# MASSACHUSETTS MOSQUITO SURVEY



1939

MASSACHUSETTS DEPARTMENT OF PUBLIC HEALTH
IN CO OPERATION WITH
WORK PROJECTS ADMINISTRATION

# MASSACHUSETTS MOSQUITO SURVEY



## TRAINING COURSE
## FOR
## FIELD PERSONNEL

EDITED BY
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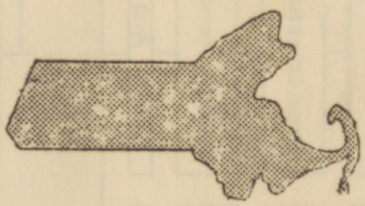

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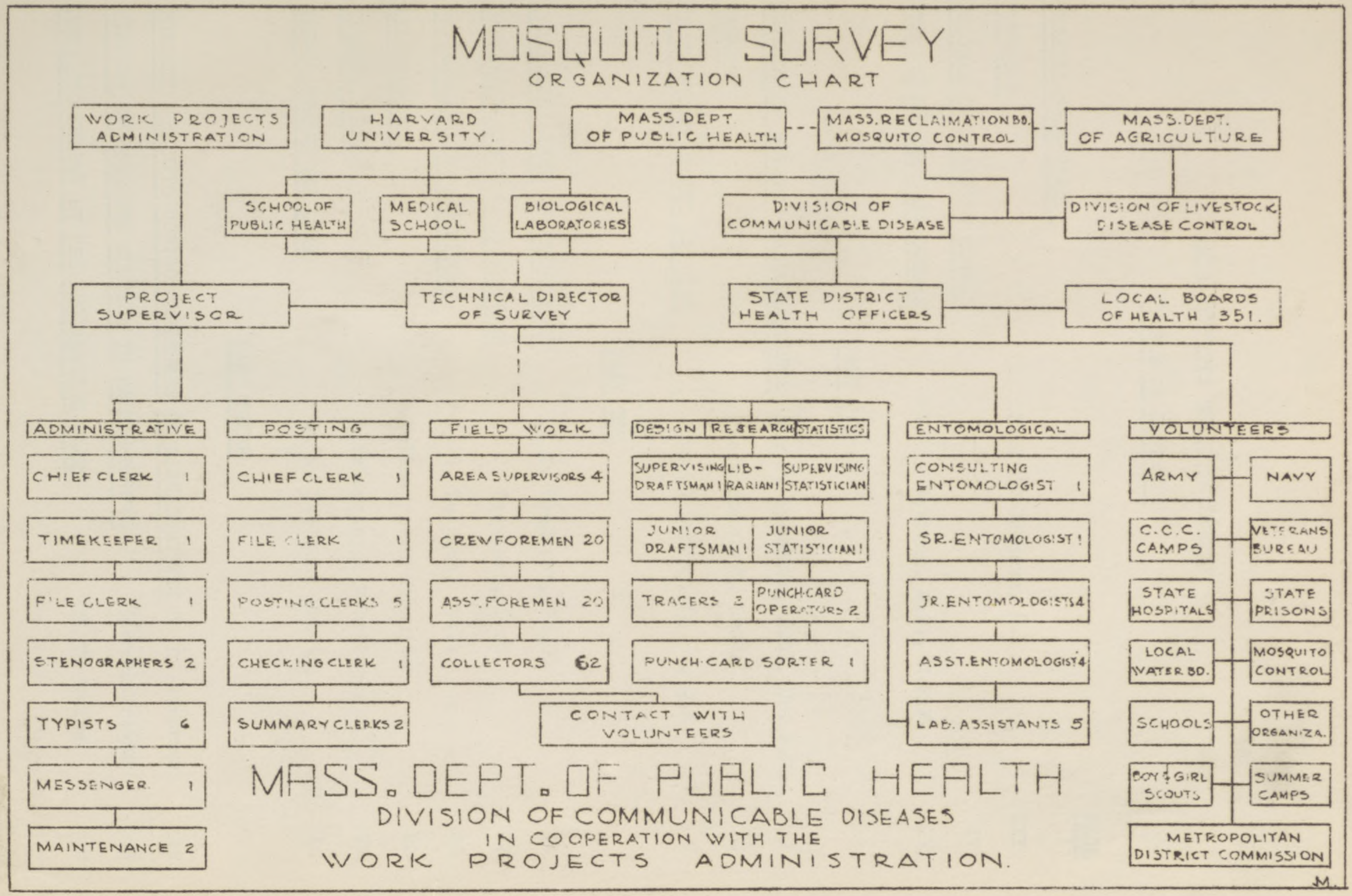
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SCHOOL OF PUBLIC HEALTH
MEDICAL SCHOOL
BIOLOGICAL LABORATORIES
DIVISION OF COMMUNICABLE DISEASE
DIVISION OF LIVESTOCK DISEASE CONTROL
PROJECT SUPERVISOR
TECHNICAL DIRECTOR OF SURVEY
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LOCAL BOARDS OF HEALTH 351.
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MASSACHUSETTS MOSQUITO SURVEY

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PART FIVE

# FOREWORD

Paul J. Jakmauh, M.D.
Commissioner of Public Health
Massachusetts Department of Public Health

The training course outlined in the following pages records a new departure in surveys of this kind. It seemed wise, therefore, to prepare as much of the content of the course as possible so that others might profit by our experience if similar surveys are organized in the future.

The Department acknowledges its indebtedness to the Harvard Medical School and the Harvard School of Public Health for opening its class rooms and laboratories not only to the training course but also to the headquarters unit engaged in the identification and recording of the material collected in the survey.

The Department is also indebted to the lecturers who contributed their time without remuneration. The wide experience represented by their collective training gave the course a breadth of view and an excellence of content which could not have been otherwise attainable.

Acknowledgment is also made of the splendid work of the representatives of the Work Projects Administration in assembling the group for training on such short notice and for the care which they exercised in choosing individuals suitable for the work.

MASSACHUSETTS DEPARTMENT OF PUBLIC HEALTH

MOSQUITO SURVEY

PROGRAM OF TRAINING COURSE FOR FIELD WORKERS
JUNE 19-23, 1939

| HOUR | MONDAY | TUESDAY | WEDNESDAY | THURSDAY | FRIDAY |
|---|---|---|---|---|---|
| 9 A.M. to 10 A.M. | DR. ROY F. FEEMSTER<br>Outline of Survey Announcements | DR. J.C. BEQUAERT<br>Characteristics of Mosquitoes | DR. G.S. TULLOCH<br>Development of Mosquitoes | DR. G.S. TULLOCH<br>Where Mosquitoes Live | MR. ROBERT W. WALES<br>Mosquito Surveys By The Reclamation Board |
| 10 A.M. to 11 A.M. | DR. CHARLES T. BRUES<br>Insects | GEN. F.F. RUSSELL<br>Mosquito Borne Disease | DR. ROY F. FEEMSTER<br>Causes of Disease | DR. V.A. GETTING<br>Daily Work of Crew | DR. W.A. DAVIS<br>Mosquito Transmission of Equine Encephalomyelitis |
| 11 A.M. to 12 M. | DR. JOHN E. GORDON<br>Records and Records Keeping | DR. V.A. GETTING<br>Survey of Collection Point | DR. L.D. FOTHERGILL<br>Sleeping Sickness in Humans | MR. EDWARD WRIGHT<br>MR. GEO. P. STRATTON<br>Mosquito Control | DR. V.A. GETTING<br>Analysis of Data and Summary of Procedures |
| 12 M. to 1 P.M. | DR. HARRIE W. PIERCE<br>Sleeping Sickness in Horses | DR. J.C. BEQUAERT<br>Different Kinds of Mosquitoes | DR. V.A. GETTING<br>Labels | DR. ROY F. FEEMSTER<br>Organization of Cooperating Agencies | DR. PAUL JAKMAUH<br>DR. ALTON S. POPE<br>and<br>W.P.A. Authorities |
| 2 P.M. to 5 P.M. | Laboratory Demonstrations | Field Demonstrations | Field Demonstrations | Field Demonstrations<br>Examination | Field Demonstrations<br>Issuing of Equipment and Supplies |

# PREFACE TO TRAINING COURSE

Vlado A. Getting, M. D., M.P.H.
Technical Director, Mosquito Survey

The Massachusetts Mosquito Survey was organized in an attempt to survey the state for possible carriers of Equine Encephalomyelitis. During the summer and autumn of 1938 an epizootic of Equine Encephalomyelitis occurred in the southeastern portion of the Commonwealth. Concomitantly there was an epidemic of the disease among humans. This was the first time that Equine Encephalomyelitis had been found to infect man.

Laboratory experiments have shown that it is possible to transmit the virus of Equine Encephalomyelitis by mosquitoes.The epidemiology of the disease in Massachusetts in 1938 suggested that the mosquito was probably the vector concerned in its spread. Later in the fall of 1938 a mosquito survey was made on a small scale in a portion of the involved area.Unfortunately by the time the survey was started, the season was well advanced and only a few of the very late mosquitoes were found.

Epidemiological data suggests that Equine Encephalomyelitis is apt to re-occur in the same locality in succeeding years. Search for the localization of vectors of this disease was, therefore, in order. During the winter of 1938-39 plans were made for the organization of the present mosquito survey.By early spring the Department of Public Health was prepared to begin. Unfortunately funds for the Project were delayed in the General Court of the Commonwealth. A second delay was experienced with the approval from the Works Progress Administration for their portion of the Survey.Finally, by June ninth, the Project was fully authorized.Within a few days a skeleton force was organized, material prepared and on the nineteenth of June the training course for members of the Mosquito Survey Project was started.

The training course consisted of a series of lectures given by people in the various fields of Public Health. In addition to these lectures there were laboratory demonstrations and field trips.The object of the course was to teach the men the more common and important facts about mosquitoes, mosquito transmission of disease and Equine Encephalomyelitis. Field supervisors, crew foremen, and assistant crew foremen composed the bulk of the class. Several of the office personnel as the chief clerks, statistician, research worker and draftsmen were also present.There were in all about forty people in the course. The lectures were given in the morning and lasted fifty minutes with a ten-minute intermission in between.The afternoons were devoted to laboratory demonstrations and field trips.The first afternoon was devoted exclusively to acquainting the men with mosquito larvae and adults in the laboratory. Various insects often confused with mosquitoes were also included in the demonstration in order to enable the men to differentiate between these and mosquitoes. Various aquatic plants which afforded protection to larvae were brought into the laboratory and demonstrated to the class.

The other afternoons were spent in the field. The class was divided into five groups of about eight each. Each group was in charge of one entomologist. The groups were taken into selected places where methods of collecting larvae and adults were demonstrated.Thereafter the men made collections under the direction of the entomologists. In this way each man was able to make several collections of both larvae and adults on four successive days under the supervision of a trained person. On the last afternoon the field work was completed a little early, and a test was given to measure how much had been learned. This week of lectures and demonstrations gave the men sufficient training to enable them to teach their crews where and how to collect mosquito larvae and adults.

The lectures which follow are not formal presentations; they are based on stenographic notes taken at the lectures, which were given by the various speakers. In most instances they were presented to the speaker for correction and then edited by the technical director. They are not intended as formal lectures but are merely a record of the information which we attempted to impart to the class during a short intensive training course in the technique necessary for the proper collection of mosquito larvae and adults.

OUTLINE OF SURVEY - ANNOUNCEMENTS

Roy F. Feemster, M.D., Dr. P.H.
Director, Division of Communicable Diseases
Department of Public Health of Massachusetts

You who are here today have been called together for training in the methods of carrying out a mosquito survey.

The reason for our survey is that last year a disease, not a new disease particularly, but a disease caused by a newly discovered germ appeared in Massachusetts and caused the illness of thirty-four individuals, twenty-four of whom died. We do not know the future of this disease. It may be that we shall never have any larger number of cases in a single year than the number we had last year. On the other hand, we may have several hundred cases, many of which would be fatal.

It is fairly firmly established that the mosquito carried this germ to the persons who were ill last year. Because of this fact, the State Department of Public Health felt that we should have complete information about mosquitoes, about where we can find them in the State, and about the kinds we can find in the different parts of the year. The reason why we need to have this information is that, of the forty different kinds of mosquitoes we have in the State, only five have been incriminated as capable of carrying this disease which we know as "sleeping sickness." For this reason we want to know where those which have been incriminated are located. We are not interested where the other thirty-five are except that they are uncomfortable to have around, and because they are pests that bite us. The mosquito control work done recently in the State has been to rid us of the pest.

The mosquitoes are to be collected by Work Projects Administration workers. You who are here for this training will be doing it only incidentally. You men will be either supervisors or crew foremen, and the collectors will be working under your supervision. Your first job will be to see that the men get out in the field each day, and the remainder of your time will be spent going to boards of health to collect material which will have been obtained by volunteer collectors. They consist of a large number of citizens who will be collecting this summer. The specimens picked up by you must be forwarded to our laboratory.

The plan of this survey is very simple. We have men employed by the Work Projects Administration who will go to the cities and towns once each week and visit certain spots which already have been designated on maps. These maps you will have with you as you go out. There have been a sufficient number of men put on this project so that each town will be visited once each week, and from six to twelve different spots will be investigated to see whether or not there are mosquitoes or larvae in each spot. The number of places visited will depend upon how far these spots are apart, and will vary with local circumstances. Each collector should be able to visit somewhere between twenty-five and fifty different spots each week. Unless there is some reason for change, usually the same men will go to the same places each week. The specimens will be delivered to the crew foremen at the end of each day to be held until the supervisor picks them up. Once a week, on Friday, the field supervisors will come to Boston for a conference with the central office staff, and at that time they will bring in all specimens which they have collected from the crew foremen. These specimens will be taken to the laboratory where a group of entomologists will identify the mosquitoes and the information will be tabulated and spotted on maps.

The purpose of this course is to bring you men together and give you facts and information which you need to carry out this program. Besides outlining the plans for collecting specimens and delivering them to our laboratory in Boston, we have to go over the methods of collections, the duties of each one of the workers, and then outline very carefully the plan of operation. In addition, all field workers need to be extremely well-informed about mosquitoes because everywhere they go citizens will be asking questions about them. They may also ask questions about sleeping sickness, and so for this reason the training which you will have this week will include information in regard to all these questions. You will be told not only about mosquitoes and encephalitis but about diseases other than "sleeping sickness" which can be carried by mosquitoes. After we have conveyed to this group the information in regards to the project, it will then be the job of the crew foremen and the supervisors to go back to the field and train the field collectors. Of course, they do not need as much information as you do. You will be visiting boards of health, summer camps and Civilian Conservation Corps camps to pick up specimens and talk with someone in regard to what it is all about. The other collectors are not here because of the added expense. It is up to you to give them the necessary instructions; show them what to do with mosquitoes, where to look for larvae, and what to do with the larvae after capture.

There are a number of things in the way of announcements which I should like to make before we go into this course, so I am going to pass out some printed materials: Program of Course, Encephalitis, Mosquitoes and Learn about Mosquitoes.

You will notice in the program of the course that we have obtained the services of a number of men who are experts in this line. The mornings will be spent here in this room, with breathing spaces in between lectures. The afternoons will be spent in demonstrations. This afternoon, at 2 o'clock, report back at the laboratory. You will be taken upstairs and given an opportunity to see specimens at close range. You will also be given other information which you will need when you get into the field. Tomorrow afternoon you will be transported by automobile out to the field places where mosquitoes or larvae can be found. Thursday afternoon, you will have another period in the laboratory.

# INSECTS

Professor Charles T. Brues,
Biological Laboratories
Harvard University

Insects form the largest group of animals on earth and from the mere fact that they are so abundant and are represented by so many different species it is difficult to give any adequate account of them in a single lecture of this sort. There are, however, certain general characteristics with which you should become familiar if you are going to be occupied with insects this summer.

In general there are two striking characteristics of insects: they are small or very small animals in which the body is divided into three distinct, separate parts, which we call the head, the thorax, and the abdomen.In addition the thorax bears two or rarely one pair of wings which enable the animal to fly. Some kinds, however, like the parasitic lice and fleas,are without wings and of quite different appearance. The insects are the only animals besides birds which are provided with organs of flight. The thorax is separated into three more or less separable parts and in addition there are three pairs of legs which enable the animal to walk or run. The presence of these six legs is a characteristic of insects which does not vary and which enables us to recognize them as members of this group of animals.

If we examine the structure of an insect more closely and look at the head we see that it bears on each side a large oval structure which is usually brown, red, or black. These are the compound eyes which serve as the main visual organs of the animal. Their structure is extremely complicated and we cannot go into it at this time. Arising from the front of the head, near these eyes, is a single pair of jointed filaments known as the antennae. These are composed of a number of pieces and form a flexible structure which bears some of the important sensory organs. By means of these the insect smells and this sense is extremely acute, probably more so than in any other group of animals. Consequently, they can detect odors at very great dilution and they are able to find their food-plants or their mates from surprisingly long distances. At the forward end of the head there is a pair of jaws,fitted for biting; but instead of moving up and down, like our own, their movement is from side to side. They vary greatly in shape and size in different insects.

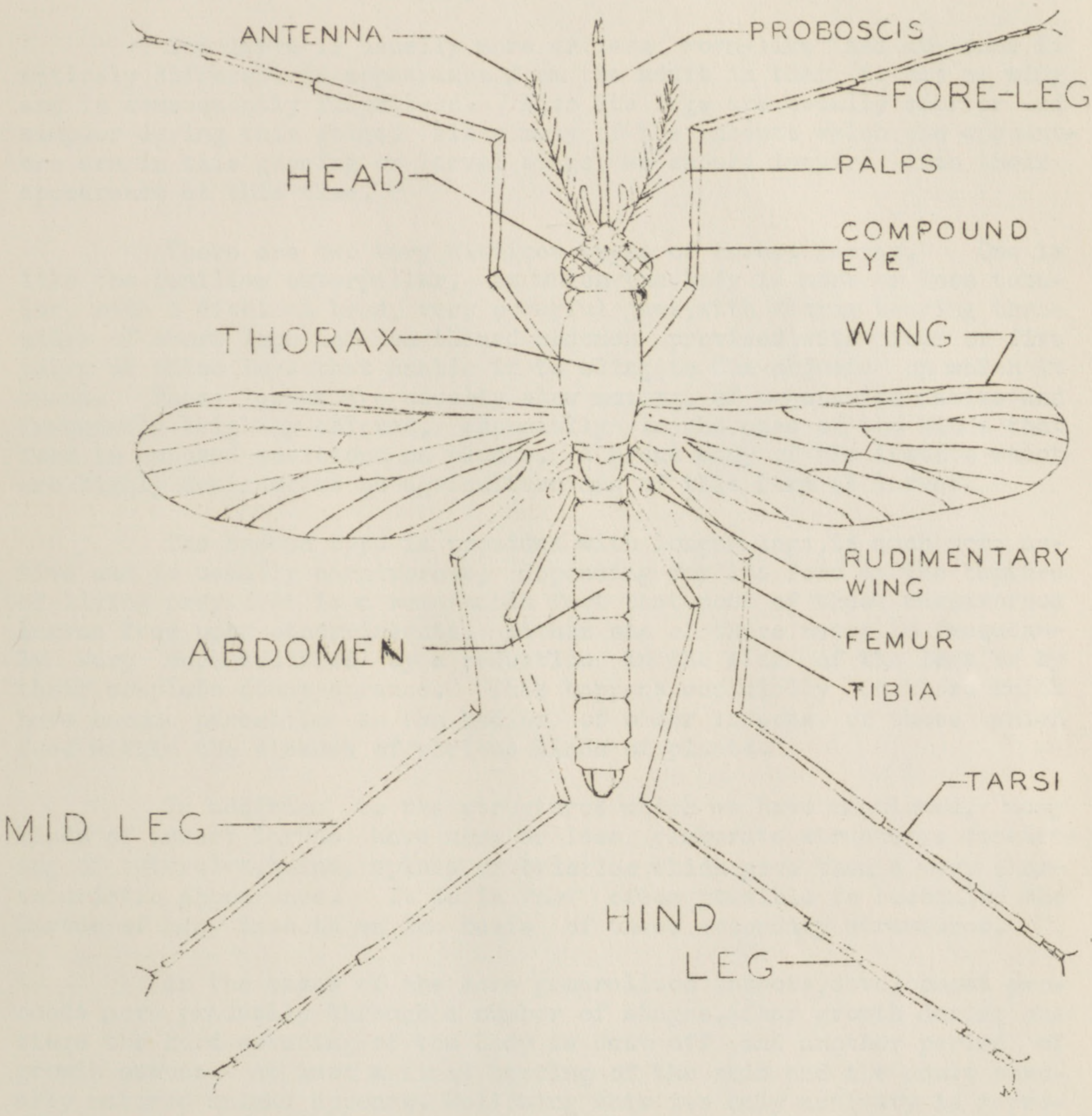
A remarkable modification of these jaws is encountered in insects which suck blood or the sap of plants; thus in mosquitoes, fleas, and many other forms, the jaws together with certain other of the mouth parts, are drawn out into long stylets. By means of these they are able to pierce the skin or plant tissues and suck up the liquid nourishment. On the front of the head there are three accessory visual organs, known as ocelli. These are small, simple eyes and serve the insect to see objects close to its own body.

