discourse on the reptiles of the world, and the confidence he displays when handling his pets, gives the audience a truer conception of the part snakes play in our scheme of living. He very adroitly brings out the fact that most people would take very positive action if they found a snake in their bedroom, but these same people exhibit only casual interest over a little mosquito on the bedroom wall. Then he points out that these little mosquitoes are actually responsible for more of the world's ills than the much maligned snakes.

The printed word can be disappointing. In newspaper articles I hold with the school that feels satisfied if the name is spelled correctly. "Canned" releases are usually like some other canned goods, corny. Even these don't always appear in print in the same form in which they were submitted. In an effort to improve this situation, each zone foreman is making an effort to enlist the support of their respective newspapers in publishing news on mosquito control activities of local interest. Each foreman keeps his local paper fully informed on the work being done in that particular area. District policy and activities are blended into this local note whenever it can be done to advantage. Other mediums of reaching the public through the printed word are used, notably the pamphlet. We have had the pleasure this past year of "hatching" our first issue.

This booklet, made of 24 pages of pictures and a miscellany of written material, originated with the idea of informing the public on what they were buying. Confronted with the appalling fact that comparatively few people were taking advantage of the service available to them, we felt that something should be done to shake them out of their indifference and, if possible, correct the mass of misinformation on mosquito control and mosquitoes. Our effort is now being distributed to each home within the district, and copies have been sent to others interested in pest abatement. May I say here that I am somewhat in the position of a father? It's alright for me to call my offspring a brat, but woe-be-tide the outsider who makes disparaging remarks about my "baby." Honest cirticism is welcome, however, with the thought in mind that in the very near future the association may be financially able to print a handbook for lay distribution. The difficulties and mistakes experienced in our release may benefit any future publication, for either local or state wide distribution. A large share of the cost of producing this booklet was borne by friendly commercial agencies.

Other steps in our march toward efficient mosquito control are: emphasis on good appearance, both physically and in everyday conduct; a close contact with other similar groups; a nearly hopeless race to keep up with new developments; proper consideration of all merchants within the district in regards to purchasing; full cooperation with all civic groups; and rather detailed entomological operations and pictorial records to better chart the future.

A very welcome aid to our public relations has been the apparent decrease in the area's fly population. Actually a by-product of present-day mosquito control, this decline of a very obnoxious pest has brought forth more appreciative comment than all other activities combined. Mosquito control is taken for granted. They're paying for it and expect us to do a good job. This agreeable situation is being fostered by expanding fly control measures, but always under the cloak of mosquito control. The small additional cost to the district will return big dividends in happy taxpayers. This side-stepping direct responsibility is not because we lack courage — rather, it is another deliberate step aimed toward good public relations.

Our next paper will be "How California Compares in Mosquito Control with Other Regions," by H. F. Gray, Engineer, Alameda County Mosquito Abatement District, Oakland.

HOW CALIFORNIA COMPARES IN MOSQUITO CONTROL WITH OTHER REGIONS

By H. F. GRAY, *Engineer*
Alameda County Mosquito Abatement District
Oakland, California

Mr. Gray: The topic presented to me for discussion, "How California compares in mosquito control with other areas," is couched in the form of a question such as no one but a jackass would ask, and no one but a damn fool would attempt to answer.

That, Professor Herms, was recorded.

But before I enter upon this asinine discussion I have the pleasure of calling attention to the fact that Commander Rock and Mr. Sunderland from the Twelfth Naval District are up stairs there, very quietly in the corner. We have had very excellent relations with the Navy in past years, and we sincerely hope that it continues.

I will allow this to be recorded for a while, while I am speaking in terms of glittering generalities, but after I get down to specific comparisons I am going to shut the recorder off. I don't want to get shot when I go to Florida, or up to Portland, or back to New Jersey, or possibly Virginia. If you are going to make comparisons as to mosquito control problems and mosquito control work in various places in the world, you have to remember that there are variations in conditions which modify what you will do and what results you may be able to get. The type of terrain varies very greatly in different parts of the world and, above all, climatic conditions vary so widely that it is extremely difficult to evaluate any particular area in relation to another unless you have a good acquaintance with the variations.

Just as an example, within our own state of California we have very decided differences in climatic conditions between the coastal counties and the interior valleys. We have a relatively cool climate on the coast and a moderate humidity, probably averaging in the vicinity of 50 or 60 percent relative humidity. We have cool breezes at night, and the nights are usually cool even in the hottest days of summer. But if you go into our interior valleys — the Sacramento and San Joaquin Valleys — you have during a number of months of the year temperatures that are running up above 100° F., and sometimes up to 120° in the shade. The development of mosquitoes is extremely rapid under those conditions. The central valleys also have a much lower humidity than we have along the coast. In some cases it gets to such a low state of humidity that I doubt if a mosquito dares spit during any time of its existence, because she couldn't afford to lose that much fluid. Now, if you try to make any comparisons between California and other areas, you have to take into consideration that we

have variations of our own in climatic conditions and terrain, and so on, and these other areas have very decided differences compared with us.

