THE USE OF PAROUS LANDING RATES AS A SURVEILLANCE TECHNIQUE TO MONITOR MOSQUITO POPULATIONS[1]

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Introduction

Mosquitoes have always been a source of annoyance to people. Their blood-sucking habits rarely cause severe pain but multiple mosquito bites can become a very real nuisance. Most mosquito species have limited biting cycles but their feeding activity too often coincides with leisure hours. The day at the beach or the evening barbecue has become an important interlude in the hurried life of most people and mosquitoes seem to be particularly adept at disrupting the hours of pleasure.

In general, tolerance to mosquito bites is a function of exposure. The native populations of coastal areas in southern New Jersey are used to living with mosquitoes and it takes many bites before they complain. The populations of inland areas are far less tolerant and relatively few bites can result in a wave of complaints. Most families are also traveling a great deal. Many are moving to the suburbs and most are willing to invest a portion of their salaries for several weeks at a recreational resort. These areas are often close to the major mosquito populations in the State; thus, people do get bitten and do complain.

Mosquito control agencies respond to complaints. Their job is to protect citizens from mosquitoes and complaints are one measure of adult mosquito activity. Mosquito control agencies, however, cannot wait for complaints to locate adult populations which require control. They rely instead on a number of surveillance techniques to detect potential nuisance. Light traps, truck traps and landing rates are just a few of the methods which are used to monitor adult mosquito activity. When surveillance detects high populations, control is warranted to alleviate nuisance. Adult control is usually relaxed during periods of low populations because nuisance is minimal.

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Mosquitoes as Vectors of Disease

In addition to causing considerable annoyance, mosquitoes can also function as vectors of disease. New Jersey experienced a mosquito-borne viral encephalitis emergency in 1975 which produced cases of St. Louis encephalitis in humans and eastern encephalitis in horses. There was an extreme need for protection and both county and state mosquito control agencies mobilized.

Mosquito control during the emergency period was professional and effective. The mosquito populations were reduced and disease transmission was minimal. During the period, control was directed toward the high populations. New Jersey instinctively used its experience in nuisance control to prevent disease. Although this approach is common throughout the United States, there is little evidence to suggest that it is the most effective method of vector control. Recent research indicates that the question should be examined more closely.

The Concept of Parity

High mosquito populations are usually an indication of a fresh emergence in brooded species. As a result, the majority of individuals are seeking their first bloodmeal. They can cause considerable annoyance at this time but disease transmission is minimal. Control is necessary to minimize nuisance and reduce the overall population which might later cause a health hazard (Fig. 1). As the populations age, the numbers decline. Natural mortality takes its toll after chemical control has reduced the original numbers. People are then willing to venture out of doors, complaints are not received and repellents are less likely to be utilized.

Whether control is warranted at this time is open to question in view of the low numbers which remain. These older populations are often ignored but they contain the potential vectors of disease. The individual mosquitoes which make up the population have laid at least one batch of eggs and are seeking their second or third bloodmeal. These mosquitoes are termed parous since they have oviposited before and can be recognized by dissection and examination of their ovaries. Since mosquitoes cannot transmit disease until they have acquired parasites, the parous portion of the population poses the health hazard.

Field Studies in New Jersey

A field population of *Aedes sollicitans* was closely monitored at a coastal area of New Jersey during the summer of 1975. Light traps and

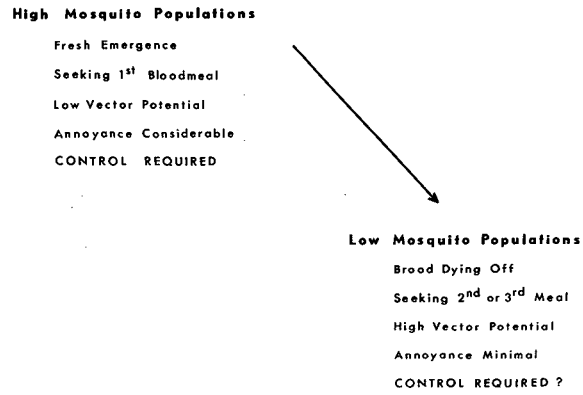

Fig. 1. Some of the epidemiological relationships during periods of high and low mosquito abundance.

landing rates were used to minitor nuisance; mosquitoes coming to bite were dissected to determine the percentage which had obtained a prior bloodmeal. Figure 2 shows the adult population within a single brood measured by nightly light trap collections as well as the parity of the population over the same period. Light trap data have been converted to a five-point moving mean to minimize fluctuations due to climatic conditions. The numbers of mosquitoes increased until June 21-22 and then progressively declined until minimum numbers were captured just prior to July 4. Data indicated that adult control was not necessary over the holiday period because the numbers were too low. The parity data produced a typical curve. As the brood aged, the parous rate increased indicating that a greater percentage had bloodfed and laid their eggs. By July 4 when populations were at their lowest, nearly every mosquito was seeking its second or third bloodmeal.