The middle portion of the body which we said was known as the thorax contains mainly the muscles which move the wings and legs and is thus, from a physiological standpoint, different from the head, which serves for sensation and feeding, as we have already seen. The wings are parchment-like, flat structures which vibrate at a very rapid rate during flight. Sometimes this rate of movement is so rapid that it produces a hum, like the familiar noise of the bloodthirsty mosquito. From the standpoint of classification, the wings are also very important structures as the thickened veins which traverse their surface form characteristic patterns that are very useful in recognizing the different groups.

The legs of insects consist of a series of more or less similar pieces, most of which are represented in all kinds of insects, although their size and form varies greatly in connection with the habits and activity of the different kinds. Each one is attached to the thorax at the side of each of the three thoracic parts. Next to the body there is usually a large rounded, oval piece known as the coxa. Following this is a small, slender section, which serves to articulate the coxa with the large thigh or femur. This femur is frequently enlarged, especially in insects like the grasshoppers, which jump, since in this case the large muscles are enclosed in this section. Following this is a long, more slender piece or shank, known as the tibia. It generally has two strong spines at the tip upon which the animal walks. The last section, or tarsus, includes a number of short pieces, generally five in number and this bears at its tip two sharp claws. In many insects there are pads or sucker-like structures between these claws which are adhesive organs that enable insects like the housefly, for example, to walk upon glass or other slick objects.

The hind part of the body, or abdomen, houses mainly the organs which are concerned with digestion, storage of food and reproduction. It is composed of a number of more or less similar pieces which fit together somewhat like rings. Their connections are quite flexible so that the parts of the abdomen can be moved upon one another to a much greater extent than the parts of the thorax. It bears no appendages except at the tip. There we find, sometimes in the female, a structure for laying the eggs which may even be modified into a sting, like that of the wasps or the bees. In the male insect there are sometimes appendages of various shapes which are secondary sexual structures useful during copulation.

So far, of course, we have been describing the adult insect but all of us undoubtedly know, for example, in connection with butterflies, that the young insect is very different in appearance from the adult. These changes which go on during development are known as metamorphosis and they are essentially similar, although more complicated than the well known development of the frog through a tadpole stage. Almost without exception insects develop from eggs which are produced in large numbers to be deposited in various places by the mother. Compared to the size of insects their eggs are rather large and like the eggs of birds contain a large amount of food material. Ordinarily the insect egg is oval and provided with a very tough shell. However, they vary considerably in shape and are sometimes strikingly colored or provided with peculiarly shaped shells. The female insect is fertilized only once during her life but is commonly able to produce a large number of eggs. This is undoubtedly one of the reasons why insects are so abundant.




A GENERALIZED DIAGRAM OF A FEMALE MOSQUITO.

In the more primitive kinds of insects like the cockroaches, the young which hatch from the eggs, are very much like the adults, but in the more highly modified groups there hatches from the egg a very different sort of creature. This is known as a larva and is represented in the familiar butterfly by the caterpillar.

The larva is usually more or less worm-like and at once is entirely different in appearance from the adult in that it has no wing and is consequently flightless. Also its legs are usually shorter and simpler during this stage. Since many of the insects which one encounters are in this growing or larval stage, we should inquire into their appearance at this time.

There are two very distinct types of insect larvae. One is like the familiar caterpillar, in which the body is more or less tubular, with a distinct head, very powerful jaws, with thorax bearing three pairs of short legs and lengthened abdomen provided with four or five pairs of false legs that enable it to cling to the objects on which it feeds. These larvae are usually slow moving, of vegetarian habits and frequently brightly colored, especially in the case of the kinds that feed in exposed positions on plants. A great many of the insects which are highly destructive to agriculture are of this form as larvae.

The second type is provided with longer legs, is much more active and is usually carnivorous, depending for its food on the capture of living prey. It is a remarkable fact that most of these carnivorous larvae feed upon other insects. Either one of these types is frequently very much modified by a reduction in the size of the legs or by their complete disappearance. This happens especially in those which have become parasitic in the bodies of other insects or those which feed within the tissues of various kinds of plants.

In addition to the structures which we have mentioned, many kinds of insect larvae have more or less elaborate structures consisting of tubercles, horns, spines or bristles which give them a very characteristic appearance. It is in fact often possible to recognize the larvae of many insects on the basis of these secondary structures.

In the cases of the more generalized insects, development proceeds more gradually through a number of stages. After growth during one stage the hard covering of the body is cast off and another period of growth ensues. At last a final casting of the skin and the adult sexually matured animal appears. Following this its only activity is reproduction and feeding as it does not increase in size or change otherwise. In the case of the higher insects where there is a larval stage this does not pass directly into the adult but a resting or pupal stage follows the larva and from this pupa the adult appears.

With this very brief account of the insect itself we may inquire as to how it gets along in life and what internal organs are concerned in performing the various life processes. Aside from feeding and growth we know that all animals have to be provided with some sort of an apparatus for breathing and for the circulation of blood in the body. In addition, of course, they must be provided with reproductive organs to allow for the propagation of their kind.

In the case of insects the bodily functions are performed in **a more or less** different way from that with which we are familiar in higher animals. One of the most striking peculiarities of insects is their method of respiration. The respiratory system opens on the body by a number of paired pores or spiracles. These openings are connected with a complicated system of tubes which branch into very fine divisions and are to a very considerable extent anastomosed together. In this way the necessary oxygen is carried to all parts of the body. This arrangement which is known as the tracheal system is sometimes provided in very active insects with large bladder-like swellings which aid in ventilating it.

The heart is a very simple affair which lies near to the upper wall of the body. It serves to pump the blood slowly and as there are practically no blood vessels the blood moves very slowly among the internal organs which are bathed in it. The main function of the blood, therefore, is to distribute food material and its respiratory function is very slight. The alimentary canal is more or less similar to that of all the higher animals, consisting of a long, frequently complicated tube to which the various digestive glands are connected. On account of the variety of insect food there is naturally a considerable variation in the structure of the alimentary canal.

The nervous system is very highly developed, consisting of a large complicated brain in the head and a secondary brain in the thorax, the latter controlling most of the motor activities of the animal. For their size insects are very powerful creatures and they move very rapidly, consequently they have developed a very powerful muscular system, the greater part of this being confined to the thorax. This is due, of course, to the fact that both the wings and the legs are associated with this part of the body.

Compared to their size also the reproductive system, at least of the female, occupies a very considerable part of the abdomen. A single insect commonly produces several hundred eggs and occasionally the number mounts into the thousands. These are produced in fan-like ovaries consisting of numerous tubes in which a long series of eggs are in process of formation continuously.

As to the habits of insects, about one half of the living kinds feed on plants and it is some of these that are so important to agriculture and horticulture as they destroy important food plants of man. Many others serve more or less as a check in the vegetarian forms since they capture them for food. Another extensive series are parasitic, living in the larval or growing stage in the bodies of other insects and a few actually live as parasites of mammals including man. Some of these latter are internal parasites like the larvae of the bot-fly and others live on the surface of the body like the fleas and lice. Others like the mosquitoes, are in a sense parasitic in that they suck the blood of man and higher animals. It is amongst these latter parasites that we find some of the most important enemies of mankind since many of them carry organisms which cause human diseases. It is, of course, in this important activity of mosquitoes, namely the transmission of equine encephalomyelitis, that this course of lectures has been prepared. The specific relation and importance of these insects is to be covered during the later sessions of this course.

John E. Gordon, Ph.D., M.D.
Professor of Preventive Medicine and Epidemiology
Harvard Medical School and School of Public Health

The 1939 Mosquito Survey of Massachusetts is a project concerned with public health. It is perhaps worth while to point out that the reason for undertaking the work is the same one that is responsible for the beginnings of many other public health studies. In general, public health service was organized in this country, as in most countries, to meet a particular emergency. For this mosquito survey, the reason was the unexpected recognition of a new kind of encephalitis of man, presumably transmitted from other animals by mosquitoes.

As public health developed and projects of this nature became more and more frequent, it became necessary to carry on sustained programs directed towards the reduction of unnecessary sickness and death and to improvement in community health. Before public health work had long been under way, it became apparent that record keeping was an important part of the program.

As far back as we can go in public health studies, we find evidences of the need of record keeping. John Snow, in his classical investigations of cholera in London many years ago, left records of his work that are a model of recording careful observations. Budd's study of typhiod fever in 1854 furnishes another classical example of what records should be in public health investigation.

Why do we need records? We need careful recording of services given and results accomplished over a period of time represented by a special study, for these reasons: that such records mark the scientific method in public health, and that appreciation of the need for tangible recorded fact be realized in order to properly analyze results. Records also justify expenditure of effort, and determine that what is accomplished in the day's work fits into the predetermined plan of what it is desired to attain. Records are necessary to determine, day by day, the progress of any study and whether the desired ends are being accomplished. You must take stock from time to time by looking over what has been done. It is absolutely essential to have adequate records in order to justify money spent.

It is important to have records for improvement of services. A given method in this particular project cannot always be judged by its usefulness in some other study. Localities and types of problems differ, so that it is necessary to have specific records of individual accomplishment. Adequate records require that a good deal of the planning be done in advance about what is to be recorded and how it is to be done. Public health records and public health activities, in general, are of two kinds. The first is related to routine activities, the second to special investigations. Included in the first category are records which deal with vital statistics. The keeping of these records is a civic requirement, actually not a function of public health authority nor its sole responsibility. A knowledge of births, deaths, marriages and other vital phenomena is of value in many activities of goverment. The system of vital statistics has developed slowly in the United States from its start about sixty years ago, and it is not yet complete.

Another type of routine record which has to do with communicable disease practice is called case reporting. If a case of communicable disease occurs in a family, according to law it must be reported by the doctor, the nurse, or the head of the family. Other common records have to do with accomplishment in the field of tuberculosis, chronic disease, such as heart conditions and cancer, school health problems, and physical examinations of well babies.

The Mosquito Survey is a part of the efforts directed toward control of cummunicable disease but belongs to the second class of activities, the special studies. The aim is to determine the relation of the mosquito to disease in Massachusetts. To accomplish that, information is necessary about when these diseases begin, how many cases there are, how long they persist, and the sources of infection.

From the standpoint of satisfactory records of accomplishment, public health records are not very old, probably about thirty years. Because public health problems are so diverse, and because public health itself is of relatively recent development, much time passed before uniform comparable records became available for the country as a whole.

There is a distinction between the ideal record and the satisfactory record. Our aim in this particular mosquito project is to try to have satisfactory records. It is my plan to give you some idea as to what constitutes satisfactory records. Record keeping apparently had its beginnings in hospitals, since hospitals for years, have been putting down facts about sick people. Public health records dealing with healthy persons and not with disease were first patterned after those of sick people. Gradually they have acquired their rightful individuality. The records of the physician and nurse are not necessarily the ideal records for public health.

Kinds of records: A satisfactory record is one so made that any one can take the information and study, analyze, and rearrange the factual information which you, as an individual, have collected. It is necessary that the records be adequate. This problem of a mosquito survey is an individual, single, particular interest having very definite ends. We must be certain that what we include on record forms gives that kind of information. It is wholly apparent that, if we took a poll of the various workers in this project, we would find that different members had different interests. One person would be interested in how far a mosquito could fly, another in whether it comes from fresh or salt water, and still another in the question of whether it did or did not bite. We all have different interests, but we must have records which fit the needs of the whole group and of the project in general.

Another essesntial feature of records is orderly arrangement. The best opinion in the world and the best recorded facts are useless unless you can find them. It is also essential that these records be carefully preserved. If you are going to preserve records and have an orderly arrangement, the facts must be entered according to an accepted classification and make use of an accepted terminology. Scraps of information, therefore, are practically useless.

No one likes to keep records, but they must be kept or it is impossible to make use of what is learned. What are the uses to which we are going to put these records? Why are they kept? Certainly the first use is to assemble pertinent facts, not of individual circumstances or conditions but the relationship of all circumstances as they fit into the problem as a whole. It isn't what we can find out about mosquitoes in Arlington that is important, but what we find out in Arlington which relates to the mosquito project as a whole, and the relation to disease transmission. Whatever practical value this mosquito survey may have depends on the rational plan for improved public health work which may be developed from the facts determined. It is not the facts in relation to one locality which are important,but the facts from the State as a whole.

Records are useful to the worker,and to the agency responsible for the project, as protection against unfair or unwarranted criticism. If you have written down what has been done, you have proof as to your activities. You can show how the time was spent in this investigation, and to what purpose it was directed.That information is of distinct importance in connection with the appropriation of necessary funds for support of this project.

Legal requirements are another important consideration.You can always justify action if you have adequate records.

Records are important in determining a fair distribution of duties. Some parts of the project will certainly be more time-consuming and require more exactness than others. Therefore, the distribution of duties and responsibilities in a fair manner among the various personnel is aided by adequate records.

The Plan of Records: A point to emphasize is that each person engaged in a project should have sympathy and understanding of the work for which others are responsible. The field worker should not feel that his obligation is just to deliver material to the men in the laboratory. The laboratory man must know the circumstances under which the material was collected, in order to properly interpret what he sees. If adequate field records accompany the material collected,the laboratory man is aided and the field worker is assured of the information he wants. Coordinated effort between field and laboratory is largely dependent on the written record which passes from one to the other.

It is important to report to the Director of the project, just how the records are working.That can only be determined by actual trial in the field. If you find them unsatisfactory for recording the information you are able to obtain, report that fact, so that the necessary changes may be made and they become workable.We have never seen the perfect record form, so don't accept the ones you are using as being that. They likely have shortcomings, and these should be pointed out.

On first inspection of a record form, one finds that many different kinds of things are asked for. It is worthwhile to ask yourself certain questions about the information that is apparently desired.

1) Is it possible that the desired information can be obtained only with varying degrees of accuracy? Single out those items which must be done with utmost care and exactness. Some items can only be recorded with approximate accuracy.

Others can be determined with real preciseness.

2) Get an idea of the amount of time involved in collecting the different sorts of information a given record form asks for. Entering a locality you will have about so much time to devote to collecting material and making records. Look over the form and determine which are the more important items and about how much time you will have to spend with these. The remainder can likely be done in a fraction of the time. This assures maximum accomplishment.

Another essential of records is to so record the information that it can be used readily in administration, and in the evaluation of results. Some records are used principally for completing administrative reports, others for completing official records, and a third kind for statistical purposes. The records of this project largely serve this last purpose and also to evaluate results and determine conclusions from original investigation. The records require exactness and orderly arrangement to a greater extent than do administrative or civil records.

What are the aims of satisfactory records? The first thing to be emphasized is a wholly dispassionate statement. Avoid opinion as much as possible. The record you make should represent fact. It should contain as nearly an approximation of quantitative relations as possible. Be definite and try to think in terms of quantitative relationship. You probably will have several record forms and it is good to establish in your own personal work a system to follow in filling them out in series.

Uniformity. Many people will use these records, and the more nearly your records conform to a uniform pattern the better suited they are for analysis by someone else, and the more readily the work can be continued if a substitute is necessary. I do not want to leave with you the idea that the record is more important than the service. The record serves to show how well the service was performed. Nevertheless, from the standpoint of the project as a whole, from the consideration of what we hope to accomplish in the study of mosquitoes, and because of the wide extent of the work and the number of persons involved, perhaps it is fair to say that the record you make is just about as important as the service you render. This is usually true of a cooperative effort where a considerable number of people are involved.

After records have been made, they must be used in order to justify their existence. No matter how good records are, they are of no purpose unless the information is available and is used. There is a huge amount of information buried in hospitals and in health departments where it is masked, never found, and never put to practical use, largely because of superfluous, inconsequential and irrelevant detail. In studies and investigations such as this, we find it necessary to organize records so that the yield of worthwhile fact is appreciable. The prime essential is to separate significant from non-significant information. A good record is not voluminous. The shorter and more precise it is, the better it is. Brevity and preciseness characterize good records.

Granted then this first requisite of brief, precise records, the original record constitutes the raw material from which conclusions are drawn. No conclusion has greater value than that determined by the reliability of the original record. The fundamental success of programs like this depends on the original records.

We have emphasized brevity and preciseness,completeness of information is still another requisite. You will have various kinds of forms. All items must be considered. You can write "yes","no", or "unknown" but some answer must be given to every question.

The final analysis and conclusions depend upon the data you submit. They must be accurate in every detail. It is important to have records legible. Some people naturally write a better hand than others. Try to express correctly the statement you wish to make. Sharp, concise statements of a few words tend to be more accurate than lengthy dissertation.

The next important thing about good field records is simplicity. The need for simplicity can be expressed in the observation that records should be the servant and not the master of the field epidemiologist. The simpler records are the good records. Complicated records require much time of the worker in the field, and from the clerks who have to analyze these records.

Another point, most good field workers have some simple method of keeping their results always available. Sort and arrange the records in the field kit, using some kind of simple index. You can index alphabetically, geographically, by subject, or numerically. Usually in field work either alphabetical or geographical filing is best.

All observations made in the field should be recorded in the field. One of the poorest practices is to work all day collecting information and then try to write down what has been done after returning to the central office, or at home that night. Some details are bound to escape; in varying degrees, the record will be inadequate and inaccurate. Field records should be made at the time observations are made. Write down immediately where and when so many mosquitoes are collected. It is impossible to remember all of the details of a day's work. Furthermore, the only record that will hold in court or which will actually substantiate work is an original record made at the time of observation. A copy of a record is not legal.

When you leave a blank space instead of filling in all items called for in a record form, it may mean that the information was negative, that you forgot to ask about that particualr item of information, or that the facts were not obtainable. There are always these three possibilities, so follow the practice of recording "negative", "not obtainable", or "unknown". Make an entry for each of the items called for.

Don't be concerned about having to record "unknown"or the fact that you didn't have time to complete a particular assignment on a given day. If you should happen to strike some unusual circumstances, it may be that a part of the day's program cannot be accomplished. Don't hesitate to put down the fact that you were unable to accomplish what you had set out to do. Just state the reason it was not done, such as, "time too short".

Another point is that after the record is made and before it is turned in to the person responsible for filing, chec k it over and see if everything is accurate and that the form is complete.

I have given an indication of relative differences in the value of information. Many different kinds of information are collected in the field. All do not require the same emphasis, and all do not have the same value. What are the kinds of field information?

I) Objective information is something that you can see, feel, or hear. You can tell that a man is white. You can't tell what nationality he is; he tells you that, but it is a matter of objective information that he is white and not yellow.

II) Subjective information is a sort of hearsay evidence. This is information that someone else tells you, information that you learn about indirectly, and it is quite apparent that it often has less value than objective information. If you see a mosquito in a certain place, that is an entirely different circumstance than the situation where you learn from talking to the oldest inhabitant, that he has seen many mosquitoes in this collecting place. Subjective information is open to varying degrees of reliability and interpretation. If you see a man with a rash, that is good reliable information. If he says he has a headache, that is subjective information. Perhaps he has and perhaps he hasn't. What he calls a headache, perhaps you wouldn't.

III) Opinion is the third kind of information; it ranks below both objective and subjective information. Opinion is just about as good as the amount of experience the informant possesses. A person may say that there are many mosquitoes in a given locality. Your opinion of what constitutes many mosquitoes may be entirely different, even in the proportion of twenty to one. Things reported as opinion depend upon the experience of the observer, and rarely is the judgment of one person exactly duplicated by that of another.