For one thing, in California there are several mosquito species which breed throughout the year. But if you go into Illinois in January, for example, all breeding ceases from perhaps about the first of November to say in April. They have winter conditions which make outdoor work difficult to impracticable. We can work on maintenance, for example, all through the winter as a general rule. Back East they cannot for a number of months do very much outdoor work. Bob Vannote will correct me in that, if I am wrong. I consider this to be quite a serious handicap to outdoor maintenance, the maintenance of drainage systems and other structures, for example.

California is essentially rainless from about the first of May until about the early part of October, and therefore it should be a mosquito man's paradise, for the reason that he does not have new rainfall providing additional and perhaps unexpected breeding places. If you go into the southern states of the United States, the eastern seaboard and the middle west, summer rainfall is quite common. Sometimes it is exceedingly heavy, and they have the constant creation of new mosquito breeding places. You might say, "Well, that makes it pretty tough." I can assure you, gentlemen, that it does make it pretty tough to exercise effective control measures. On the other hand, we are not entirely fortunate here in California, because we substitute for that summer rainfall the application of water by irrigation systems. Any of you who have ever worked in the Sacramento or San Joaquin valleys, where there is a good deal of irrigation, are quite well aware of the fact that some idiot farmer can almost always apply more water than his land can take, run it off down the roads and into unexpected places, and then you have some new breeding places that you didn't know existed until perhaps you stumbled upon them when the neighbors started complaining and you had to go out and hunt for them. So I don't know that the disadvantage of the eastern states in regard to natural rainfall is a disadvantage that is very greatly in excess of the problems of irrigation that we have under our more arid summer conditions.

On the other hand, we do not face some of the things and situations that they have in the East, along the seaboard particularly, and one of the things that you will meet in tropical areas. That is — some of the summer storms may approach hurricane, typhoon and tornado proportions and, when that happens, you will have extensive damage to the structures that you have built, and sometimes you may have a lot of your work torn out by an exceedingly bad storm, and then you are in a pickle of trouble right there. Another thing that can happen, and this is very apt to happen in the Florida area, is that when one of those big hurricanes comes along, it may pile up the tides along the shores and the shore marshes for weeks on end, and the water can't get out in spite of the drainage system, and you just have a devil of a time with mosquito breeding, particularly *Aedes taeniorhyncus*. Control difficulties are tremendously enhanced in the Florida area by some of these tropical storm situations in relation to the piling up of tides. Fortunately, we don't have that particular difficulty here in California. We do not have summer storms, and the winter storms are usually not bad enough to bother us to any particular extent.

Areas of flat terrain are harder to drain than areas which are hilly. In California we have on the average a more varied terrain and more hilly country, except in the central valley, than in many of the areas in the eastern part of the United States, particularly the north central states, New Jersey and Florida. Their relief is lower than ours, and their problems of hydraulics and drainage are therefore more difficult to take care of. In that particular respect California does have a certain amount of advantage.

Our relatively low humidity in California is an advantage because all mosquito species seem to be more active, live longer and are perhaps more penetrating in their hide-piercing effect with a high relative humidity than they are where it is particularly dry. I don't know whether that is only an impression, but it does seem to me that they can bite a little bit better under humid conditions than they do under arid conditions. About the only exception that I might make to that, however, is our *Aedes flavescens,* which we have up in the Shasta-Modoc area, which is a large mosquito that lives in a dry country, and can she drill! She really takes a piece of meat out of you when she bites.

There is perhaps some difference in the background of why mosquito agencies have been created in California and in some other areas. In California, in spite of the fact that many of our districts were organized originally with the impetus coming from the real estate and commercial agencies, there has always been a strong public health influence, and we have never been able, nor have we attempted, to get too far away from the disease prevention aspect or from close cooperation of the State Health Department. In a good many other areas in the United States the emphasis has been primarily on strictly a nuisance aspect and economic considerations. That is not true in the southern states of the United States, but there you have almost no development of the independent mosquito abatement district. Much southern mosquito abatement is done directly under the health department, is purely a public health function, and the health departments are unlikely to concern themselves very much with species which are not disease-vectors; in other words, they will stick pretty close to *Anopheles* malaria problems, and dengue. We are more apt out here to take the whole field; to take both vector mosquitoes and pest mosquitoes more or less as they come.

I will probably be criticized for even these general remarks, but now what about specific instances? Here's where I shut this thing off!

(Remainder of discussion not recorded.)

Mr. Raley: I will now present Dr. W. C. Reeves.

Dr. Reeves: At the time the topics were selected for this particular report, I was a little bit dubious about what tie-in we might have with other topics that are on this program. However, developments of the last day and a half have shown, first, that we will have some potential ammunition, a continuation of the fight up north as to how far mosquitoes will fly and in which direction — and of course we all love a good fight. Our information is on the wrong species of mosquitoes, but the representatives from Washington and Oregon are very welcome to it if they want to use it. Secondly, yesterday we had considerable in-

formation given us on detrimental potential effects of mosquito control on wildlife, and I believe we can have an optimistic note in the second half of this paper on the possible beneficial effects of mosquito control on wildlife. This paper, as was Dr. Hammon's paper yesterday, is not my paper but it is a paper from the Neurotropic Virus Unit of the Hooper Foundation, the Kern Mosquito Abatement District and the Disease Laboratory of the Bureau of Game Conservation of the California Division of Fish and Game — and for this reason we feel that is the only fair way in which to present it, as there are many people in this room who contributed to this work, as well as those who are not here.

