. This general information probably comes as no surprise to personnel in mosquito control work; however, it represents, in this case, a rapid preliminary attempt by a non-entomologist to quantitatively relate mosquito activity to a weather element. I am sure that, with adequate entomological data, some degree of success along these lines can be achieved. Weather data are generally excellent for such purposes.

Those phases of mosquito control activities which, it seems, should be examined more closely with a view toward their improvement are the ones involving data collection and analysis. Information on these subjects was obtained in lengthy conversations with many entomologists. First there is the non-standardization of instruments, light traps in this case. The fact that lights of differing intensities and fans of differing capacities are used makes comparisons of light trap catches invalid, except in those cases where lights and fans are uniform. It appears that much time, effort, and money are being expended in collecting and identifying mosquitoes caught in traps, and compiling the data. A sufficiently valid explanation as to why this is so large a part of the entire program has not yet, in the opinion of the author, been advanced by entomologists because, considering the non-standardized instruments with which these samples were taken, the data are of such limited use. Of course, it is necessary to do a certain amount of taxonomic work to identify possible disease vectors. However, would some of this effort not be more profitably utilized in a research program? Also, although weather is admittedly an important factor, no systematic attempt has been made to use it as an ally in a mosquito control program. It seems that even weather forecasts are not always obtained in advance of scheduling a spraying operation. One mosquito control man stated that he checked the prevailing winds. He was unable to answer the question, "Why?"

It is felt that a line of research on the ecology of the mosquito, with the aim of making a control program as effective as possible, should be undertaken. An attempt should be made to learn, in quantitative terms, the effects of individual weather elements and combinations of weather elements on mosquito activity. In the absence of long, standardized records of mosquito activity, laboratory experimentation is suggested as the fastest method to achieve this goal. To determine the effects of temperature, relative humidity, illumination, etc., on mosquitoes, it is suggested that use be made of a "climatic chamber"—the size to be determined by the entomologist on the basis of his needs and his budget—in which these factors could be varied at will. It has been mentioned that, not having unlimited space in which to fly, the mosquito might be affected psychologically and might not react normally. Assuming this to be true, why could this device not be used to study the effects of these factors on eggs and to study the absolute ranges of tolerance of adults, larvae, and eggs of the various species?

To study the effects of wind speeds on mosquitoes, it is suggested that a modified wind tunnel be used. A cage divided into two parts could be constructed, with a cylinder connecting them in such a manner that passage through the cylinder

would be necessary to go from one part of the cage to the other. A device for moving the air through the cylinder at controlled speeds would convert it into a miniature wind tunnel. Mosquitoes could then be placed in one part of the cage, perhaps together with a repellent, and an attractant in the other part of the cage. In any event, the entomologist would provide the maximum stimulus for the mosquito to fly from one part of the cage to the other, and wind speeds through the tunnel would be increased to the point at which the mosquitoes could no longer make the flight, thus determining the maximum wind against which a mosquito will fly.

In order to have comparable data in this field it would be necessary to standardize all collection devices. Observations should be taken as often as practicable, but at least once a day, so that an attempt could be made to relate mosquito activity to weather or other forecastable factors selected by the entomologist.

Meteorology can be used by the entomologist in planning and executing his spraying operations. Research might reveal the size and concentration of drops of insecticidal spray which are most effective in killing mosquitoes. Studies of this type, relating weather conditions to chemical warfare operations, in which optimum dispersion of smoke, gases, and spray is required, have been done many times. Other research tailored to the unique needs of mosquito control personnel might be undertaken in cooperation with Meteorology Departments of State Universities and interested governmental agencies.

To recapitulate:

1. The entomologist, with the help of the meteorologist, should attempt to relate mosquito activity to forecastable weather factors.

2. The entomologist, through continuing surveys, would know the age and composition of the adult mosquito population in his area, and also the stages of the larvae in the breeding grounds affecting his area.

3. The entomologist, knowing the aforementioned items, could interpret weather forecasts slanted toward his needs in planning his day-to-day control operations, with the aim of modifying the operation to his financial advantage.