IV) Speculation is the fourth kind of information; it is something which you have neither seen nor learned by first hand information. It is not even opinion. It is this sort of information in answer to your question, "Have you seen mosquitoes in this locality in the last day or two?" and the reply, "I don't think there are any mosquitoes over there right now, but my brother-in-law told my wife about two weeks ago that there were some there."

V) The fifth kind of information is that acquired by consulting proper authority. It is not evidence derived from your own observations, but is equally reliable and can be considered dependable, according to the source from which it was obtained. As examples, a mother's statement of the age of a child, or the recorded temperatures in a weather bureau.

You will always encounter incomplete or indefinite statements. If a person says he does not know his age, you can estimate his age and write "about thirty years old," or you can make the differentiation that he is a child or an adult if you can't estimate his age in any other way. This is far more satisfactory than the commonly encountered "age unknown".

The next thing to be emphasized is about dates. If you have a record which says "Has this patient had measles" don't write "yes". That is reinforced by no attempt to determine whether the statement is true or not. The answer "1932" gives indication of greater probable liability. In general, the more dates in field information the better.

In conclusion, all records of any health study or health interest, are the official property of the Department of Health. They belong to no individual, but are to be used for a common purpose by a group of workers. It is essential to have complete records. Records must be properly filled out and turned over to a person responsible for filing them. Personal notes do not enter into adequate record keeping. The field worker should use some simple form of filing system to keep records in order.

What you write on a record form should be entered with the idea that it is as important, significant, and intelligent as a telegram. Try to make statements so clear that there is only one interpretation. Many people are going to use these records and for many different purposes, so that the information itself must be open to only one interpretation.

# CHARACTERISTICS OF MOSQUITOES

J. C. Bequaert, Ph. D.
Consultant Entomologist

## I. Economic Importance of Mosquitoes.

The short lectures on mosquitoes by Dr. Tulloch and myself will be kept as popular and non-technical as possible. They aim at giving a few correct notions about these insects,which may improve the results of our survey.

A few words first about the economic importance of mosquitoes, as some notion of this will help in answering questions by the ordinary citizens you will have to inconvenience in your search for the pests. I believe that if the practical importance of mosquitoes, particularly to each individual and his family, can be brought home, few citizens will be unwilling to cooperate with us.

It may be emphasized that from the point of view of man's welfare, comfort and health, mosquitoes are by far the most important of all blood-sucking enemies of mankind. They are practically universal in distribution, very often breed in immense numbers, are extremely blood-thirsty, enter human dwellings commonly and often migrate some distance to do so, and finally they inoculate man and domestic animals with some very dangerous diseases. In many hot or moderately warm countries, it is often a question of who will rule, man or mosquito. This may happen even in the limited areas of temperate regions right here in New England.

In our area, mosquitoes are at present chiefly important as pests, that is, through the irritation caused by the bite. The reaction to mosquito bites varies from one person to another, and differs also with the kind of mosquito. In most persons, however, the reaction is sufficiently annoying to suppress any feeling of enjoyment at the beaches, woods, lakes, etc.. In some persons, particularly in children, the reaction is very pronounced, causing welts that may itch for days.

The damage done to babies, for instance, has not been sufficiently emphasized in my opinion, and it is a good point to bring out to mothers in the course of our survey. Sometimes the source of the annoyance is right near the house in poorly drained sewers,water cisterns, bird-baths, etc.. Of course, houses can be screened, but it is rare to find a house where every screen is perfect, and even then a stray mosquito may get inside if the pests are very abundant in the neighborhood. Screening, moreover, is of little use in summer resorts, camps, bathing beaches, etc., where people want to frolic, picnic, in the open.The annoyance and damage to domestic animals, in reducing the yield in milk, for instance, should also be considered. A serious pest of mosquitoes in a locality lowers the value of real estate. It has been shown by intelligent control measures in New Jersey, Long Island, etc., that where the mosquito pest has been dealt with effectively the value of real estate (due to increased demand) has gone up materially within a few years.

Mosquitoes also are the active carriers of many important diseases of man and domestic animals. These diseases are caused by certain peculiar parasites, germs, or viruses which in practically every case are not inoculated into man or animals in nature in any other way than by the bite of an infected mosquito. Such diseases are frequent in Massachusetts. I mention briefly some that are of importance to us. They are discussed elsewhere by General Russell.

Occasionally in the past, (1903-04) there have been outbreaks of tertian malaria in eastern Massachusetts, and now and then a case may still occur. We have the usual carrier of this type of malaria, (Anopheles quadrimaculatus) right in this vicinity; so that, if a malaria patient visits us during the summer a small epidemic is not impossible. Under present conditions, however, malaria dies out the next winter, probably because the few summer cases are adequately treated or leave the vicinity; while the few infected mosquitoes die or lose their infection.

Equine encephalitis, or sleeping sickness of horses, originally known only as a disease of horses, has been recently recognized in man in Massachusetts. Experimentally, this disease has been transmitted in the laboratory by eight different species of mosquitoes, and five of these occur in Massachusetts. Which of these is the actual or usual carrier in nature we do not know as yet. It is the occurrence of this disease in this State that prompts the present survey.

There are also a number of diseases in animals to be considered. A worm (Dirofilaria immitis), living as adult in the heart of dogs, and as larvae in the blood of these animals, has been found recently in eight dogs from Massachusetts by Doctor Augustine. This worm is transmitted by certain mosquitoes present in Massachusetts.

II. Mosquitoes and how to recognize them.

Let us now analyze a mosquito so that we may more easily identify the fellow. The body is divided naturally into (a) head, bearing mouth parts, beak or proboscis, eyes and antennae (feelers); (b) thorax, bearing legs (six, in three pairs), and wings (one pair); also halteres or poisers which are the modified hind wings; (c) abdomen, consisting of a number of rings.

The important characteristics of a biting mosquito are:
(1) the slender build, with long, thin legs and narrow wings;
(2) the long beak or proboscis, always much longer than the head;
(3) the thread-like feelers;
(4) the scales that cover body and wings; these are readily rubbed off.

As the scales produce the markings which are characteristic for the kind or species, mosquitoes should be collected with care, killed in dry tubes, and handled as little as possible after death (shaken out gently into the vial or box in which they are to be shipped to the laboratory);

(5) the rather small size; our largest mosquitoes are well below one-half inch in length (9 mm. to be exact).

Note also that only the females bite (in the species that suck blood). Males have a proboscis, but do not bite. They have feathered feelers; females do not. Males are usually found in low vegetation or swarming and buzzing in the air.

These swarms sometimes may be mixed with females, when mating occurs. Males sometimes and females more rarely may be found visiting flowers. Sometimes males are found in houses attracted by light, but they will never attempt to bite a person.

Non-biting flying insects sometimes mistaken for mosquitoes include midges and crane-flies. But none of these have scales on their body or wings. Midges have no long proboscis. Most crane-flies are larger than mosquitoes and have no beak; a few have a beak, but do not bite with it. Crane-flies have given rise to the tales of the giant (New Jersey) mosquitoes.

III. Other biting flying insects of Massachusetts:

Punkies or no-see-ums (Culicoides) These are very small, with short legs and very short beaks (shorter than the head), body and wings bear no scales, but hairs instead.

Black-flies (Simulium) are smaller than mosquitoes, short and squatty, and more or less hunch-backed. The proboscis is very short, not quite as long as the head, which bears very short feelers, or antennae. There are no scales anywhere on the body. The wings are glossy and practically without hairs.

Horse-flies and deer-flies (Tabanidae), are fly-like, thick-set with short legs. They do not have the thread-like feelers (or antennae) of the mosquitoes. There are no scales on the body, and the proboscis is short.

Stable-fly and horn-fly Both look like the ordinary house-fly, but have a long beak with which they can suck blood through the skin. The stable-fly is the size of a house-fly; the horn-fly is much smaller. The stable-fly attacks animals and man. The horn-fly rarely bites man, but commonly attacks cattle.

If you are bitten by something that flies, it might be well to collect it, and send it to the laboratory. All biting insects are under suspicion as possible vectors of disease.

Joseph C. Bequaert, Ph. D.
Consultant Entomologist

In yesterday's lecture I gave you a few pointers as to how to make sure that a flying insect, whether biting or non-biting, was a true blood-sucking mosquito. To an ordinary person a mosquito is just a mosquito and if he is told that not all mosquitoes are the same, as likely as not he will not believe it. If finally you succeed in convincing him that there are several different kinds, or species, of mosquitoes in his locality, he will probably ask you why waste time on such matters. Why not simply destroy all mosquitoes without worrying about what kind they are? The answer to this question is that all the several kinds of mosquitoes are not equally important in a given locality, either as pests or as carriers of disease.

To make this clear let us consider the case of malaria and mosquitoes. That mosquitoes might have had some connection with malaria was suspected many years before proof could be brought. But no proof could be given until two matters were settled, first, that malaria was caused in man by the development in the blood of a definite, peculiar parasite, secondly, that this parasite was carried from sick to healthy people not only by a mosquito, but by a very special kind of mosquito, the so-called anophelene or dappled-wing mosquito. This discovery that a very special kind of mosquito was involved, explained at once why malaria causes epidemics only in certain definite regions; while mosquitoes are found nearly everywhere. It also gave the key to the control of malaria. For the species of mosquitoes differ not only from one another by certain external features such as the way they sit, spots on the wings, rings on beaks or legs, banding of abdomen, stripes or spots on thorax, etc.

Not only do mosquitoes differ from one another and thus may be readily identified; but different species of mosquitoes live under various conditions. The full grown flying mosquito of a particular species differs from one of another species in its life habits and manner of living. The early immature forms of mosquitoes, the larvae of wrigglers as they are commonly called, are likewise different in their habits. Some species lay their eggs in clear fresh water, some prefer quiet small bodies, others prefer running streams. Several species of mosquitoes breed only in brackish or salt water. Therefore, if you wish to control malaria, you have to know not only how but where to destroy the particular specie of mosquito that carries malaria, either in the flying stage or as a wriggler. If you concentrate your efforts, time and money on controlling that one kind of mosquito you may get results; whereas if you attempt to destroy all mosquitoes you will waste your endeavor on a job which is in most cases economically impossible to complete.

This is equally true for any other disease carried by mosquitoes and also for mosquitoes that act merely as a pest. Mosquito nuisance in a given locality is due almost always to one or a few species, the others being unimportant for one reason or other. The pestiferous species, however, will differ from one locality to another. Near the salt marshes the one or two species that breed there in abundance will cause the trouble; but these will not be found in western Massachusetts. Some of the salt-marsh mosquitoes may migrate many miles from their breeding places. Consequently, if they invade a city or town, no amount of control work done in or near that city or town ever will reduce the mosquito nuisance.

As the present survey is concerned with mosquitoes as possible carriers of equine sleeping sickness, you will now realize why we want to find which species of mosquitoes occur, or at any rate which species are prevalent, in every section of the State. One of the things, for instance, we want to find out, is how far away from salt marshes the salt marsh mosquitoes may migrate in Massachusetts.

When people began to realize how important mosquitoes were to mankind, not only as a pest, but also as carriers of disease, entomologists spent a tremendous amount of time trying to distinguish the different species, both in the flying (adult) and wriggler stages. At present it is possible to recognize some fourteen hundred kinds of mosquitoes throughout the world. Fortunately we have but a small number of species in New England namely, thirty-nine. Of these, thirty-six have been found in Massachusetts. Even more luckily, only eight or ten species are ever abundant enough to act as pests or, to be efficient, as carriers of disease. These eight or ten species may be called the "criminals" or "public enemies" among mosquitoes. The chief job of controlling mosquitoes is to spot the "criminals". As is the case with criminals in human society, this is most easily accomplished when the whole population is kept track of by some method of personal identification. This is one reason why entomologists spend so much of their time trying to recognize and classify all the different species of mosquitoes, whether "criminals" or not. There is, of course, the added reason that some supposedly innocent mosquito may turn out eventually to be a "criminal".

The job of recognizing the different species of mosquitoes calls for special knowledge and will be done in our survey by experts. I shall content myself here with pointing out how these various species of mosquitoes differ, in the way they live, particularly with regard to their feeding habits. This will be helpful to you in getting as much as possible all the species occurring in one locality.

I. Strictly domestic mosquitoes. These mosquitoes not only enter human dwellings freely in order to bite people and animals, but they breed near the houses in sewers, water barrels, cesspools, etc., or sometimes even inside the house. In Massachusetts only one specie, the so-called "rain-barrel" or "house" mosquito (culex pipiens) is a true domestic mosquito.

II. Semi-domestic mosquitoes. These breed a short distance away from human dwellings, but generally under conditions created by man: water standing or flowing very slowly in pastures; water impounded by dams. The adults also enter houses and stables freely in order to bite. The best local examples of this type are the malaria mosquitoes of which there are four kinds in Massachusetts, two of them, Anopheles punctipennis Anopheles quadrimaculatus, are fairly common, and two Anopheles maculipennis and Anopheles walkeri, are rare. The adults of these mosquitoes often pass the winter in cellars or barns.

III. Wild, migrating mosquitoes. These breed far away from houses or towns, but the adult females travel considerable distances to human beings and animals, in order to suck blood. The most notorious examples are the salt-marsh mosquitoes, of which there are two kinds in Massachusetts: (A) The brown salt-marsh mosquito, Aedes cantator, without white ring on the beak. It appears first in Spring, about the middle of April: (B) The white-marked salt-marsh mosquito, Aedes sollicitans with a white ring about the middle of the beak. It appears later, about the middle of June. Both are fierce biters and migrate up to thirty or forty miles, flying usually against the breeze.

IV. Wild, non-migrating, biting mosquitoes. These breed usually in the woods or swamps and attack people who venture there; but the adults do not migrate. They will annoy only people in houses or on porches where buildings are placed close to or among their mosquito breeding places. The majority of the thirty-six Massachusetts species probably are of this group. The most important is the inland swamp mosquito, Aedes vexans; the woodland pool mosquito, Aedes stimulans; the tree-hole mosquito, Aedes triseriatus.

V. Wild, non-blood-sucking mosquitoes. Although they have a beak like other mosquitoes, they neither bite either man or animals. There are a few of these in Massachusetts, the best known being the pitcher plant mosquito, Wyeomyia smithii.

# DEVELOPMENT OF MOSQUITOES

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Chief Entomologist

Before discussing the development of a mosquito let us consider the development of insects in a general way.

In the insects we have four methods or four types of development which can be expressed as (1) no change (2) gradual change (3) half change and (4) complete change.

In the first type there are but two stages in the life cycle, the egg and adult. The form that issues from the egg is a miniature of the adult and simply increases in size during development. Since no change, except in size, occurs this is called development without change (ametabolous). An example of this is the silverfish or silverfin, an insect which is found in cellars, around waterpipes, in bathtubs, etc. In insects of this type the eggs and adults are found in the same places.

The second method of development is by gradual change in which there are three stages in the life cycle, egg, nymph and adult. The form which issues from the egg resembles the adult somewhat but grows to look more and more like the adult as it increases in size.In this type of development gradual changes take place until the adult stage is reached and thus we use the term <u>gradual development</u> (paurometabolous). Examples of this type of development are cockroaches, grasshoppers, katydids,etc. All three stages in development are found in the same place, i.e. eggs, nymphs and adults of cockroaches are found in sink cabinets and the like.

The third type of development is by half change.There are three stages in development namely egg, nymph (naiad) and adult. The egg and nymph stages are passed in the water whereas the adult is a free flying insect. This is the first instance in which we have one portion of an insect's life cycle being passed in a different place than the rest of the cycle. An example of the insect having this type of development is a dragon fly or a devil's darning needle. This insect lays its eggs in the water. After a period of time the egg hatches and the nymph(naiad) emerges and swims about in the water. It remains in this stage for about two years and then leaves the water as a free flying insect. The nymphal stage in the water bears some resemblance to the adult insect and therefore, this type is called half change (hemimetabolous) development.

The fourth type of development is the one in which there is a complete change occurring between the immature and adult stages. There are four stages in this cycle, namely egg-larvae-pupa-adult. The larval and pupal stages are known by many terms as may be seen below:

| Stages in Complete Development: | <u>Egg</u> | <u>Larva</u> | <u>Pupa</u> | <u>Adult</u> |
|---|---|---|---|---|
| | | wriggler | chrysalid | |
| | | maggot | cocoon | |
| | | caterpillar | | |
| | | grub | | |
| | | worm | | |
| | | inch-worm | | |

The egg and larval and pupal stages are usually passed in one environment or place and the adult in another place so that these insects are like the dragon-flies in this respect and different from the cockroaches and silverfish. We can sum up the function of each stage as follows:

| Stage | | Function |
|---|---|---|
| egg . . . . | a. | Connects one generation with next. |
| | b. | Stage in which insect sometimes passes unfavorable periods such as overwintering |
| larva . . . . | | Feeding stage - period of growth |
| pupa . . . . . | | Period of internal reorganization preparatory to becoming a flying insect. Insect does not feed and is usually non-mobile during this period |
| adult . . . . | a. | Period of sexual activity |
| | b. | Period of egg laying |

Some of the insects which develop by this method are ants, bees, wasps, beetles, butterflies, moths, June bugs, mosquitoes, midges, house flies, horse flies, etc..

## SUMMARY OF METHODS OF DEVELOPMENT IN INSECTS

| Type | Stages | Examples |
|---|---|---|
| No change | egg - adult | Silver fish |
| Gradual change | egg - nymph - adult | Grasshopper<br>Cockroaches<br>Squash bugs, etc. |
| Half change | egg - nymph (naiad) adult | Dragon-flies<br>May flies |
| Complete change | egg - larva - pupa - adult | Mosquitoes<br>Flies, Bees, etc. |

Let us consider the life cycle of a mosquito.

I Egg

The eggs are very small and difficult to see without the aid of a hand lens. In some species (rain-barrel mosquito) the eggs are laid in a boat-shaped mass or raft which floats on the surface of quiet water. In the malarial mosquito the eggs are laid singly and are provided with special floats which keep them at the surface of the water. In most other species the eggs are not provided with special structures, for keeping them afloat (Fig. I). Consequently they sink to the bottom and are very difficult to collect. The number of eggs laid by one female mosquito is about 150-200.