A FINAL SUMMARY OF FLIGHT RANGE STUDIES ON *CULEX TARSALIS* AND NOTES ON WILD BIRD MALARIA IN KERN COUNTY

By the Staffs of
The Neurotropic Virus Unit of the George Williams Hooper Foundation, University of California, and the Disease Laboratory of the Bureau of Game Conservation, California Division of Fish and Game

At last year's conference we reported the first studies on the flight range of *Culex* mosquitoes in California: that in Kern County *Culex quinquefasciatus* may frequently travel a mile, and may fly as far as two and a half miles; that *Culex tarsalis* may travel at least half a mile; and that *Culex stigmatosoma* were recovered as far as one mile from their release point.

During the summer of 1947 these studies were continued in cooperation with the Kern Mosquito Abatement District. As in the previous year, mosquitoes were marked with the fluorescent dye, Rhodamine B, and were released in the center of an experimental area. Daily collections of adult mosquitoes were made at collecting stations varying in distance from 0.2 to 2.5 miles in every direction from the release point.

In 1947 particular emphasis was placed on a study of the flight range of *Culex tarsalis,* although a small number of *Anopheles franciscanus* and *Culiseta incidens* were released at the same time.

Of over 20,000 marked *Culex tarsalis* released, 18 females and 10 males were recovered. The majority of the recoveries (22 out of 28) were made upwind from the release point, and the maximum range of recovery was 2.5 miles for females and 1.1 miles for males. The majority of recoveries were made within one mile. Marked specimens of *Anopheles franciscanus,* both male and female, were recovered at a maximum distance of 0.9 miles; and *Culiseta incidens* males were recaptured at 0.6 miles.

The present studies were designed to determine the "effective" flight range of the species, rather than the maximum range of flight. We would consider the "effective" range to be the maximum distance which a species normally would be able to fly from a breeding place in numbers sufficient to transmit disease or to become a nuisance.

In the case of our studies it was not possible, with the personnel and time available, to collect extensively beyond the two-mile zone. Only six stations at that distance were visited regularly. Also relatively few stations were utilized between 1.5 and 2 miles. It is obvious that the relatively enormous area involved beyond the one and one half mile boundary into which released mosquitoes could disperse (provided food and shelter were available) was scarcely touched. However, the fact that even one female of *Culex tarsalis* or one of *C. quinquefasciatus* was recovered at 2.5 miles from the release point leads us to believe that, given an extensive breeding ground of either or both of these species, large enough numbers of these could disperse beyond one mile to become a problem. Thus we feel that we are justified in recommending that control measures be carried out in a zone not less han one and one half miles beyond the human or animal hosts to be protected from these *Culex* mosquitoes. It could very well be that, under different conditions of temperature, humidity, wind or topography these mosquitoes would have a longer or shorter life and an inclination to travel longer or shorter distances. However, this does not detract from the fact that, for the first time experimental proof has been obtained in answer to an important practical problem of mosquito control workers.

As is indicated by the title of this paper, the following section will be devoted to some notes on wild bird malaria. During the past several years we have been asked an increasing number of questions by mosquito abatement workers and by laymen concerning the relationship of bird malaria to human malaria; what effect malaria has on birds, and which mosquitoes are carrying it. Popular articles and references in the newspapers on the use of bird malaria for testing possible anti-malarial drugs have undoubtedly stimulated this interest, and at times these studies have led to misunderstanding. Many of the recent advances in drug treatment of malaria have been due to the fact that possible therapeutic agents could be tested first against malaria of canaries and, if effective in such cases, then tested against human malaria.

In 1885, only five years after the discovery of malaria in the blood of man, a similar type of parasite was found in bird blood. It now is known that at least 4 species of *Plasmodium* may infect man, and that in North America at least 9 species of *Plasmodium* are found in birds. The malaria parasites of man will not infect birds; those of birds do not infect man.

As yet very little is known of the prevalence of infection among birds over wide areas or of the detrimental effects of malaria in birds. Although death or prolonged illness from malaria frequently occurs in man, a similar condition is not recognized in wild birds. Of course, if such were the case, it might not be recognized, since sick birds will hide or else are quickly disposed of by predators. However, there are indications that malaria may be one of the important factors in the mortality of nestling birds.

The method of transmission of malaria was first demonstrated 50 years ago by Ronald Ross, who worked with a *Culex* mosquito and avian malaria. His observations were later confirmed in the case of human malaria and *Anopheles* mosquitoes.

Since the time of Ross, a number of blood-smear surveys have been made to determine the frequency of malaria infection in birds and the species of *Plasmodium* with which they were infected. Surprisingly, there is no record in the literature of field studies to determine which mos-