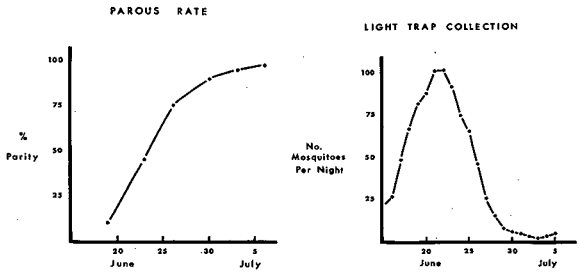

Fig. 2. A comparison of parous rates and mosquito numbers measured by light trap for *Aedes sollicitans* during the summer of 1975.

The number of parous mosquitoes landing per minute can be calculated by multiplying the landing rate per minute by the parous rate of the population. Figure 3 shows the mathematics involved with several examples. High landing rates and low parity produce low parous landing rates; low landing rates and high parity can produce high parous landing rates

Landing Rate/Min. x Parous Rate = No. Parous Mosquitoes Landing/Min.

20 per Min. x 5% = 1 Parous Mosquito/Min.

10 per Min. x 30% = 3 Parous Mosquitoes/Min.

5 per Min. x 100% = 5 Parous Mosquitoes/Min.

Fig. 3. The calculations used to obtain parous landing rates.

The parous landing rate of *A. sollicitans* is compared to the light trap collections in Figure 4. Data indicate that the number of potential bites from parous mosquitoes increased as the brood aged. Comparison with light trap data reveals that when the mosquitoes were most numerous, the parous landing rates were low. The parous landing rates were highest when light traps indicated minimal populations.

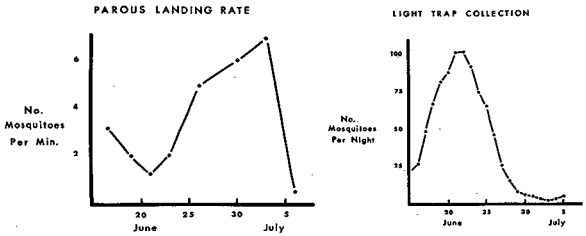

Fig. 4. A comparison of parous landing rates and mosquito numbers measured by light trap for *Aedes sollicitans* during the summer of 1975.

Control Recommendations

Data in Figure 4 reveal that control recommendations based on a single surveillance technique can be misleading. The high populations measured by light trap on June 21-22 showed that control was needed to alleviate nuisance. The high parous landing rates from July 1-4 indicated that control may have been warranted for public health reasons after the brood had dissipated. The population in this example was controlled by State Airspray on June 23 and the action undoubtedly depressed the potential of the rising parous landing curve later in the month. Data suggest, however, that the population might have been controlled twice if disease had been a concern at the time. Once to prevent nuisance and reduce the overall population; once more to reduce the residual biting population to prevent disease transmission.

Conclusions

Parous landing rates appear to be a good indication of the vector potential of a mosquito population but the techniques are relatively new and have not been widely tested under field conditions for most mosquito species. As a result, no data are available to identify the parous landing rates which represent a dangerous situation. When answers are found to the fine points of these concepts, control recommendations may be based on vector potential during an emergency. When this occurs, New Jersey will practice total vector control.

MR. SCHMIDT: I have one question for Tom Candeletti. With the one slide that you showed your peak populations of *sollicitans*, about the beginning of August, as the population was building, all of a sudden it took a drastic drop and then it built back up to the peak. Do you have any idea what caused that drop because I have graphed a similar drop for the mosquitoes in Middlesex County?

MR. CANDELETTI: Well, I don't know the exact reason, but it could have been due to – well, that was a light trap graph – it could have been due to cloud cover, a bright moon or possibly even control. I don't really know exactly what brood that was on when we controlled it.

DR. SUTHERLAND: I have a question for Rich and Wayne. Rich suggested, I think, that control of parous mosquitoes might logically await the virus determination, and I was wondering how long it would take from field collection to a final decision as to levels of virus in that population that you might treat? How long would it be two or three days you have to wait for that assay?