II Larva

The egg hatches when conditions are favorable and the young larva or wriggler swims actively about in the water. It takes in food

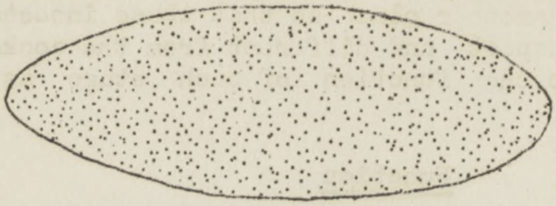

Fig. 1.-The egg of the yellow fever mosquito

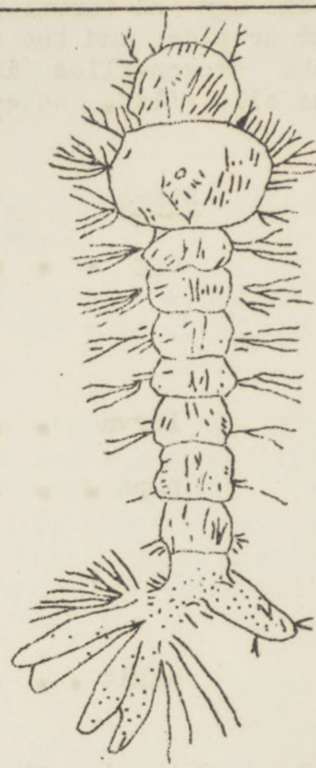

Fig. 2.-Yellow fever mosquito larva

Fig. 3.-Yellow fever mosquito pupa

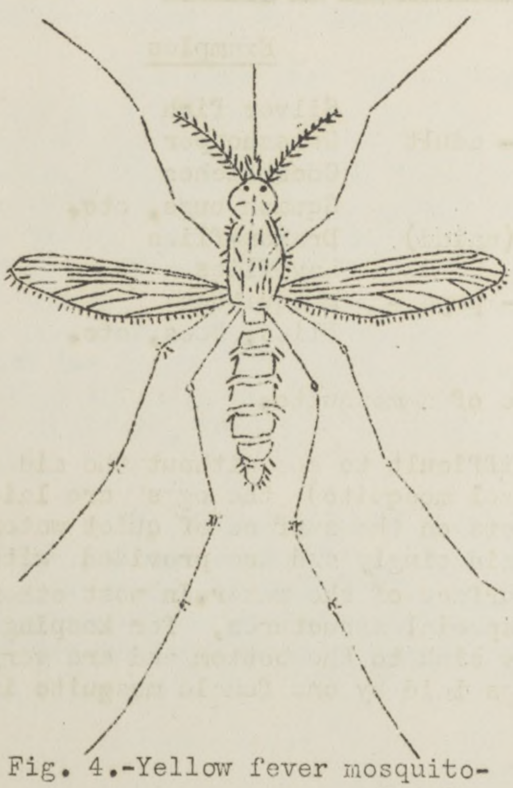

Fig. 4.-Yellow fever mosquito-female

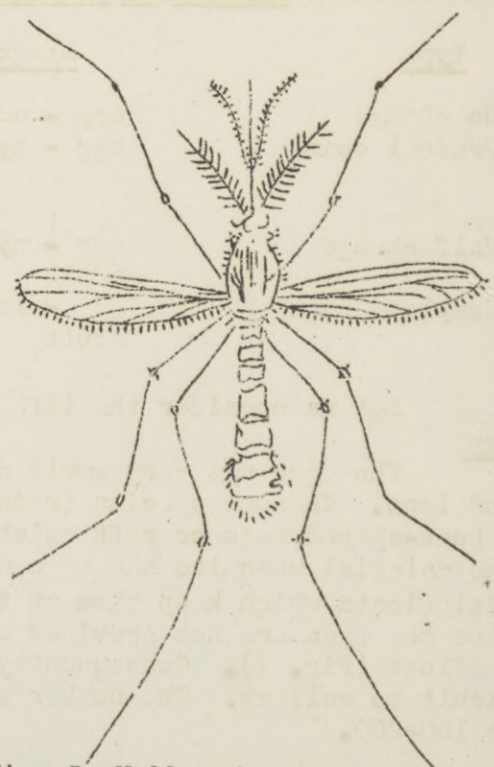

Fig. 5.-Yellow fever mosquito-male

and is known as a first stage larva and increases in size. It then sheds it s outer skin (molts) and a new and larger one develops which permits it to increase in size again. This is known as the second larval stage. By successive molts it passes into the third larval stage and finally into a fourth or full grown larva. It is in this last larval stage that it is possible to identify the species without difficulty.

The larva when full grown is about one half inch long.Although it lives in the water it must come to the surface to take air. It is provided with a special tube which it puts through the surface of the water to secure air. (Fig. 2).

Most mosquito larvae rest with the head hanging down at an angle from the surface (Figs. 6 and 7). The malarial mosquito,however, differs in this respect and assumes a position parallel to the surface,(Figures 6 and 8).

III Pupa

After about ten days in the larval stage, provided that conditions are favorable, the mosquito changes into a pupa (Fig. 3). In this stage it breathes by means of a pair of trumpets situated on the head. During this period it takes in no food. It is mobile and swims about rapidly when disturbed from it's resting place at the surface of the water.

During this period the insect is undergoing internal reorganization in preparation for becoming a free flying mosquito. The pupa stage is short, lasting about three to four days under favorable conditions.

IV Adult

When the adult mosquito is fully formed within the pupa it forces it's way out through a slit on the upper side of the pupa case and rests on the cast pupal skin. After a period of an hour or so,the adult mosquito's wings dry and it is ready to fly.The males and females differ in appearance as can be seen from the Figures 4 and 5 .

This difference is clearly seen in the region of the head where the antennae of the male are large and feathery while those of the female are small and covered with few feathers. The male mosquitoes are sometimes called "featherheads".

Another important difference between males and females is that the females usually suck blood while the males do not.The males are said to feed on nectar and plant juices and consequently are seldom seen.

The females are the important agents in the transmission of disease since they suck the blood of an infected man or animal which contains the germs of disease and then bite another non-infected person and thus spread the disease.

The female mosquito has mouthparts which are very effective for sucking blood.These mouthparts are enclosed in a sheath which slides backward as the sharp mouthparts are forced into the skin. This sheath is forced backward so that when the mouthparts are fully inserted this sheath is bent double on itself underneath the head of the mosquito. After the

Figure 6. Life cycle of the rain barrel or house mosquito (Culex pipiens)
1. eggs in a raft 2. newly hatched larvae 3. full grown larvae - note breathing tube piercing surface and position of larva hanging at an angle 4. pupa - note air trumpets 5. adult emerging from pupa
6. adult

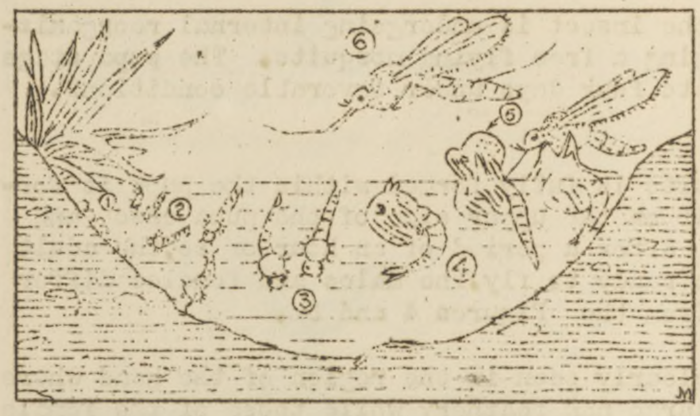

Figure 7. Life cycle of the salt marsh mosquito (Aedes sollicitans)
1. eggs - laid singly, have no floats and drop to bottom
2. newly hatched larvae
3. full grown larvae - note short air tube piercing surface and position of larva hanging at an angle 4. pupa note air trumpets through which it takes air 5. Note adult emerging from pupa
6. adult

Figure 8. Life cycle of the malarial mosquito (Anopheles maculipennis)
1. eggs laid singly - Have lateral floats which keep them at surface
2. newly hatched larvae
3. full grown larvae - note position parallel to surface
4. pupa 5. adult emerging from pupa 6. adult

mosquito has had a full feed of blood it gently withdraws it's mouth-parts, the sheath slides back in position and the mosquito flies away. After the female has a feed of blood, eggs begin to develop in her ovaries and after a few days they are ready to be laid. The female seeks out a suitable place and deposits eggs which starts the cycle again.

NOTE: This lecture was illustrated by lantern slides and by 400 feet of a motion picture film entitled "The Yellow Fever Mosquito."

## WHERE MOSQUITOES LIVE

George S. Tulloch, Ph. D.
Chief Entomologist

This morning I am going to talk about places in which mosquito larvae live. It is important to know this since the only practicable way to control mosquitoes is to control the places in which the larvae live.

Mosquito larvae are able to develop in any collection of water on which there is a quiet surface film, abundant food supply of microscopic organisms and an absence of predacious enemies, such as water beetles and fish. These conditions may be realized in an old tin can filled with water or along the grassy margins of a river. For convenience I have listed some of the places in which mosquito larvae live. They are divided into two groups:

I. Domestic Situation
   A. Gutters
      1. Houses
      2. Buildings
      3. Streets
   B. Tin cans
   C. Rain barrels
   D. Flower pots
   E. Cesspools
   F. Culverts
   G. Catch basins

II. Open Country Situation
   A. Fresh water
      1. Edges of ponds, streams, brooks
      2. Rainwater pools on fields, meadows, swamps, etc.
      3. Roadside ditches, drainage ditches
      4. Treeholes, pitcher plants, Mansonia areas
   B. Salt Water
      1. Coastal marshes
      2. Tidewater flats, etc.

Let us consider the domestic situation first. This Spring in New York there were large numbers of malarial mosquitoes and, since that city has very good drainage systems, it was difficult to find out where the mosquitoes were breeding. After some search the larvae were found developing in the gutters under the eaves of houses, which were clogged with leaves and debris so that water collected and remained there for days. This illustrates an old saying that "Mosquitoes are where you find them". We don't expect you to climb about people's houses looking for clogged gutters, but you should point out to people you talk with of the importance of keeping house gutters free of debris.

Gutters along streets which are not taken care of properly have collections of water in them, particularly after rains, which remain long enough for the larvae to complete development. Tin cans frequently found around summer camps and other places often become filled with rain water and thus provide suitable places for larval development. Rain barrels are exceptionally fine places for mosquito larvae since water usually is present during the entire Summer. We have one specie of mosquito known as the rain barrel mosquito which prefers this habitat. Flower pots partly filled with soil left unused for long periods of time often accumulate sufficient water to allow larvae to develop. Cesspools that are too small to accomodate the needs of a dwelling and overflow provide desirable places for larvae to develop. In other cases the cesspools may be improperly covered so that adults may have access to the water and deposit eggs. These in turn hatch and produce eggs. Since cesspools are usually too close to houses such conditions as mentioned above should be corrected. Culverts under streets are frequently clogged with debris and produce suitable breeding places. Catch basins, usually located at street corners, are never completely drained and contain water in which larvae develop. In some cities these places are oiled weekly but in others nothing is done and consequently mosquitoes in large numbers develop there. In addition to the situations which have been discussed there are probably ten or a dozen more which could be mentioned. You should remember to look at any collection of water found in the neighborhood of houses because often times the most unlikely spot will yield larvae.

Now we come to the open coundtry situations, and here the list could be very long. For convenience in discussion I have divided them into the fresh and salt water situations. Large bodies of water, such as rivers and lakes and ponds usually do not contain larvae except along the grassy margins, where the surface film is quiet and where some protection is afforded the larvae from their enemies. Small brooks and streams, however, are very likely breeding places for larvae since the slow currents permit the growth of protecting vegetation. Other suitable situations in the open country are rain water pools in fields, meadows, roadside drainage ditches and irrigation ditches, swamps, hoof prints' depressions, tree holes, etc.

In Massachusetts, we have two mosquitoes, the larvae of which live in unusal situations. The first is the pitcher plant mosquito, the larvae of which live in modified leaves or "pitchers". The second is the Mansonia mosquito, the larvae of which live attached to the roots and stems of certain aquatic plants. The structure which attaches the larva to the plant is the air tube and through it air is obtained from the spaces of plants. This larva is one which does not come to the surface and consequently is very difficult to collect.

Now, we come to the saltwater situation with coastal marshes, tidal flats, etc. Here we have an interesting relation. Sea water, forty miles off the coast of Boston, is 3½% salt for every 100 pounds of water we pick up. Salt water pools are left by high tides way up on the shore and are not washed away by succeeding lower tides until the next high tide occurs. A few warm days and the water evaporates leaving a concentration of salt in these little pools, and so it is possible to find in such pools more salt than in salt water.

The lantern slides which I am about to show you are concerned with breeding areas, not local ones, but similar to some of the local ones we have.

(This lecture was illustrated by lantern slides of breeding areas in Massachusetts, Alaska, Puerto Rico.)

## PRESENT MOSQUITO CONTROL MEASURES IN MASSACHUSETTS

George R. Stratton
Massachusetts Reclamation Board

When it was suggested that we talk before this group about to start out on this survey, Mr. Wales, Mr. Wright, and I talked over a little bit as to how the thing would be handled. It was finally left that as Secretary of the Reclamation Board, if they left anything unsaid, I would say it. There is a province that is particulary mine,--the record work. Perhaps because of my acquaintance with that part of it and the wording of the law, I may be able to give you information as questions come up in your field.

I suppose people are going to ask you what you are doing, and when you explain that you are getting samples of mosquitoes, they probably will want to know what you are going to do about getting rid of them. In fact, I found, in appearing before the legislature, that some of them think you are going out to get rid of the mosquitoes. We had the benefit of New Jersey's experience in the name of our work,--mosquito control. The New Jersey authorities named theirs "mosquito extermination work" and after a few years wished that they hadn't named it that. So we called ours "mosquito control work." I remember that after we had worked on the North Shore for several weeks, we received a card from someone who didn't bother to sign his name:

> "A mosquito got into our house last night and bit the baby. Will you come down and control it?"

Not knowing whether he meant the baby or the mosquito, we were rather helpless.

The act which turned over the mosquito control to the Reclamation Board was rather careful not to provide any funds that would do work in certain localities. The thought was, I think, that the locality should take care of its own problems, but that they were willing to provide for a central board which could offer information and advice. If it was found necessary to group a number of towns in order to accomplish mosquito control, through the Reclamation Board the authority could be set up so that all the towns could contribute and the money could be spent in the places where the mosquitoes were breeding. Under the previous existing set-up, one town could not appropriate money to be expended in another town. But under this act we can group a number of towns so that the expenditures can be made in any locality. I think that was the real keynote of the legislation on mosquito control. It was absurd for one town, in Barnstable County for instance, to do mosquito control work, for they might clean up every acre in their municipality and still suffer from mosquitoes that came in from adjoining towns.

That act authorized us to employ field agents or engineers as the need arises for them and as the funds appropriated permit. A request for survey of mosquito breeding conditions and possible remedies must come from the selectmen of a town or the mayor of a city. It need not be a petition, just a request for a survey. Our report would include a rough estimate of what could be done about it and a still rougher estimate as to what it would cost. We endeavor to find out, in such a case, if there is any real community interest. We feel called upon to find out if the request represents a community sentiment and a desire to do something to correct the condition. That is not only necessary to accomplish anything worth while in the way of ditching, but it is also necessary to keep up the maintenance. To guide you in your talk with people interested, I think the real point is that they work through the local authorities in applying to the State Reclamation Board and we will give our very best attention to the situation and tell them the necessary steps to correct conditions. Now we never dodge the issue. We tell them unless the State gets on to another spree of spending money to relieve unemployment, a local appropriation or local contribution is required to do the work. There are no funds in our hands to carry on the construction work, except in the three years when the depression was felt the worst and Federal funds were used under the sponsorship of The Civil Works Administration.

Let me go on to tell the steps that follow after petition is made to the Board. We send out our men and make a report to the selectmen or mayor, and we tell what the conditions are and what could be done to correct them; also what would be needed in the way of an appropriation. In case an appropriation is made, we are then authorized to set up a project; that can be either one town or a group of towns. We can create a project and appoint local commissioners, just as we have done in Cape Cod, Nantucket, and Natick. They are then in a position to carry on the work. But first the money has to be sent in to the State Treasurer through the State Reclamation Board, and all expenditures from that money are made with the approval of the State Reclamation Board. The reason for State supervision is that in planning a project like the Cape Cod Mosquito Control Project where fifteen towns contribute money,--some authority is needed to supervize the project. The Reclamation Board recommends the best methods of carrying out the work, and see that the rights of every town are protected. While the commissioners direct the work, hire the people, and send in the bills, the final drawing of the schedule and approval of the expenditures have to be done by the State Reclamation Board. The appeal for the establishment of the Cape Cod Project for funds contained the statement that the work be done under the State Reclamation Board and the money would be spent under the direction of the Reclamation Board.

We have a number of slides which were made up some years ago of the type of work done, and the areas where work needed to be done. These are followed by two small reels of film of the work we have done and the work done in New Jersey.

# HISTORY OF MOSQUITO CONTROL IN MASSACHUSETTS

Edward Wright
Massachusetts Reclamation Board

Doctor Feemster has asked me to tell you what has been done by the Commonwealth of Massachusetts in mosquito control. I would like to say that for several years, while I was chairman of the State Reclamation Board, much of my work was on mosquitoes. The work was extremely interesting and, I think, of considerable value to the state as a whole or at least to the eastern part of the state.

It may seem to most of you that very little has been done about mosquito control in the State and, when you get into this collection business,you may find that very little has been done. On the other hand, the Department of Public Health and the State Reclamation Board have given it considerable thought, and in 1931 a considerable amount of money was appropriated for mosquito control drainage work, The history of the situation shows that the first work in Massachusetts in mosquito control was done by the Department of Public Health in an investigation of the Neponset River for the purpose of providing a new channel for the river and draining a meadow of about three thousand acres in area which lies in Walpole, Norwood, Canton, Westwood, Dedham, and Milton. That was one of the huge mosquito breeding areas in the state. The Department of Public Health was authorized to make an investigation, but the legislature didn't appropriate funds until 1911. Then an appropriation of one hundred and fifty thousand dollars was made, one half of which was to be paid by the State, and the other half assessed upon the owners of the land. The river from Norwood to Hyde Park was straightened,deepened, and corrected in a great many ways; but at the time when the original work was done the State Board of Health recommended an additional appropriation under which the meadows themselves could be drained into the main channel. It may be of interest to point out that the legislature has never appropriated the necessary funds for carrying on the ditching work to supplement the important dredging work that was carried on in 1911, 1912 and 1913. However, during the early days of the Civil Works Administration, the Reclamation Board did arrange a project, particularly in Norwood and Canton, under which some of the ditching of the meadows was carried out, and a considerable improvement was effected. But the huge area of meadows in Norwood, Canton, Westwood, Milton and Dedham still remains to be properly drained. It is interesting to point out that the entomologists who were working for the Department of Public Health in 1897 thought that the Neponset Valley was a particularly bad malarial area. The Department of Public Health pointed out that if the meadows were drained, the malaria would be cut down.As Doctor Feemster has probably pointed out, there is now practically no malaria in Massachusetts. In 1902 to 1904, however, there was a considerable amount of malaria in Dedham due to the fact that laborers working on an extensive sewer project carried the malaria parasite and hordes of mosquitoes were present.

The next work done in the State was in 1902. It was the very extensive report prepared by John R. Freeman, a leading engineer, which resulted in the construction of the Charles River Dam. A pathologist was employed by Mr. Freeman, one Dr. Theobald Smith, who became famous in science. The Freeman Charles River Report contains thirty or forty pages about mosquitoes written by Dr. Smith. That half-tide Charles River Dam was built in 1913 or 1914. Previous to the construction of the dam, the Charles River Basin was a tidal estuary, and rose and fell with the tides way up to the Watertown Dam.

The next work done by the State was in connection with the Alewife Brook area in Somerville, Cambridge, Belmont and Arlington. The Department of Public Health recommended that the brook be properly deepened and straightened and the stream was corrected so that the rather serious mosquito menace in that area was put under control.

Then in 1918 the Department of Public Health was directed to make an investigation of wet lands. Nothing came of that, but a few years later the original State Drainage Board was set up by the legislature. That is now the State Reclamation Board. Following the 1918 report, very little developed, but Professor C. Whipple, a member of the Department of Public Health, in 1920 recommended a large appropriation by the State for mosquito control work.The legislature thought well of it but didn't think much of the financial aspects of it, and an appropriation of only two thousand dollars was made for mosquito control work for the whole state. The Department collected various reprints on mosquito control and sent them to the various local boards of health.

Then things went along for about ten years with nothing developing in the line of mosquito control until about 1929, when the mosquitoes were so fierce down on the Cape and on the islands of Nantucket and Martha's Vineyard, that it seemed necessary to do something. I don't know how much you have had on the various species of mosquitoes, but the salt marsh mosquitoes are the ones that buzz the loudest and bite the fiercest. So in 1929 or 1930 Nantucket made a small appropriation and collected some privately subscribed funds, and under the Reclamation Board a project was set up consisting of the Board of Selectmen and certain interested individuals. A considerable amount of ditching was done. This project is still going on.

At about the same time, the Cape became very much interested in mosquito control work and a fund of one hundred thousand dollars was privately subscribed. A commission was organized under the reclamation Board consisting of three of the leading men on the Cape: Captain Oscar Nickerson of Chatham; Mr. Harry Dowden, Secretary of the Cape Cod Chamber of Commerce; and Mr. E. Webster Hallet. That project started and did a wonderful piece of work. It is still going strong. I hope that the entomologist of that project has been here to see what you gentlemen are proposing to do. He is a full-time man and has had a great deal to do with the work. The superintendent of the work is Mr. Myhre. He knows every inch of Barnstable County,and is one of the most valuable men on mosquito control work in the country. Much of the original Cape work was done by contract. The ditches are about ten inches wide and one and one-half to two feet deep.

The hard work done on the Cape showed that it was a very valuable project for putting some of the unemployed into valuable work. In the early Spring of 1931 when Mr. Ely was Governor of the Commonwealth and the depression was beginning to be seriously felt,he wanted a million dollars from the legislature for putting the unemployed to work. He did not get very far with his first request, but through the Commissioner of Agriculture and other officials the proposition was put up to the Governor that mosquito control was a very valuable way of putting unemployed laborers to work. We pointed to three mosquito drainage projects amounting to an estimated cost of two hundred and seventy thousand dollars: one in Bristol County, another in Plymouth County, and another in Essex County. The Governor put the proposition before the legislature and, much to our surprise, almost over night the two hundred and seventy thousand dollars was placed in our laps. We had to devote a great deal of time to get the work started --- buying rubber boots, getting the necessary implements; and the work went off with a bang. This was before the Civil Works Administration and the other alphabetical administrations. There was a great deal of difficulty as to how the men should be hired. I think the State Reclamation Board was the first State organization to actually cope with people who were unable to get employment elsewhere.

The work was laid out entirely on the seacoast because we were convinced and are now certain that, dollar for dollar, that work was more valuable than similar work inland. More than one thousand men were employed at one time. There was comparatively little expense. The tools were not expensive, but we had trouble with keeping rubber boots on the job. The work went along very nicely, particularly in Plymouth and Bristol Counties. We had more or less political difficulty, but a great amount of work was done. The work turned out so well that additional State appropriations were made, amounting to an aggregate of six hundred thousand dollars. It is interesting to point out that, when the Governor was getting this money, he didn't see any need for adding a clause to the act for maintaining the work which was originally done on the State appropriation; but, after considerable argument, we prevailed upon the legislature to add a section under which the original work must be properly maintained. Today some one hundred and fifty men are at work along the seacoast maintaining the ditches which were originally dug under State appropriations. The money spent in this State to date on mosquito control work since the early part of 1931 has amounted to a total of one million two hundred fifty-three thousand dollars. Mr. Stratton will show you with still pictures and moving pictures how we carried on the work. In rough terms we have dug in this State somewhat over four thousand miles of ditches. Some of you have seen these ditches--about ten inches wide and one-half to two feet deep, some four hundred feet apart on an average. Where we find small salt ponds the size of this room, we have dug a special ditch into the pond.

I have a vivid recollection of dipping up larvae in a salt marsh in Duxbury, a cup of salt water with probably 500 wigglers in it. If you go down there now, you can perhaps pick up your cup full of water, but you don't find the wigglers in it. One could hardly walk down in the Maddaket district of Nantucket, where there is a large salt marsh, because of the hordes of mosquitoes. Nobody could live there. Now people are building houses, and the valuation of that part of Nantucket with the houses and improved conditions has risen over one hundred per cent since the mosquito control work has been done.

There is a bill now before the legislature under which the State Department of Public Health, the Metropolitan District Commission, and the State Reclamation Board will investigate the Charles River meadows in Needham, Dedham and West Roxbury. There is a huge meadow there which is only a few inches above the crest of the dam at Newton Upper

Falls. A year ago, when we had a flood, it was a huge lake. A month ago it was a huge lake due to the heavy rainfall. When it is flooded in the latter part of May or during June, or August, the municipalities in that district are very difficult to live in. We have done some Works Progress Administration work in those meadows, but it has been ineffective because of the fact that the dam holds the water back, and the meadows cannot be unwatered.This investigation will provide for studying the water levels, the dams at Newton Upper Falls and Lower Falls, and down through Waltham and Watertown,to see if it is practicable to reconstruct the Dam at Newton Upper Falls in such a way that it can be partly collapsible and keep the water below the meadows during the mosquito breeding season.

The important thing to point out is that the salt marsh mosquito work is comparatively simple,but the fresh water work is more difficult because of topography and because of water rights. All of the State appropriations for mosquito ditching were expended in salt marsh work with the exception of some twenty thousand dollars of fresh water work in the town of Wenham. Some of the areas on the Cape are below ordinary low tide, so that the areas are always flooded, and one of the things that the State Reclamation Board has done is to assist in the construction of a dike at Provincetown, as an example, where the mosquitoes were so thick that they killed birds and animals. Mr. Wales probably has told you about them. Ditching was of no value because there could be no suitable outlet. As a result, a dike about one quarter of a mile long was built by the State to keep the tide water out. There is a tide gate in the dike so that at extreme low tide it would open and let the water that had seeped in out of the ~~out of the~~ ocean.People are now accustomed to go to that area without finding any trouble from mosquitoes.

We have also had to do with the construction of a dike on the huge marshes back of Salisbury Beach. That is not so successful because the storms have washed parts of it out from time to time. There is another dike,at Marshfield,that was built many years ago, mainly for the purpose of reclaiming a huge area of land.It has had some effect in preventing the breeding of mosquitoes.

I don't know whether I should touch on the question of oiling. A considerable amount of oiling is now being done on the Cape and on the South Shore, particularly in areas that cannot be drained. They are using probably one thousand gallons of range oil every week on the Cape to prevent the larvae from coming to the surface. In some places a substance called pyrethrum is used which is also good.

We have had a great deal of difficulty in maintaining some of the drainage systems along the seacoast. In some instances, rip-rap was put in at the outlets at considerable cost.

I want to point out that when the Work Projects Administration work started the arrangement was made that no projects would be financed by the Federal Government until they had been approved by the State Reclamation Board. I haven't the figures of the amount of Federal money that has been spent in this work in the State, but it has been a considerable sum. It is still going on, but not as actively as in the earlier days of the Works Progress Administration.

I am going to read briefly a part of an article which I read at the New Jersey Mosquito Extermination.Commission at its annual meeting in Atlantic City in March of this year to indicate what the Federal government has done:

> "The use of Federal funds for mosquito control drainage work has appeared, in Massachusetts at least, to be an excellent and most worthwhile form of Works Progress Administration project in that it is of reasonably lasting benefit and the material costs are low. According to information obtained by a committee of the Conference of State Sanitary Engineers, consisting of Messrs. Hazelhurst of Alabama, Clarkson of Georgia, LePrince of Tennessee, Hargis of Texas, and the writer, some five million cubic yards of excavation in mosquito control work was accomplished in the United States in 1936 and an equal amount in 1937 in a total of some two thousand projects. This, with our form of ditches, would mean over twelve thousand miles for each year. It is to be assumed that the Works Progress Administration authorities appreciate the value of the work."

Somebody issued a statement in the press a year ago that the successful work which had been done along the seacoast had headed the mosquitoes inland. Now that, of course,is not based on fact, but I hear it frequently. I don't know how it can be so. We know that salt marsh mosquitoes fly great distances, perhaps forty miles, and there are records of a flight of as much as seventy-five miles. However, the salt marsh mosquitoes do not lay their eggs in fresh water,so that they don't reproduce in the fresh water regions. They have sense enough, in some unknown way, to go back to the salt marshes to lay their eggs. From any scientific standpoint,therefore,any statement that the work we have done has headed the mosquito inland is nonsense.

We have had some conflict with the wild-life people. They feel that where we have drained the salt ponds there has been a good deal of damage to ducks and other shore birds. Our conflict here in Massachusetts has been considerably less than it has been in some other states. It has been controlled here by putting in small dams in some of the ditched areas, in such a way as to hold limited depths of water in these areas and to allow the small minnows that live on mosquito larvae to enter at high tide. At the moment there is no conflict with the people who are interested in wild life in this State.I would point out that at the last meeting of the New Jersey Association, one of the United States Public Health officials stated that the expenditure on mosquito and other insect control in the country at large last year was one hundred and forty-two million dollars.

Now I would like to say just a word about the New Jersey work before we show these pictures.When we started in on this work, General Hale, of the Massachusetts Department of Public Works, was a member of the State Reclamation Board.Just after the Nantucket work was started, General Hale, Mr. Stratton, and I went to New Jersey and found out how the work was being done there.Somewhat over six million dollars has been expended in New Jersey. They are very mosquito-conscious in that State. You don't hear of the Jersey mosquitoes now because the situation has been very well corrected there. In Massachusetts we have a method of assessing for maintenance work,and on the Cape they have a law for assessing thirty-five cents on a thousand dollars of valuation.

As Doctor Foemster knows, I have been engaged in State sanitary engineering work for somewhat over thirty years, and I sincerely believe that I have had a greater feeling of satisfaction in the work we have done in mosquito control than in almost any group of water supply and sewerage projects. We have put the unemployed labor to work and have drained the standing water so that the mosquito eggs don't have a chance to hatch out. Of course, on the incoming tide the water comes in but it carries fish that live on such larvae as may be there.

I understand you have had some difficulty in finding larvae in Dedham. Last year when these meadows were flooded, in June and July, you could collect a handful of mosquitoes almost anywhere in town. This year it is comparatively dry, and there is no chance for them to breed.

A new reprint is being prepared on Massachusetts mosquitoes by the State Reclamation Board and, when printed, copies will be available to the personnel of this project.

# MOSQUITO SURVEYS BY THE RECLAMATION BOARD

R. W. Wales, Entomologist
Massachusetts Reclamation Board

It is my purpose to tell you what has been learned concerning the species of mosquitoes prevalent in Massachusetts in the course of the work on the control of the mosquito nuisance by the Reclamation Board. This work was started in the summer of 1929 and has continued regularly since then. The first summer the work was largely confined to Cape Cod and consisted principally of a survey of the mosquito conditions in that area for the purpose of determining what species of mosquitoes were prevalent and which of these was responsible for the nuisance that existed throughout the area. The problem there was caused by the effect of mosquitoes on the development of Cape Cod as a summer resort. The almost continual presence of great numbers of mosquitoes throughout the area during the summer was proving to be a serious obstacle to its development and the elimination or at least reduction of the nuisance was essential for summer residents. Mosquitoes were of importance because of the annoyance of their biting. There seemed to be no problem to their being vectors of disease.

The survey was successful in determining the species principally responsible for the nuisance. On the results of the survey were based the extensive control measures that have been carried on since 1930 on Cape Cod. It is well-known that the control of the mosquito nuisance there has been successful and Cape Cod is an example of what can be done by a well-organized and administered mosquito control project.

In 1930, the Reclamation Board made surveys of the rest of the coastal region of the State for the purpose of determining whether conditions were similar to those found on Cape Cod. Some work was also done in the Charles River Valley and in a few scattered localities in the eastern part of the State where requests for information concerning the control of the mosquito nuisance had been made. Dr. Tulloch worked on these surveys in the summer of 1930, concentrating principally on the seacoast from Gloucester to the New Hampshire line, and on the Charles River.

In the fall of 1930, operations for the control of the mosquito nuisance were started on Cape Cod, Nantucket had also undertaken control work, starting earlier in the season. In 1931 and 1932 extensive control measures were undertaken by the State on the rest of the coastal region of the State.

Due to the large amount of control work that was done in 1931 and 1932, the limited personnel of the Reclamation Board was occupied principally in supervising the actual control work. Little was done, therefore, in gathering information about the distribution and importance of mosquito species in other areas with one exception.

During May and June of 1932, mechanical traps for catching adult mosquitoes were operated at four stations in the Charles River Valley and considerable information was obtained concerning the species prevalent at that time and in those places.

From 1933 to the present, the work of the Reclamation Board has been largely the supervision of the maintenance of drainage ditches dug on the salt marshes, surveys in cities and towns where information concerning mosquito control was requested, and assistance in the procurement and operation of Work Projects Administration projects for the elimination of mosquitoes. No detailed surveys of any particular areas of the State have been made. A great deal of information concerning the prevalence of mosquito species has been obtained in the course of this work and the balance of this paper will consist of a resumo of that information.

The most important group of mosquitoes is the Aedes Group both from the standpoint of the number of species represented and from the numerical occurrence of mosquitoes infesting inhabited areas. Of the species of Aedes, two breeding on salt marshes were found to be the principal cause of the mosquito nuisance on all parts of the seacoast. These are Aedes cantator and Aedes sollicitans. Both species are distributed throughout the coastal region and apparently are the only species breeding in important numbers on our salt marshes. Where conditions are favorable they are produced in enormous numbers and may infest an area of many square miles, adjacent to the breeding places. Our surveys located them in important numbers eight to ten miles from the nearest salt marshes. In New Jersey they have been found to work inland as far as forty miles. These species were largely responsible for the mosquito problems of Cape Cod, Nantucket, and the rest of the coastal area of the state. Control measures have greatly reduced the numbers of salt marsh mosquitoes produced, and at the present they are not produced in great numbers anywhere except along the North Shore from Essex to the New Hampshire Line. In this area much control work has been done and it is estimated that about half of the heavy producing marshes have been ditched. This has produced a marked reduction in the numbers of mosquitoes in the area infested by them, but they are still the source of a very serious nuisance.

Of these two species, Aedes cantator is generally found in the greatest numbers in the spring and fall, and Aedes sollicitans in the summer. Aedes cantator appears to select breeding places where the salt content of the water is less than that of normal sea water, and Aedes sollicitans in places where no dilution by fresh water other than that of rain occurs. Both of these species bite in broad daylight under full sun as well as in the dusk of morning and evening. They will not enter buildings as readily as many other species but do not hesitate to follow their prey inside if the opportunity is presented.

Aedes taeniorhynchus, a salt marsh breeder of the south, does not occur in important numbers in Massachusetts. I have come across but one specimen in the ten years that I have been with the Reclamation Board. This was an adult found at Essex.

Several species of Aedes breed in fresh water area under a wide variety of conditions. On fresh marshes such as occur along the rivers, and brooks, the common species are Aedes implacabilis (abserratus), Aedes aurifer, Aedes cinereus, Aedes excrucians, Aedes fitchii, Aedes stimulans, and Aedes vexans. These all may occur in large numbers, Aedes implacabilis appears to be the first to hatch in the spring. The larvae rarely are found after the middle of May. The adults apparently live for several weeks after possible breeding places have dried up. Aedes cinereus is probably the most important of these species from standpoint of numbers, closely followed by Aedes excrucians and the very similar species Aedes fitchii and Aedes stimulans.

In the fresh water swamps which are shaded after the leaves come out, Aedes canadensis breeds in large numbers. Its breeding apparently is not confined to shaded area, however, as the larvae have been taken in meadows and other open pools. This species is a common one in fresh water breeding areas on Cape Cod. Aedes excrucians and Aedes aurifer have been found associated with it in breeding pools.

Aedes vexans--this species is undoubtedly the most important of the fresh water breeding Aedes species from the standpoint of the numbers produced, its general distribution and the wide variety of conditions under which it breeds. It hatches in breeding pools as early as the first of May, and continues to hatch throughout the summer and until late fall, whenever conditions are suitable. It is an inhabitant of temporary pools as are most of the species of Aedes. We have taken it from rock pools, from small pools back from the edge of a pond, open pools in the side of a hill, old ditches in a river meadow, in a cattail marsh, from ditches close to the salt marsh associated with Aedes cantator, from pools in dumps and from field pools where rain water stands for a few days. It is the principal mosquito breeding in the summer in the meadows along the Housatonic River in Pittsfield and is common on the Charles River meadows. Its flight range is apparently greater than that of most of the fresh water Aedes, the adults being numerous, at least two or more miles from known breeding places and probably considerably more distant.

Aedes atropalpus breeds in water that collects in depressions in ledges. On the sea coast it is found in such pools that are above high tide limits. It is undoubtedly a serious factor in the mosquito nuisance in localities where favorable conditions for breeding exist. I have found it breeding in rock pools in the White Mountains, indicating that it is widely distributed.

The species of Aedes named above are the ones that our surveys have shown to be produced in sufficient numbers to cause great annoyance by their bites. With the exception of those species breeding on the salt marshes they are believed to be generally distributed throughout the State.

Of the Culex group, four species are common in the State:-Culex pipiens, Culex territans, Culex salinarius, and Culex apicalis.

This group of mosquitoes is a small factor in the mosquito problem in the early spring but grows in importance as the season progresses and in most localities constitutes the major source of annoyance in late summer and in the fall. Of the species named, Culex apicalis is found in pools that are more or less permanent such as grassy ponds, pools in fresh marshes, and the like. It is reputed not to bite human beings and so probably is not important as a source of annoyance. The larvae will undoubtedly be found many times by most collectors in this survey.

Culex pipiens--this species is commonly known as the rain barrel mosquito. Rain barrels, however, are just another accumulation of water to it, for it seems to breed anywhere that mosquitoes can breed. Water polluted with sewage produces it in tremendous numbers. Tin cans, clogged eaves' troughs, rock pools, and almost anything else that will hold water for a few days in the summer is likely to contain the larvae. The very general distribution of this species is due to its habit of depositing its eggs directly upon the water surface. Many generations may be produced in a single season. In a wet summer such as occurred last year, tremendous numbers may be built up by late summer and fall. It is not necessary to discuss this specie in detail here, as others will undoubtedly have considerable to say about it.

Culex territans--the larvae of this species are frequently found where Culex pipiens is breeding. The adult form is not easily distinguished from Culex pipiens and it is probable that some of the annoyance attributed to Culex pipiens is caused by this species. Our records of this species are very meager but my impression of it is that it is not likely to be found breeding so close to houses as is Culex pipiens.

Culex salinarius--this species appears occasionally in collections.It is apparently of considerable less importance than the two preceding species of Culex.

Anopheles group--two species are quite generally distributed--Anopheles punctipennis and Anopheles quadrimaculatus. Because malaria is not prevalent in Massachusetts, no special attention has been given mosquitoes of this group in the work of the Reclamation Board.The fact that there have been serious epidemics of malaria in some parts of the State in the past, however, gives an added incentive to mosquito control where Anopheles species are present.

Mansonia perturbans--the species' name of this mosquito is appropriate--it is perturbing in the viciousness with which it bites, in the difficulty of locating its breeding places, and in finding means of preventing the breeding. The larvae remain attached to the roots of certain plants growing in water, the common cattail being one of them. The adults have been found in many localities but only on Cape Cod have the larvae been found there by the entomologist of the Cape Cod Mosquito Control Project, Mr. Armstrong. This mosquito is present in great numbers on the Charles River near Norumbega Park.Dr. Tulloch has told me of finding the larvae of another species of Mansonia in Puerto Rico of which previously only the adult form was known.

Species of mosquitoes other than those discussed above have been taken in our surveys but in such small numbers that they have not appeared to be important factors in the mosquito problem. Since the work of the Reclamation Board has to do with the control of mosquitoes responsible for creating a nuisance by their biting,our interest has been primarily to discover the species which are of importance from that standpoint. It is the species named above that appear to be principally involved.

# THE CAUSES OF DISEASE

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Today I want to give you a background for a better understanding of the cause and method of transmission of "sleeping sickness". To do this I shall give you an outline of the causes of disease in general. There are many different kinds of diseases and most of them have their own individual causative agents. Some are caused by germs and related organisms and some are not. Today we are interested only in those caused by living agents.

It should also be noted that we can differentiate in general between injuries, such as those caused by the bite of a cat or the kick of a mule, in which the effect is primarily external, and disease in which the effect is primarily internal except as the result of the internal injury shows up on the exterior. The causative agents of disease can be roughly divided into those belonging to the animal kingdom and those belonging to the vegetable kingdom.

There are two classes of animal agents; the helminths, or worms, and the protozoa -- small unicellular animals.

The worms are complicated in structure and have well differentiated organs such as an intestinal tract and an excretory system. Those causing disease in humans vary greatly in size, some being so small that they escape the eye unless viewed through a magnifying lens, and others grow to considerable size. They choose various parts of the body for attack, those most familiar to the public being those which live in the intestinal tract. Among these, tape worms and round worms are large, while hookworms and thread worms are small. One which causes the most serious consequences is the worm responsible for the condition known as trichinosis. This disease is acquired by eating raw or improperly cooked pork containing the immature forms of the worm known as larvae. In the human intestine these develop into adult worms and produce thousands of other larvae which migrate into the blood and are carried all over the body. Whenever they stop they cause injury, and inflammation results. Sometimes they get into the eye or other special organs and the results are very serious.

The second group of animal agents, known as protozoa, are never seen unless examined through a microscope. These consist simply of one cell and consequently lack any complicated structures such as are found in larger animals. One of the simpler protozoa is the amoeba. It consists of a transparent envelope containing fluid in which floats the nucleus, the principal living part of the cell, and various foodstuffs which the amoeba has engulfed. This variety of protozoa is responsible for amoebic dysentery. Back in 1933, many people became ill at the Chicago Fair because this simple little animal got into the water which many visitors drank at certain hotels. The long continued illness which sometimes results often renders the victim so weak that he falls an easy prey to other diseases which may come along.