DR. CRANS: I feel like a sacrificial cow here because the State Health people are right here in the front row. I'm going to dodge it. I don't think that we have to wait for a decision or a particular date. I think what we need is ongoing information to know whether or not there is virus activity of any kind and then these decisions would be made. Certainly if we had to wait for a decision on whether we had virus on this day or that day, you wouldn't have time to control a population. But if this monitoring was started early in the season, we would at least have a point where we were able to pick it up and say, "Yes, there is virus activity this year; we ought to watch these older populations more critically."

MR. ROPER: A question for Mr. Downing. Is there any particular reason why you picked a five-day moving mean for your graph detemrination?

MR. DOWNING: Only because it has appeared in the literature as sort of a standard. Other ranges could be a weekly or a seven-day moving mean.

MR. ROPER: Were your collections done on a seven-day-a-week basis or a five-day-a-week basis?

MR. DOWNING: Well, our collections were every day, all week long, so that it would be possible to do it either way. It could go shorter; it could go to three or four days depending on – you can tailor this to your own needs. There are a couple of dangers or things to consider and that would be not to make the period so long that you lose actual population fluctuation. I have seen three-week moving means, not for mosquitoes but for some other insect. This wouldn't apply to mosquito populations because the population could increase and decrease twice in that length of time. So there is some flexibility here, but there are some things to consider as well.

MR. IMBER: Dr. Crans is advocating treatment from a vector viewpoint. Of course when you suggest that, you suggest treatment of low populations. When would you reach the point of no return from a control standpoint?

DR. CRANS: I think I indicated that we don't know. I think we have to find out. I think this is the next step. I'm not saying that every low population should be controlled, but we have to develop a threshold, a point at which we feel that there is a problem. And I don't want anyone to get the idea that I'm suggesting that we do away with the nuisance control because that's the most important of all. This is just an added control during periods of emergency.

MR. LOMBARDI: I just wanted to say one thing. Most of the talks today centered around surveillance and basically temporary control procedures. I think surveillance has a very, very key role and I tried to mention this in my own talk. In permanent water management or marsh management procedures I think that New Jersey in the past, since the inception of mosquito control here, has been oriented toward marsh and water management. I think we have the tools available to us now, as you've probably seen in other talks, to proceed ahead with marsh and water management projects particularly in the saltmarsh regions where we can attack key breeding of *Aedes sollicitans.* I think we have to talk about water management, marsh management, as an offensive means of control. I think that we ought to be on the offense. Temporary control is only a defensive measure to be used as a temporary tool. I just want to beat the drum for offensive mosquito control.

DR. MURPHEY: A question directed to the panel in relation to the marsh management. I've seen various estimate about the amount of grid system ditching along the Atlantic Coast, and these estimates vary anywhere from 67% to 85%, but it indicates that there's been quite a lot of it done and been installed. And we hear much about open marsh water management as to its advantages – and I don't argue the point; the evidence is there that it does provide many advantages – but what is being considered for possible modification of grid system ditching because that represents the bulk of our marsh water management. When we take an air flight over a marsh, along the Atlantic coast, this is what we predominantly see.

MR. LOMBARDI: I'd like to comment on that. I wasn't here when Joe Shisler presented a paper which a number of people worked on cooperatively. But if you looked at some of the data that was presented there, the amount of ditching per acre varied tremendously on the basis of what previously existed in a particular area. Now, in my particular region I have 10,000 acres of saltmarsh. The greatest majority of it had been grid ditched and when we talked about covering 3,500 acres this past year, we were talking of adding approximately 34 feet of ditch per acre. This is what you referred to as a modification of the grid system. I call it open marsh management work, but it is work taking off from a system which happens to be there already.

Now, on the other hand, if you happened to look at some of the Cape May data and also the Cumberland data, they were working in areas where they had considerably less grid work done to start off with, and some of the figures in terms of footage per acre ranged as high as 261 feet per acre; that's on an average. I would dare to say that in highly concentrated breeding areas you may even come up with more footage per acre. But in my particular situation we averaged out over 3,500 acres to add 35 feet per acre. Some acres were not touched at all.

DR. MURPHEY: Do you maintain the grid part of it?

MR. LOMBARDI: We do not touch the grid part of it unless it is non-functional. And we have generally found that we have a very good life on ditches which were properly placed to start off with. I would say that of 120,000 feet of work that we performed during this past summer probably less than 5,000 was in cleaning of old grid systems. Now should it fall into a situation where we're actually producing mosquitoes on that section of marsh, then we would maintain the system which applied; and if there happened to be new pothole developing for one reason or another, we would also tie them into the system.