There are other protozoa which have structures very different from amoebae. Some have little oscillating projections called flagellae, Many of these inhabit the intestinal tract.Protozoa may also attack other parts of the body -- for instance, the malarial parasite which lives in the red blood cell of the human body. Under the microscope it has no color value, and in order to study it, a thin film of blood is placed on a slide and stained which makes it possible to see the structures of the parasite. At first it is small, but it continues to increase in size and eventually it divides up into about 20 new parasites. The red cell breaks and all of these parasites then attempt to attack other blood cells.There are different kinds of malarial parasites. They vary in structure and in the period of development. In the case of tertian malaria, every forty-eight hours a new lot of parasites are turned loose, and they go through the same cycle again. The injury produced by the malarial parasite is due largely to the fact that they are continually destroying red blood cells. The condition produced by this destruction of red cells is known as "anaemia". There is a rise in temperature following the release of each lot of new parasites, which accounts for the periodic rise and fall of the temperature in this disease.

We must go on now to the small plants which cause injury.First, consider the molds. All of you have seen fruit on which molds were growing. The mold is the most complex of these small plants which affect the human. The mold consists of an interlacing mass of little fibers from which, in order to reproduce and start another mold, they send up a tree-like projection,and on this projection grow "seeds",or spores, in various arrangements. Many of these molds are entirely harmless, but certain important diseases of humans are caused by particular varieties. A simple kind which has this mass of fibers, but with the spores on the inside of the fiber instead of the outside, causes what is known as athlete's foot. Athlete's foot is a disease which is quite prevalent, and if we were to search among you, we would probably find about 50 per cent to have some small spot between the fingers or toes caused by this germ.

A second type of small plant is the yeast. It is simpler in structure and grows a bit differently. It is a cell with a nucleus, but instead of growing in fibers, it puts out a little projection called a bud, which grows larger and larger and soon there are two separate cells. When they divide and multiply rapidly, they may fail to separate entirely and are seen clinging together. Certain important diseases are caused by yeasts,but not by the common kinds used for making bread and other domestic purposes.

The next group also has a fairly complicated structure.The members of this group are known as "spirochaetes".These have various shapes, but are in general spiral. Syphilis is caused by a spiral organism. There is a difference of opinion as to whether "spirochaetes" should be classified as animals or as plants, but they are usually considered to be small plants.

When we go a step further into a still simpler living agent, we come to those known as bacteria. Some are simply little spherical bodies. They can only be seen through a microscope. Several hundred thousands of these bacteria can be crowded into one red blood cell. There is no well-marked nucleus in these smallest of plants. Because they are transparent, we have to put them on a slide with some sort of stain, as with the malaria germ in order to see any structure. We can classify them into certain rough groups by the shape. One, which is round, we classify as a coccus (Greek word for berry);staphlococcus,when they grow in bunches,as grapes; streptococcus, when they grow in chains instead of in bunches. Some of them grow in pairs with a clear envelope around them, which we call the capsule. This variety is called pneumococcus, - the important cause of pneumonia.

Some have elongated shapes like rods. In order to have a name for them, we use the Greek word meaning "rod" and we get the name "bacillus".The disease known as typhoid fever is caused by one of these bacilli. The disease, tuberculosis, is caused by another one of these rod-shaped bacilli, as well as anthrax, paratyphoid fever, diphtheria, and tetanus. The tetanus germ has a special type of structure.Before it stops growing, it produces a spore. The spore grows in the end of the tetanus bacillus and the body of the germ wastes away leaving only a round spore, which is very resistant and can survive for long periods of time under very adverse circumstances. It can be found lying out in any fertilized field. If it enters an open wound, it rapidly multiplies. The person affected cannot open his jaws once the disease has begun, hence the condition is known as lock-jaw.

Some of these bacteria have other shapes. Some of them are slightly spiral in shape and are frequently joined together in pairs.Such a germ is the cause of cholera, a disease which we do not have here in America, but which is quite prevalent in Asia.This germ is known as "spirillum".

Now we come to the group of living agents which we cannot see. We do not know whether to classify them with the plants or animals because we cannot examine them to find out. These are known as viruses. This is a very important group of living things which cause disease in man. You will be interested to know that there are numbers of conditions that are caused by these smallest of living agents. We can start with hydrophobia, or rabies. To this we can add measles, mumps, chickenpox, smallpox, and infantile paralysis. We must now add another disease, recognized for the first time in man in Massachusetts last year,called encephalitis. This is only the beginning of a long list of diseases caused by these exceedingly small things which we can discover only by taking material from a sick animal and injecting it into a well animal.

So much for the kinds of living agents. Now we shall explain some terms which are used whenever we talk of diseases. The term "incubation period" is one which is used very frequently. Usually when germs enter the body,not very many of them gain entrance at the same time, and so we do not have an immediate injury of any consequence. It is only as they begin to multiply and begin to produce more and more injury that we discover we are sick. For instance, the streptococcus, which causes blood poisoning,may enter through a blister on the heel,as in the Coolidge boy, and invade the blood stream. When these germs get in the blood stream, they spread throughout the body. The length of time which elapses between the time the germ enters the body and the time the first symptoms begin, is spoken of as the "incubation period". These periods of incubation vary a great deal in the different diseases.In measles, it is about two weeks, and mumps about the same; in chickenpox, about three weeks; and rabies, several weeks, and sometimes two or three months. On the other hand, in a disease like scarlet fever which is due also to the streptococcus, the "incubation period" is short, for within two or three days after the germ enters the throat, the symptoms begin because the multiplication of the germs is very rapid.

Of course, the injury produced by these agents is not by chewing up your body or by using claws, because they do not have such appendages. They produce injury by robbing the cells of the body of materials which should nourish them, and by producing poisons which injure or kill body cells.

When the diphtheria germ is growing in the body, it rapidly produces a substance so poisonous that when one part in 10,000 is injected into a guinea pig or other animal, it causes death. The poisons produced by most germs, however, are not nearly so injurious.

How does the human body fight these germs? As soon as the germs begin to secrete these chemical substances, and they circulate around in the body, the body begins to produce antidotes. These antidotes go to the places where these germs are growing and neutralize the action of these poisonous materials. Then ensues a chemical warfare. The result depends upon which is the stronger. If the germs produce their poisons faster than the animal can produce antidotes, then the animal succumbs; if the animal produces antidotes faster, it survives. We make use of this information when we lend help to animals which are sick by injecting antidotes taken from animals which have recovered from the same disease. These antidotes against bacteria and their poisons are called antibodies.

Some of these antibodies can be manufactured by more or less artificial methods. The manufacture of diphtheria may be used as an example. When the diphtheria germ grows in certain fluids it produces its poison, known as toxin. By special methods this toxin can be robbed of most of its power of injury, but it can still produce antibodies. This modified toxin, or toxoid, is injected into a horse. The body cells of the horse manufacture antitoxin. Quantities of blood are removed from the horse at regular intervals. The fluid, or serum, which is left when the blood cells are removed contains the antitoxin. This is injected into a child with diphtheria so that the antibodies formed by the horse will help him in his fight against the disease.

If we wish to prevent children from catching diphtheria, we can inject some of the same toxoid into them. They will form their own antitoxin, which will protect them from injury if they are ever attacked by the diphtheria germ. Usually about ninety-five per cent of those receiving three doses of toxoid at intervals of three weeks apart will be protected against the disease.

All this is leading up to the problem of encephalitis. Encephalitis is a medical term for any inflammation of the brain, but the particular kind in which we are interested this year is that due to the equine virus. This has been considered to be a disease of the horse, but humans are now known to be affected by the same virus. Since both the brain and the spinal cord are affected in the horse, the disease is usually known as encephalomyelitis. The public thinks of the condition in both man and horse as "sleeping sickness".

When a horse has this disease, or when humans have it, antibodies are naturally produced in the blood and the animal will not have a second attack. If we take blood from a recovered animal, in the laboratory we can demonstrate antibodies in the blood serum. This can be used as a method of determining if a particular person or animal has had the disease.

A vaccine which will protect horses against the disease has been produced but so far has not been tried on man. Many horses have been inoculated with this vaccine this year in Massachusetts.

# MOSQUITO BORNE DISEASE

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The idea that insects could carry disease is not an old one. At one time, people did not understand how disease spread from person to person, and they attributed it to Providence, witches, and all that sort of thing. In fact they had no clear idea how disease spread. Then gradually they learned that contagious diseases spread directly by contact. Some diseases spread more rapidly than others, influenza, as contrasted with smallpox. For example; some like paralytic poliomyelitis attack only a few people, at least only a few seem to be susceptible to it. Then there were some diseases like yellow fever, about which the physicians and epidemiologists disputed continuously as to whether the disease passed from person to person or not. They knew there were epidemics of yellow fever. They knew that people could associate with yellow fever patients and not get the disease. There was no end to this discussion until the question was finally settled by Walter Reed in 1901.

He was a major in the army and was ordered to go to Havana where there was an enormous amount of yellow fever. It was a huge problem, and he was sent down to see if he could solve it. The Spanish War began in 1898, and in 1900 there was an army of occupation. The more troops went there, the more yellow fever occurred.

Preceding this, Doctor H.R. Carter of the United States Health Service had been working in Mississippi in 1898. Carter was originally an engineer, but he broke his leg and everybody told him he would not be able to work as an engineer, so he studied medicine and became one of our great medical men. He went to Ormond Mississippi. Where he observed that when a man develops yellow fever, some of the people who are exposed will develop the disease. If a patient comes into a community which had no yellow fever recently, it is certain that many persons will develop the disease. The interval between the arrival of the infecting case and the occurrence of secondary cases in this neighborhood was the subject of his study. People for a hundred years had known of an interval between the arrival of the case and the occurrence of secondary cases, but nobody had studied it with any care. As it is too difficult to trace contacts in a city, Dr. Carter went out into the country. Ormond was not a town or a Hamlet, it was merely a neighborhood community, consisting almost exclusively of white people working their own lands. They had little intercourse with the outside world and practically all were susceptible to yellow fever. Fortunately they were intelligent enough to know and tell the truth. What Carter says of that little community in Mississippi is true of all communities, that people are willing to cooperate. All you have to do is to be frank in explaining your objectives. They, in turn, will be truthful with you.

Carter found that a yellow fever patient would come in from New Orleans, and there would be no secondary cases for two to three weeks. That is, Mr. A. would go to A. house in Ormond. His friend would come there and visit him during the first two or three weeks and go away and would not develop yellow fever. After that period, everybody who went to his house came down with yellow fever. His conclusion was that it took that length of time to infect the environment. Moreover, the incubation period of the disease is only six days, so if it spread from person to person, you would have had the first case in six days.

Walter Reed read this paper, which was published in 1901, just about the time he was ordered to go to Havana and he said, "Here is an interval of two to three weeks, and the incubation period takes at most only six days;so there is a second incubation period in some other host besides the patient to make up this period. It may be that an insect has to be infected and has its own incubation period, and these two periods together will make up the two to three week." He formed the idea that there were two hosts that were infectious, not only human but some insect; and he published his observations and conclusions. It was quite reasonable for him to think this because not so long before in 1899, Sir Ronald Ross, working in India had shown malaria of man and malaria of birds was carried by mosquitoes. So the idea that mosquitoes carried disease was not entirely new. Someone remembered that Theobald Smith had shown that Texas cattle fever was carried by ticks; that was in 1893. Before that Sir Patrick Manson,living in China, showed that elephantiasis was due to a parasite carried by the Culex mosquito. So before Reed and Carter started working on the transmission of disease by mosquitoes, they had these things to look back to: malaria and elephantiasis carried by mosquitoes and cattle fever carried by ticks.

Reed proved the theory in an effective and simple way. He built a shack and divided it into halves by a mosquito screen. The two sections were exactly alike,but down the middle was this ordinary everyday screening. In one side he put some mosquitoes that had bitten yellow fever patients; in the other side there were no mosquitoes. In the side that had the mosquitoes, he sent in men three times, morning, afternoon, and the next morning. They were bitten each time by several mosquitoes; and although they were in only a half hour each time at the most, all these men develop yellow fever. Fortunately they all got well. On the the other side of the house, where there were no mosquitoes, he put in a dozen men; and they lived there, spent all their time there for 21 days, and not one of them was sick with anything whatsoever. So there was a nice experiment. Two rooms exactly alike except that one had mosquitoes which had bitten yellow fever patients and the other did not. In the mosquito room they all got yellow fever. In the mosquito-free room nobody got yellow fever.

After that, health authorities stopped disinfecting ships, trunks, blankets, clothes, etc., for yellow fever and started killing mosquitoes, and this is all we have been doing since. This is an example of the way a disease was proved to be carried by mosquitoes.

Which mosquito carries the yellow fever virus? Do all mosquitoes carry it or is there a particular one? There is one that is more important than all others, the Aedes aegypti. You may find it here, and you may not. I hunted for it in New York and could not find it. But we know that in former times we had yellow fever in Boston and in New York. It was confined to the docks, where there were buckets for fire protection, buckets for laundry work,etc.. This mosquito, we have every reason to believe, was once one of the tree-hole mosquitoes. As you go along the highway you will see tree-holes. It is a favorite hiding place of this mosquito and it is here they breed. The Aedes aegypti mosquito went through a certain amount of evolution. When it came around a house inhabited by human beings, it found water that was stored in rain barrels buckets, tin cans etc., in artificial containers, not in ponds or puddles. It does not breed in ponds; by reason of the fact that it started out as a tree-hole mosquito and then moved to a house, where it found containers ready for its use, it rather lost the power of active swimming and fighting, so that it didn't have the ability to protect itself against its natural enemies. If you look at any pond you will find that it is full of larvae of all sorts; and these feed upon each other, -- the big fast ones kill off the small slow ones. The Aedes aegypti is one of the slow ones and can not fight off its enemies, so it never survived in puddles. But in artificial containers it survives. It gets along on very little food; it will live where other mosquito would starve.

That will remind you that in disease we usually have one group of mosquitoes to fight. If we had to fight all of the mosquitoes there are, we would have to give up. The first thing to find out is which is your enemy. That is quite complicated. There are nine mosquitoes and one tick which have been shown to be able to carry the virus of equine encephalomyelitis. This means, in all probability, that three or four of these are of real importance, and the rest are curiosities. Which are important and which are unimportant? You never know until you test all and settle the question. Malaria, which is a world-wide disease, is carried by the genus Anopheles, but not by all species. Some are better carriers than others. There still is malaria up here, along the coast, and to a certain extent along the Gulf, carried by Anopheles quadrimaculatus. Along the Pacific coast they have a different mosquito and in Cuba they have Anopheles alb;manus,--which is also the common vector in Panama. In South America there are still others. There are a good many species of the genus Anopheles which may carry malaria, and therefore what is true of Massachusetts may not be at all true of Montana. The best illustration of that is the malaria in Palestine.

Jerusalem in the Turkish days had a frightful reputation for malaria, severe malaria; the children, especially, were sick for years. During the World War, General Allenby marched into Jerusalem, his sanitary inspectors proceeded to treat it just as they treated any other camp. They went around oiling water, to stop mosquito breeding. They oiled right and left, and much to the surprise of the people, who always lived there malaria disappeared. The only trouble was they didn't like to have their wells and cisterns oiled. When they began to object about having their water oiled, the engineers stated,"Just put a cover, a screen, over the cistern, and we won't oil it." They did, and it was perfectly astonishing to see that every house ahd been raising its own mosquitoes in its cistern. When they were screened, it was noticed that the mosquitoes were crowding up against the screen in enormous numbers trying to get out. In Jerusalem and in that region The Anopheles bifurcatus is the vicious malaria carrier. This same mosquito can be found all around the Mediterranean. In Italy, this mosquito is not important; Anopheles maculipennis is the important carrier. The family of mosquitoes may behave differently in different parts of the world.

We must make, therefore, a detailed survey of each one of these mosquito problems. It is very probable that you will find one set of conditions along the eastern coast here,--say within 30 miles of the salt marshes, and in The Berkshires you will find another. What you have to do is observe and get the facts. If you cannot understand them after you get them don't worry, that is someone else's problem. You may find there is one carrier on the Cape, another around Boston, another in the Berkshires; or there may be none in the Berkshires or none in the Metropolitan district. Therefore you are going to make a census of mosquitoes and that is why you are going to learn how to collect them. They have to be examined and classified. You want to write down your facts. Write down whatever you are going to say about the collection of the mosquitoes at the time you are making the collection, or you will forget.

How do we account for the fact that the same mosquito infects people in Jerusalem and not in Italy? The labels we put on mosquitoes are more or less artificial. They look alike to us and we say they are the same. In Europe we have an Anopheles maculipennis (spotted-wing mosquito). It exists all over Europe from North Africa to Scotland and from Spain into the Balkans. For years the importance of Anopheles maculipennis was discussed. One could go to certain areas around Rome, where there was a lot of malaria, and one found a fairly large number of these mosquitoes; but around Naples even more mosquitoes were found, but no malaria. Both of these mosquitoes were Anopheles maculipennis. They used to say that there was Anophelism without malaria and Anophelism with malaria, and no one could understand why. Up to a few years ago they thought there was something in addition to the mosquito and they called it the X factor.

A few years ago an old retired medical officer in the national department of health in Italy, after retiring at the age of 70, concluded he would take a vacation. He had heard a lot of talk about the mosquito and malaria and he went to the Pontine marshes and said he would amuse himself and look into these things. And he took along his microscope and examined the adult insect, the larvae, the eggs. Because the microscope was an old one, it had no condenser on it. In place of that he had an ordinary magnifying glass coupled to the draw tube. The light then came down directly upon the specimen, and not through the mosquito as in a modern microscope. He looked, and saw something no one else had seen. He found an egg without a couple of bars on it, then an egg with a huge bar on it, then one that was solid black. He and his successors have divided up the eggs of Anopheles maculipennis into six varieties; three of these carry malaria and three do not.

We know horse encephalitis is present here. We do not know what carries it and we can not work effectively and economically until we do know. In Jerusalem, if they had worked against all mosquitoes, it would have been very expensive, but they picked out the one that breeds only in cisterns, and it was very economical to fight that. All they had to do was put a cover on every cistern.

Along the railroads and highways for miles you will find pits and ditches filled with water. Obviously they are breeding mosquitoes. But you want to find out what sort of mosquitoes these are. Look at all the pits through the district where you are working and you will find some of them have no mosquito breeding, but most of them will have some breeding, and most of these mosquitoes are probably harmless. Here and there you will find one that is breeding Anopheles quadrimaculatus prolifically, and that is the one you will have to do something about. Much money has been spent on mosquito control, killing mosquitoes that conveyed no disease.Do the nine mosquitoes and one tick that carry the disease if encephalitis exist in Massachusetts? No, they have a continental distribution.Only five, however,of these mosquitoes are common in Massachusetts.The fact that we have five mosquitoes in the state which carry the disease isn't enough. We have to know the relative percentages of these five. Of five mosquitoes in eastern Massachusetts one may be important and you may neglect all the others. In the Berkshires another of the five may be important and you may neglect all the others. Along the shore we have salt marshes; there you will have the salt marsh mosquitoes. In the Connecticut Valley and in the Berkshires you will not have the salt marsh mosquitoes.That is a natural division.There is no tick listed for the Eastern type of encephalitis.

# MOSQUITO TRANSMISSION OF EQUINE ENCEPHALOMYELITIS

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For mosquitoes to transmit a virus disease from one animal to another, it might seem that all that was needed would be a sick animal, a healthy one, and a mosquito which would bite first the sick and then the healthy animal. But if we look into the matter more carefully we find it is more complicated. To understand the transmission of equine encephalitis, quite a number of things must be considered. The sick animal must have the virus in the blood, where the mosquito can get it. The mosquito must bite at the right time, must be able to carry the virus, must bite again after a proper period of time, and must find an animal which can be infected.

The first thing necessary, of course, is for the sick animal to have the virus. Just because the animal is infected, however, it is not certain that the mosquito will get the virus. Because a mosquito feeds on blood, it is necessary for the virus to be in the blood so the insect can get it.

Let me give you an example of this. Suppose, for instance, we should infect a horse by giving it equine encephalitis virus under the skin. If we fed mosquitoes on that horse right after it was infected, they would not get the infection, for the virus would not have reached the blood. If we fed mosquitoes on the horse on the third or fourth day, they might become infected, because the virus is in the blood on those days. About the sixth day the horse would appear sick for the first time. But by that time the virus would have left the blood and mosquitoes could not get it. Indeed, it is characteristic of equine encephalitis that the virus leaves the blood before the animal seems sick.

The second thing necessary is to have the mosquito bite. To most of us, it seems as though mosquitoes always wanted to bite. In the laboratory, however, it is often impossible to have the mosquitoes at the desired time.

By starving the mosquitoes for twenty-four hours, they are made hungry. In order that they may feed well, the animal which they are to bite is placed in a dark room and is kept still. This is easily done by tieing a guinea pig loosely to a board. A mouse objects to even loose ties, so it is better to anesthetize mice completely.

The third point concerns the kind of mosquito. Is it a kind which can transmit the disease if it gets it? The yellow fever mosquito, *Aedes egypti*, is able to carry several viruses, those of yellow fever, dengue, and western equine encephalomyelitis. On the other hand, our common house mosquito, *Culex pipiens*, cannot carry any of these diseases. Just which of the thirty-five kinds of mosquito found here in Massachusetts can carry encephalitis is not yet known. The survey which you are about to make will be of great value in determining the dangerous species.

The fourth point is to be sure that the infected mosquito bites again after the proper length of time. Will the mosquito live long enough? The words "long enough" are used because the insect cannot transmit the disease immediately after it gets the virus. There is a delay, called the incubation period, of six to twenty days during which the mosquito bite is not infectious. After that, and probably for the rest of its life, the insect can give the disease. "Will it live long enough" is therefore important. In order to be certain that we have an infected mosquito alive after the sixth day, it is customary to use many mosquitoes in each experiment. About two hundred are used in the Harvard laboratory, and the Rockefeller Institute uses eight hundred in its tests.

The final step in transmission is for the virus to infect the healthy animal. Can the animal which the mosquito bites be infected? So far, the only animals we know that can be infected by mosquitoes are horses, guinea pigs, and mice. If we want to know whether a certain mosquito carries the virus of equine encephalomyelitis, we would not feed it on a cat. The reason for this is that a cat can be infected only by injection of virus directly into its brain, so that no mosquito could give the disease to a cat. For laboratory experiments, guinea pigs and mice are convenient.

In addition to these points, there is another which has not commonly been recognized. It has to do with the nature of the virus itself. Will the virus take under the skin? In the first experiments done at the Harvard laboratory, we tried to prove that our method was satisfactory. By means of the mosquito, Aedes egypti, we transmitted western encephalitis virus from mouse to mouse. But when we tried the salt marsh mosquito Aedes sollicitans, with the eastern virus, nothing happened. We then discovered that the virus we were using could not take under the skin, nor in the mosquito. When we took a more active strain of the same kind of virus - that is, equine encephalitis virus which had come from a child who was killed by the disease - we found it would take if injected under the skin of a mouse. This active virus infected the mosquito, so that it was carried from a sick mouse to a healthy one by Aedes sollicitans mosquitoes.

Now that you know the important steps in the transmission of the disease, you might be interested in observing how it is done in the laboratory to test out the different species of mosquitoes.

At this point Dr. Davis showed a jar containing Aedes egypti mosquitoes and larvae. The top of the jar was covered with gauze. He injected into a white mouse a mixture of nembutal and barbital. The supposition was that the mouse had been infected twelve hours before with equine encephalitis virus; the virus, therefore, would be in the blood. Having been given the anesthetic, the mouse passed through what is known as the excitement stage, and then fell asleep. It was placed on top of the gauze-covered jar containing the mosquitoes, which shortly proceeded to bite the mouse.

If we raise mosquitoes, how long does it take to do one experiment? How long is it from the time when one mosquito lays its eggs until the mosquitoes from the eggs can transmit disease? To answer these questions, we must do some addition. An egg may hatch by the third day after it is laid. The larva will take from ten to twenty days, or even longer, to develop. In order to have plenty of mosquitoes for the experiments, the insects can be raised in the laboratory. This is easy with some species, and almost impossible with others. The mosquitoes must have food and water. Without plenty of water they may die within a day. The temperature should be about 75°F, which is about that of summer temperature. In winter the room should be kept close to 75°F and the air conditioned to be moist.

In order to breed mosquitoes from eggs it is necessary to care for the larvae or "wrigglers". This stage of the mosquito can be raised in pans of water, and fed on powdered milk.

The duration of the larval stage is variable, depending on the temperature. At the usual summer warmth the larval stage lasts about fourteen days. The insect then changes to the pupa stage, which lasts two days. Adding these up we find the adult emerges about the nineteenth day. It will be two more days before the mosquito's wings and mouth parts are hard, and it is ready to bite. If the mosquito then feeds on an infected animal, it becomes infected. After the incubation period of six days the mosquito can transmit. Adding these up we find it takes twenty-seven days from the egg to transmission. Of course, this figure is only a rough estimate, but it indicates that the eggs laid one month may be the cause of disease a month later.

During this long period in the laboratory, it is very important that no infected mosquitoes get loose,It is customary to take certain precautions against this.All infected mosquitoes are kept in gauze covered cages,which are never opened after the mosquitoes are infected. The mosquitoes can feed only through the gauze.The cage is usually kept inside another, just in case one should escape from the first cage.When the mosquitoes are used, their jar is left in a dry place for two weeks and the mosquitoes die.

The purpose of all this work on the transmission of the virus is to answer the question:-How do people get infected? It is not enough to say "a mosquito", because not all mosquitoes carry virus. Then which Massachusetts mosquitoes become infected and transmit equine encephalomyelitis?

So far, four species have been found. _Aedes sollicitans_, a salt marsh mosquito, is considered important because it is common._Aedes cantator_, also a salt marsh mosquito, will transmit the disease. It is less common and therefore is less important. _Aedes taeniorhynchus_, a third salt marsh mosquito, is too rare to be important. _Aedes vexans_ is a fresh water product which grows in dirty pools along the side of the road, and is most abundant a few weeks after a heavy rain. It is common in the region of last year's epidemic, and is therefore considered important. _Aedes cinereus_ might also be mentioned; it has not yet been shown to carry the disease but resembles _Aedes vexans_ in appearance. _Aedes dorsalis_, a species rare in Massachusetts,has been found to transmit the western encephalitis.

In addition to mosquitoes, we should bear in mind other blood sucking insects. The dog tick,_Dermacentor variabilis_,may carry the disease, though no one has proved it as yet. However, it must be suspected because another tick, _Dermacentor andersoni_,can transmit the western type of encephalitis. Horse flies, of course, have been suspected but have not been proved to carry the virus.Probably more experiments should be done with flies.

So far, we have considered two sorts of animals. One sort gets sick from the virus. Horses, men and mice are in this group. Another sort transmits the virus,when it bites;mosquitoes and ticks are in this group.

There is a third group, which can have the virus without being sick or transmitting it. Such animals would serve as reservoirs, carrying the disease about and giving it to mosquitoes, but showing no symptoms themselves. An example of such a creature is the pigeon, which can be infected by virus under the skin. About eight hours after the bird is infected, the virus appears in the blood. For three days the virus is there where a mosquito could get it though the pigeon is not noticeably sick.By the fourth day the virus goes, and the pigeon remains quite well. As you see, pigeons might be carrying the disease about without our ever noticing it.

In closing, I would like to remind you that the transmission of encephalitis by mosquitoes is a complicated story. The survey which you are about to make will be of great value in making that story clear. And if we are to stop encephalitis by killing off the dangerous mosquitoes,we must know which are the dangerous mosquitoes.

## SLEEPING SICKNESS IN HORSES

Harrie W. Peirce, M.D.V.
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### Introduction

As you know last summer we had one of the worst epidemics among horses in Massachusetts that has been experienced in many years. Starting the fore part of the summer, it broke out in epidemic form about the middle of August and it was not until that time that it was definitely diagnosed as Equine Encephalomyelitis or Horse Sleeping Sickness. At that time, however, I was not in the office, but Dr. Peirce, who is Chief Veterinarian in our Division, was there and from the experience he gained at that time can give you first hand information. For that reason, I am going to ask Dr. Peirce to give the information which was gained last summer and also the plans we have adopted for this summer to try and combat this disease in horses.

Mark H. Galusha, Director
Division of Livestock Disease Control
Massachusetts Department of Agriculture

Horse sleeping sickness, now professionally known as Equine Encephalomyelitis, has occurred at times sporadically and without question for many years and in many countries throughout the world. But until comparatively recently it has not occurred in extensive or epidemic form. When definitely diagnosed in Massachusetts in the summer of last year, it was recalled by some of the older veterinary practitioners that outbreaks similar in character had been experienced and variously called sleeping sickness, spinal meningitis, cornstalk disease, botulism, ptomaine poisoning, forage poisoning, etc.. It is only within the past ten years that the disease has been reported to such an extent as to attract universal attention. In the years 1930 and 1931 the disease became increasingly prevalent in California; which fact, together with its high mortality rate, attracted the attention of laboratory workers connected with the medical profession, resulting in the discovery that the disease is caused by a virus which these investigators succeeded in recovering from the brain tissue of horses dead from this disease.

Following this outbreak in California, the disease gradually spread into other sections, advancing each succeeding season nearer and nearer to States on the Atlantic coast, where it eventually appeared during the past two years, but was not reported in Massachusetts until August of last year (1938). While it is believed that this disease, encephalomyelitis, was undoubtedly the cause of death of one horse in this State as early as June and of a few scattered cases in July, it was not called to the attention of the State authorities until August fifteenth.

In connection with this disease, certain features are noticeable, viz., it appears only during the summer season; it is more prevalent during warm, moist periods - periods favorable to the propagation of insects such as mosquitoes; that following the advent of frosts fewer horses became affected and reported cases stopped entirely after freezing weather; also that rarely were more than one or two horses affected at the same time in any one stable or on any one farm, indicating that it was not what is referred to as a contact disease. These characteristics of the disease leave little doubt but that the vective agent is some blood-sucking, biting insect, presumably the mosquito. With that conclusion in mind, you gentlemen who are to engage in the work of investigation and mosquito control may be able to render valuable service. The wood tick has been mentioned as a possible factor in the spread of trouble. To date, however, no case has been reported from Barnstable or Dukes County,both of which counties are notoriously tick-infested, but cases were found in Middlesex and other counties where ticks are not prevalent.

Upon the appearance of the disease in the eastern section of the country, laboratory workers made the discovery that, although the symptoms of the disease were practically the same in all sections, there was a definite difference in the virus that caused the disease in that section of the country west of the Appalachian mountain chain and now referred to as the western strain and the virus found in horses which died in the section east of the Appalachian chain and now called the eastern strain. Why there is so distinct a dividing line in connection with this particular disease has not as yet been explained but it appears to be a fact that the western strain has not been recovered from horses which died east of this boundary and the eastern strain has not been recovered west of said line.What is more confusing is that horses transported from one section to the other apparently are not carriers of the disease.

The symptoms of encephalomyelitis in the horse vary somewhat, occasionally assuming a nervous form in which the animal is restless and, if in pasture, will walk or even trot until it drops in a stupor and dies. The more common symptoms are elevation of temperature at the beginning of the attack, reddish-yellow discoloration of the eye membranes,drowsiness, yawning, drooping of the head, pendulous lips, clumsiness of movement followed by staggering gait, leaning against posts, walls, etc.for support and difficulty in swallowing. Thereafter, the horse falls down,paralysis, and death follow in from one to five days from the onset of the symptoms. The incubation period in natural infection is seven days. The rapidity with which symptoms may develop is well illustrated in a case of a horse at a local race track that won third place in a race,appeared sick at the finish and died twenty-four hours later with typical symptoms of encephalomyelitis. Recovery with or without treatment has occurred in some instances, the mortality rate being higher in the east where the eastern type of the disease is found, amounting to ninety percent-plus in this State. Horses allowed out at night pasture are apparently more susceptible to infection, due, undoubtedly, to more exposure.

Weather conditions in Massachusetts during the summer season of 1938 were unusually wet and muggy - ideal for the breeding of insect pests - resulting in heavy infestation of mosquitoes particularly during the months of July and August. In the months of August and September, so-called sleeping sickness became practically epidemic in the southeastern section of the State. In the area described as drained by the Taunton River, more than eighty percent of Massachusetts cases occurred in the counties of Bristol, Norfolk and Plymouth.

Veterinarians for several years had endeavored to combat the disease through the use of drugs, serums, etc.. Non-professionals or quacks were reaping a harvest through the sale of all types of nostrums. Biological laboratories were experimenting with serums and with vaccines manufactured from virus obtained from brain tissue of affected horses but had met with little success until a method was developed for the manufacture of a vaccine from virus grown on chicken embryos, too late, however, for general use last season. This vaccine, now known as chick vaccine, is produced by the introduction of the virus through a tiny hole drilled through the shell of eggs under incubation. The virus is injected into the living embryo on the tenth day of incubation. In from twenty-four to forty-eight hours following inoculation, the shell is broken, the embryo removed, and from it a pure virus is obtained. The virus is rendered harmless by the addition of formalin. The prepared vaccine is injected subcutaneously or intramuscularly into the body of an animal ten or more days prior to exposure to infection. This injection results in the production in the animal of so-called antibodies or protective agents, which protect the horse against the disease for a period of at least six months or beyond the danger period for that year. To insure protection, it is required that two injections seven to ten days apart be used. The use of the eastern type of vaccine will not protect against the western type of the disease, and vice versa.

The screening of stables, the use of fly repellants, etc. while of value is often difficult.

In an attempt to forestall the recurrence of sleeping sickness this year or at least to limit its spread, our branch of the State Department of Agriculture, the Division of Livestock Disease Control, has unreservedly advised the vaccination of all horses. A pamphlet in the form of questions and answers, was prepared and printed, and by cooperation of county agents has been distributed to farmers and horse owners throughout the State. Every town and city in the State has an inspector of animals, a man appointed to investigate and report all cases of suspected contagious diseases of domestic animals. Meetings of these inspectors, veterinarians and horse owners were arranged for by county agents of several counties. At those meetings addresses were made by Mark H. Galusha, Director of this Division. Reports received indicate a large number of horses have now already been vaccinated, especially in the area where the disease was prevalent last year.

In the New England outbreak of 1938 there were approximately 300 deaths in horses in Massachusetts. Definite records have been obtained on 269, out of a horse population of 28,879. Connecticut and Rhode Island both reported a few cases, Maine two, and New Hampshire and Vermont none.

Should you men run into cases of sleeping sickness in horses in the locality in which you are working, I would suggest that you take immediate steps to notify Dr. Getting's office or the Division of Livestock Disease Control in order that we may take steps to get the brain of the animal for a laboratory diagnosis.

# SLEEPING SICKNESS IN HUMANS

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Encephalitis is popularly referred to by the expression "sleeping sickness" in the newspapers but to us medically "sleeping sickness" is a term for encephalitis. Just bear in mind that each term means the same thing, and we shall use the term encephalitis. Generally speaking encephalitis is a broad descriptive term which means an inflammation of the brain. As a matter of fact there are many causes of such inflammation but, regardless of the cause, when individuals have inflammation of the brain, the symptoms which they may present are very much the same. One of the more important symptoms is the deep coma in which these individuals may be, which is the reason it is popularly called "sleeping sickness".

There are many different causes of encephalitis and the problem is always to determine the cause in each particular instance. Briefly I shall recite some of the causes of encephalitis. Some of them are very different from the others. For example, we have a large group that are due to one or another virus. You have had defined to you what a virus is. Bear in mind that there are a large number of different viruses. Some of them cause encephalitis and some do not. For example, smallpox is due to a virus. There are different viruses which cause encephalitis only, so it is necessary in each instance to identify what particular virus is concerned with the particular case of encephalitis. Just to show you some of the differences, rabies is really an encephalitis. In rabies one has an inflammation of the brain due to the virus.

There are other forms of encephalitis due to different agents. For example, there is the so-called African sleeping sickness. This particular disease is not due to a virus at all. It is due to a different agent, a trypanosome, a much more complex germ than a filterable virus. The African type is transmitted by the tsetse fly.

There are certain chemical poisons which may cause encephalitis, for example, lead poisoning. Small children sometimes chew paint and may develop lead poisoning, and as a result may develop an encephalitis which may be very serious.

There is another rather large group of cases of encephalitis that may follow some other infection, and we commonly speak of them as post-infection encephalitis. For example, on very rare occasions, an individual may develop encephalitis following mumps, known as mumps encephalitis. It is not very serious, however. On the other hand, following measles, chickenpox, or influenza, an individual may develop a post-infection encephalitis. This is an entirely different group.

We are only interested in those types which are definitely due to a filterable virus, such as rabies, and equine encephalitis. In this rather large group there are a few well-defined types that have occurred in the past as epidemics. For example, the type about which we know the most occurred in St. Louis a few years ago, and is spoken of as St. Louis encephalitis. This was a rather severe epidemic. The disease was most common in patients living in St. Louis county, outside the city. Gradually it spread to the city itself. A very definite virus was isolated from patients and was proved to be the cause of the disease. This type occurred in the summer months. It was rather serious and occurred more frequently in older individuals than in younger ones. The mortality was fairly high but not as high as in the horse disease, however. The method of transmission of this form of encephalitis has never been proven. There is a strong suspicion that it may be transmitted by mosquitoes but this has never been proven.

Another form, occurring in Japan, is called the Japanese B. encephalitis. It occurs in the summer time and is very similar to the St. Louis type and occurs in epidemics. Large numbers of people are involved during the short period of summer. It is very similar in its seasonal relationship to the St. Louis disease but is due to a virus very different from the latter. You must remember that all these viruses have different properties by which we can tell them apart. It is only recently that the Japanese B. encephalitis has been shown to be transmitted by a mosquito, a particular type of mosquito, the ordinary Culex variety which is one of our more common mosquito pests.

A number of years ago there occurred an epidemic of encephalitis in New South Wales in Australia which is called Australian X disease. That, too, was due to a particular type of filterable virus which is entirely different from the others. That disease was a rather extensive one. At first observers thought it to be an epidemic of poliomyelitis or infantile paralysis. But it was proved later to be a peculiar type of sleeping sickness and the virus causing it was isolated and studied. However, the method of transmission was never discovered.

You will recall that all of these are summer types of encephalitis and that they are all epidemic types. There has been another type of encephalitis called winter encephalitis or Von Economo's disease - after the Austrian who first discovered it. It was originally described as an epidemic type of encephalitis occurring in the winter. It was often referred to as encephalitis lethargica during the World War. We have never discovered its actual cause though we suspect it is a filterable virus. It is different in many respects from the summer forms. It occurs mostly in the winter time and is a very bizarre and chronic type of disease with varying manifestations. There are often sequellae or after effects which are different from the summer type. This gives you some idea of what we mean by the term "encephalitis". This term refers to a process due to any one of a variety of different causes and the problem, always, is to determine the cause in each particular instance.

Now, for a discussion of the problem at hand, that is, encephalitis in man which is due to the virus that causes the disease in horses. I shall briefly describe the disease in horses to give you an idea of it so that you may know the sort of problem we have in investigating it. This disease probably existed for a number of years in the United States but was not recognized until 1931 when Meyer and his associates in California discovered the virus which caused it. They were studying a severe attack in horses in the San Joaquin Valley at that time. In horses the disease occurs only in the summer and it was quite obvious to the early investigators that it was not spread from horse to horse by contact. In the far West, epidemics have occurred simultaneously in areas three or four hundred miles apart. This was a very peculiar circumstance. The first step in understanding it was made by Colonel Kelser of the United States Army Veterinarian Corps. In 1933 he discovered that the horse virus could be transmitted from animal to animal by the bite of a mosquito which transmits other diseases as well, including yellow fever. There are many technical difficulties in such experiments.This,of course, would explain the occurrence of the disease within a localized area even though the horses had no contact with one another.However, it didn't explain the occurrence of the disease in widely separated geographical areas.

About two years after Meyer discovered this virus on the western coast an epidemic occurred on the eastern coast in Virginia and New Jersey. This was due to a similar but different virus and caused a much more severe disease in horses than the western type. It soon became evident that we had in the United States two distinct types, the eastern and the western.

When this epidemic occurred on the Eastern Coast several interesting observations were made. It so happened that the disease occurred simultaneously along the coast of both sides of Chesapeake Bay.A distance of about 25 miles of water intervened between the two areas. This was rather interesting, and while it is possible that mosquitoes could be carried that distance it is not very likely. In 1933 it was shown by Giltner and Shahan that pigeons could be experimentally infected with the virus.It was not known, however, that it caused natural disease among these birds. Later it was shown by others that a number of species of birds could be experimentally infected. Then it was suggested that birds might be the possible vector in carrying the disease over widely separated areas.

During the course of the epidemic among horses last summer we got out first positive evidence that birds might be a vector. A number of ring-necked pheasants, which had died in Connecticut, were sent to Doctor Tyzzer, of the Harvard Medical School, and he was able to isolate the virus from them. At this time a large number of pigeons were dying in the metropolitan area. Doctor Dingle and I secured one of these pigeons and we were able to isolate the virus from it. Here, then, was direct proof that the disease does exist naturally in birds. This would adequately explain its transportation to widely separated areas. We already know that there are numbers of different varieties of mosquitoes which will transmit the disease.As you know, these will feed on birds as well as on other animals.

It was suspected by Meyer shortly after he discovered the cause of the disease for the first time that it may be transmitted to human beings but he had no proof of it. He described three causes of disease under circumstances which seemed likely that it might be transmitted to man. There followed a long period of time during which we gradually became more and more of the opinion that man was not susceptible to this particular virus. Between the years 1931 and 1938 there were extensive epidemics of the disease among horses without one human being proved sick with it. The epidemics in horses have involved nearly every state in the Union.During the year 1937 there were 170,000 cases in horses in the United States. In 1938 over 180,000 horses were afflicted.This gives you an idea how widespread and extensive this disease is.

It was not until last summer when we had the epidemic in horses for the first time in Massachusetts that it was shown to occur in man. As Doctor Feemster has already told you, at that time a number of cases of encephalitis in humans were observed in individuals living in areas where the horse disease occurred. Having isolated the virus and having learned something about it in man, it seems quite reasonable to us that there were probably about forty human cases in this epidemic. It is quite obvious when you bear in mind the many causes of encephalitis which have already been outlined to you that the diagnosis may not be correct in some of these. But considering all circumstances it seems reasonably certain that we had about forty human cases, most of which occurred among young children.

The symptoms of this disease in man are not too different from symptoms of other forms of encephalitis. They differ in minor respects but in general are more or less similar. In the human cases in Massachusetts and particularly in young children, the onset of the disease was usually quite sudden with high fever. They may have had a convulsion at the beginning and then quickly develop a coma or sleeping state. The fever was high, - usually over one hundred and three degrees to one hundred and five. There were various other findings about them, such as a certain type of change in the spinal fluid which was obtained by lumbar puncture. These various other findings were of assistance to us in determining what was the probable nature of the disease. Many of these children would have an illness of two to four days' duration and then die. Some of them, of course, recovered. Proof of the nature of the disease was determined by isolating and identifying the virus from the brain tissue of some of those who died. This is a very important procedure because it is of value in determining the nature of encephalitis not only in man but in birds and all other animals and it is the sort of thing we will be doing a great deal of in all probability. To do this an autopsy is performed, some brain tissue is secured, and this brain tissue which contains the virus is ground up very fine and inoculated into the brains of mice or guinea pigs. After a period of two to three days, these animals show symptoms of encephalitis, become sick, and die. This simply shows that some infectious agent from the human being is transferred to these animals; it does not necessarily tell you what it is. The next step is to identify the virus. There are methods available for doing this, one is to inject encephalitis material in animals that have been immunized against different viruses as follows:-

A series of guinea pigs were treated with vaccine, and made immune against the eastern type. Another group was immunized against the western type. Another lot of guinea pigs were used which were perfectly normal. The unknown material was injected into the brains of all of these guinea pigs. Those which were immunized against the western type died. In fact, all died except those which were immunized against the eastern virus.

Another way of identifying the virus is by means of a neutralizing test. We can produce serums for each of these different types. We can mix this unknown virus with each of these different sera, and then inject the mixture into animals. If the serum is of the same type as the virus, it will neutralize the virus and identify it. If the serum is of another type it cannot neutralize the virus and the animal dies.

It is important to emphasize to you, of course, that these various agents are ultra-microscopic germs which we cannot see. We can only know about them through their effects in animals. They differ from bacteria in that they will not grow in test tubes. These viruses won't grow except in living tissue cells. This, of course, makes their study all the more complex. In other words, instead of using the test tube with artificial medium, we have to use a living animal. Thus, it is necessary in all this experimental work to use experimental animals such as monkeys, mice, guinea pigs, rabbits, etc.

There is another point about the disease in horses which should be emphasized. You may ask, "You make a serum which will neutralize a virus, then why can't you treat a patient with it?" Well, you cannot. One of the reasons why you cannot is that the virus lives only in living tissue cells. If you have already previously immunized the animal, then the virus can't get inside them. Once the virus gets within the tissue cells the administration of serum is of no value.

For the purpose of preventing the occurrence of the disease in horses we have a very effective method of vaccination. We can prepare a vaccine of killed virus which can be injected in horses prior to the occurrence of an epidemic and this vaccine will produce antibodies in the horses so that later if they are exposed to the virus they will not contract the disease. This vaccine is a very recent development and is extremely effective. Obviously, of course, one of our big problems is to see to it that all horses are actually immunized. This is a matter for the individual owner as well as the concern or the State Public Health Department.

Of course, I have already outlined to you the fact that birds may be a reservoir of the virus. On the other hand, as far as our information goes today, which may change as we learn more, the horse and mule are the important reservoirs of this virus, and if they are protected against this virus, certainly the disease should be reduced.

I have already indicated to you that large numbers of different birds and animal species are susceptible to experimental infection by this virus. We want to get a great deal more information about the natural occurrence of the disease in other birds and animals, and in that regard you can be of considerable help during the course of your work in the field. If you observe certain types of birds or wild animals dying in unusual numbers, they certainly should be collected and brought to the laboratory to determine if they died of this disease.

Of course, the role of the mosquito in the spread of this disease has already been emphasized to you, and here, too, a method for the future control of the disease may be suggested. If it is only a limited number of species of mosquitoes which transmit the disease, and if these particular types of mosquitoes are limited in their breeding habits, and so forth, it may be possible in the future to at least partly control them.

There is one other insect vector, however, which is known to transmit this virus, namely, the wood tick. The wood tick, once infected, carries the virus throughout its life, is able to transmit the virus throughout its life, and the virus can be passed on to a succeeding generation of ticks through its eggs. The mosquito has not been known to transmit the virus through the succeeding generation.

One of the important points to bear in mind is that after the horse is bitten by an infected mosquito, there is presumably a period of incubation during which the virus is multiplying and in which there is an invasion of the blood stream before the brain is involved which lasts only a short period of time -- twelve to twenty-four hours. It is only during this time that the mosquito may be infected by biting the animal. Evidently, the virus leaves the blood stream, invades the brain, and the horse then shows the symptoms of the disease.

## LABELS

Vlado A. Getting, M.D., M.P.H.
Technical Director, Mosquito Survey

Collection of Specimens. Wherever mosquito larvae or adults are found, collections are to be made. Each collection, however, must be accompanied by a label. This label serves to identify the place, time and conditions under which the collection was made. As most of the collections will be made at regular collection points, the label used for these collections should be filled out most carefully. In all there are three different kinds of labels; two are used for regular collections, and the third is used for occasional collections.

White Label for Regular Collections.

This label is to be used whenever specimens are collected from a regular collection point. The label is to accompany the vial or box of speeimens.

**Commonwealth of Massachusetts**
**DEPARTMENT OF PUBLIC HEALTH**
**MOSQUITO SURVEY**
**Label for Regular Collections**

**Collection Point No.......................... Date....................... Hour.......................**

**City or Town..........................................................................................**

**Condition or Area: (Circle proper word)**

**Very dry Dry Moist Wet Submerged**

**Vegetation: Dead Withered Drying Healthy Succulent**

**Weather: Sunny Cloudy Foggy Misting Raining**

**Winds: None Mild Moderate Strong Direction.................**

**Prevalence of: Adult Mosquitoes......................... Larvae.........................**

**Specimens collected from.............................................................................**

**Remarks:**

**Name of Collector............................................................**

**100M-(2)-5-'39. No. 7328-a**

Pink Label for Regular Collections.

The pink label for regular collectors is exactly the same as the white label. It is, however, only used when no specimens are found at a regular collection point. If either larvae or adults are found, a white label is submitted; if neither larvae nor adults are found, a pink llbel is submitted.

Commonwealth of Massachusetts
**DEPARTMENT OF PUBLIC HEALTH**
**MOSQUITO SURVEY**
**Label for Regular Collections**

**Collection Point No. ............Date.............Hour.............**

**City or Town.....................................................**

**Condition or Area: (Circle proper word)**

**Very dry Dry Moist Wet Submerged**

**Vegetation: Dead Withered Drying Healthy Succulent**

**Weather: Sunny Cloudy Foggy Misting Raining**

**Winds: None Mild Moderate Strong Direction..........**

**Prevalence of: Adult Mosquitoes............Larvae..............**

**Specimens collected from.........................................**

**Remarks:**

**Name of Collector.....................................**

**200M(2)-6-'39. No. 7622-b**

Both adults and larvae are to be collected at every collection point at every visit unless one or the other are not to be found. Therefore, there will be more than one collection label for each collection point if more than one container of specimens is submitted.

The first line on these two labels is the most important. It contains: 1. The collection point number which is obtained from the town map; 2. Date of collection; 3. Hour at which the collection is made. This should be marked to the nearest half-hour together with the letters AM or PM.

On the second line, write the name of the town or city in which the collection was made. Names of villages should not be used. The name inserted on this line should correspond to the name found on the town map and must be one of the 351 names of towns and cities in the Commonwealth.

The remainder of the label contains information concerning the environment in which the mosquitoes were collected.

Condition of Area. Since mosquito breeding depends so directly upon the presence of water, the degree of dryness noted at each visit should be carefully recorded. The proper term should be encircled. The definition of the terms is given below:

Very dry: When water collections, except in ponds and streams have dried up entirely and the soil is parched and cracking.

Dry: The collection area appears to be approaching the condition of very dry but moist soil can be found within an inch of the surface.

Moist: The color and texture of the soil indicates that moisture is abundant.

Wet: Water is standing or has been standing recently in various parts of the area.

Submerged: Flood waters have covered at least half of the area included in the collection point.

Vegetation. The condition of the vegetation will serve as an index not only of the present amount of moisture but of the amount of the recent past. The proper term should be encircled as above.

Dead: When all vegetation except trees and large bushes is dry and brittle indicating that the plants have had no moisture for many weeks. Such a condition is not likely to occur in New England unless the area has been chosen in an elevation from which all moisture can leak away in the dry periods of August and September.

Withered: The leaves and blades of vegetation have become parched usually with a disappearance of all green color except near the stems of the plants.

Drying: The vegetation begins to show signs of lack of moisture by the coloring of leaves which change at the tips and fringes.

Healthy: Moisture conditions have been favorable so that the leaves and blades of vegetation are of good green color and are apparently moist to the tips.

Succulent: Will indicate that the moisture and food requirements have been particularly favorable and that all the leaves appear to be thick and of the particularly healthy green seen under such conditions. Usually vegetation of this kind is seen in low areas where drying never occurs or in shaded areas which protect plants from drying.

Weather. Circle the word which indicates the condition of the weather at the time of collection.

Winds. A mild wind is barely perceptible. A moderate wind rustles the leaves on trees; a strong wind blows leaves off trees, papers along streets, and bends over trees. In giving the direction of a wind, do not try to be too accurate. Use the terms: N,NE,E,SE,S,SW,W,NW. The direction of the wind can often be easily identified in the following manner: Take out the map of the town. Locate the collection point on the map. Find north and face that way. Wet your finger and hold it over your head. The side on which your finger feels cold is the direction from which the wind is blowing. Always label a wind by the direction from which it is blowing.

Prevalence of Mosquitoes. If none, so state. If less than 25 are seen the approximate number should be stated. If more than 25 are seen, the approximate prevalence should be indicated by the appropriate term (scores, hundreds, thousands, hundreds of thousands).

Prevalence of Larvae. If none are seen, so state. If less than 25 are seen in the whole collection area, the approximate number should be recorded. If more numerous, the approximate number should be recorded by the average number which can be obtained at one dip. For example, if it appears that 5 or 10 can be obtained at a dip regularly throughout the area, the prevalence may be indicated by so stating. If more numerous, by the appropriate term (scores, hundreds, thousands).

Specimens Collected From. Adult mosquitoes collected when biting animals should be put into separate containers and the animal from which collected indicated. Those caught with a sweep-net in the open should be put into separate containers from those caught in buildings and cellars and the place of collection indicated. Larvae collected from similar environments may be put into the same container but those collected from different type of water collections should be separated and the type of collection of water indicated on the label.

Remarks. Any changes in conditions found within the collection point area should be noted under remarks. These changes may include the advent of campers or a herd of cattle. Any important change affecting the breeding of mosquitoes or attraction for mosquitoes should be noted. These items may include: flooding, drying out of collection of water, growth of weeds, burning of vegetation, permanent or semi-permanent changes in population and animals.

Be sure to write your name plainly on the bottom of the label.

Label for Occasional Collections.

**Commonwealth of Massachusetts**
**DEPARTMENT OF PUBLIC HEALTH**
**MOSQUITO SURVEY**
**Label for Occasional Collections**

**Specimen collected by**.............................**Date**.............

**Address**..................................................
No. and Street                    City or Town

**Where collected**...........................................
(If not at above address)

**MOSQUITOES: (Circle proper word)**

| **Kind of Place:** | | | **Prevalence:** |
|---|---|---|---|
| House | Street | | Scarce |
| Barn | Seashore | | Dozens |
| Garden | Riverside | | Hundreds |
| Woods | Lakeside | | Thousands |

..............................................................
(If other, describe)

**LARVAE: (Circle proper word)**

| **Kind of Place:** | | | **Prevalence:** |
|---|---|---|---|
| Pond | Ditch | | Scarce |
| Stream | Puddle | | Dozens |
| Swamp | Tin Can | | Hundreds |
| Marsh | Barrel | | Thousands |

..............................................................
(If other, describe)

**Remarks:** ...................................................

100M-6-'39. No. 7622-a

## SURVEY OF COLLECTION POINT

Vlado A. Getting, M.D., M.P.H.
Technical Director, Mosquito Survey

Gen. Russell emphasized the point that in a Survey of this nature it is necessary to obtain facts. The purpose of this Survey is to obtain facts: facts about mosquitoes, their breeding places, habits and distribution. In order to control mosquitoes we must know what mosquitoes are prevalent in the various portions of the State, where they breed and how far they fly. We must know how many mosquitoes there are in each area at any given time. For those reasons it is important that all facts gathered in the field be accurately recorded in such a manner that there will be no doubt as to their meaning.

Because it is so important to have detailed information about each point where mosquitoes are collected we have devised the Survey of Collection Point Form.

### DEFINITION OF COLLECTION POINT

A Collection Point is defined as an area 100 yards in radius, about some centre which is a permanent landmark. Such a Collection Point may be in the woods, meadow, or at the edge of a large pond. In the last instance, the centre which is chosen should be prominent, easily identified landmark on the shore, and the Collection Point area would extend 100 yards in either direction along the shore and 100 yards inland. It is important to remember that a Collection Point has a radius of 100 yards or a diameter of 600 feet. There may be within this area several different ponds or puddles, or other water containing structures as artificial pools, tin cans, tanks, etc.. In surveying such an area it is important to note all of these various water bodies as at a later date collections may be made from several of them.

### SURVEY FORM

A survey of a Collection Point consists of the recording of facts and information concerning the conditions exiating at that point and in the immediate vicinity about it.The Survey Form contains space for recording facts condering the nature of the vegetation, the water, the terrain, as well as such items as the presence of animals, people,houses, and any other pertinent information. A glance at the accompanying Survey Form reveals that the information required about each Collection Point is divided into 15 groups. Each group contains information of one type, and all together, form the basis upon which selection of points, as permanent Collection Points, will be made.The supervisors will hold each crew foreman responsible for the accurate completion of Survey Forms in his area. A crew foreman in turn will hold responsible his crew members for the proper completion of these forms.

The facts obtained from these Survey Forms will be used not only in determining what areas are selected as permanent Collection Points but will be used in the tabulation and analysis of the prevalence of mosquitoes in certain environments at the end of the season.

It is, therefore, necessary that both crew members and crew foremen realize the importance of accuracy in recording the information. The information recorded on these forms will be in addition the basis for subsequent institution of control measures whenever such measures may be necessitated by recurrence of Equine Encephalomyelitis or by some other pertinent reason. As these facts recorded in the Survey Form may be the means of preventing suffering and saving lives, all men engaged in recording this information are requested to take an active interest in their work and do their best to obtain accurate information.

COLLECTION POINT NUMBER

At the top of the Form is the Collection Point number. It is important to understand how this number is derived in order that you may put the correct numbers at the tope of each form.

The Collection Point number consists of three portions, each containing two digits. There are in all six digits to a Collection Point number. The first two digits represent the COUNTY; the second two digits represent the TOWN and the third two digits represent the POINT NUMBER.

The Commonwealth of Massachusetts contains fourteen Counties and each County is assigned a number. The Counties are numbered in the following order beginning with the Southeast and working upward to the North, and gradually westward.

| | | | | | |
|---|---|---|---|---|---|
| Nantucket | 01 | Norfolk | 06 | Franklin | 11 |
| Dukes | 02 | Suffolk | 07 | Hampshire | 12 |
| Barnstable | 03 | Essex | 08 | Hampden | 13 |
| Plymouth | 04 | Middlesex | 09 | Berkshire | 14 |
| Bristol | 05 | Worcester | 10 | | |

It is necessary to have two digits in the County number for the purpose of tabulating by the punch-card machines.

There are 351 towns and cities in Massachusetts. However, the towns and cities in each County are considered as a separate unit and are numbered beginning with 01 in their alphabetical order; thus, the second two digits in the collection point number indicate the number of the town in that County. In order to identify a town by a number it is, therefore, necessary to have the County number and the Town number.

The third two digits in the collection point number represent the number of the point in that town. The collection points in any town begin with 01 and continue on consecutively thereafter. Thus, for example, Point #5 in Boston would be labelled on the Survey Form 070105. The first two digits 07 represent Suffolk County, the second two digits indicate Boston, and the third two digits represent the point number as 05 which will be identified as such on a marked map.

Each field worker will be furnished with a map of the town he is to cover. On this map there will be marked the points which are to be surveyed. Each point has a number beside it. In the upper right-hand corner of the map are the County and Town numbers. Thus, in labeling the Survey Form the number of the Collection Point can be easily obtained by

COMMONWEALTH OF MASSACHUSETTS
DEPARTMENT OF PUBLIC HEALTH



MOSQUITO SURVEY

Survey of Collection Point No. 090201

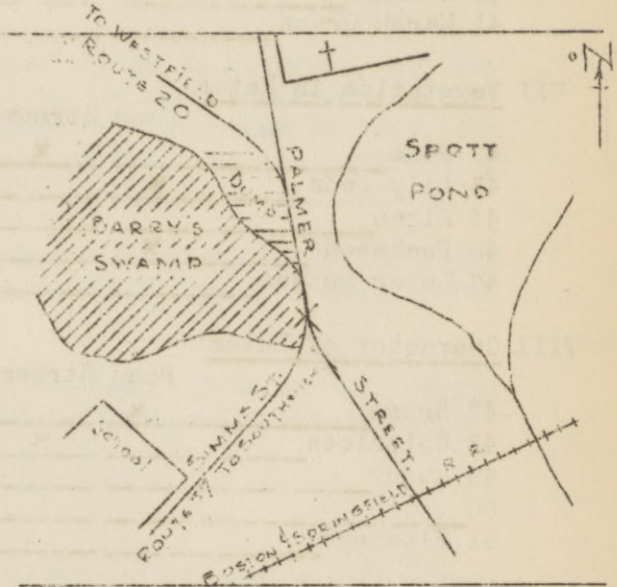
LOCATION: City or Town Arlington

Property Owner John Graham

Address: 146 Palmer Street

Center Point of Area: Junction of Palmer and Simms Streets

Drained by: Spott Pond




Sketch of Collection Point
"X" marks center of Area

DESCRIPTION OF AREA:
(Check proper terms)

I Contour

01 Level ____
02 Valley __X__
03 Hillside ____
04 Hilltop ____

II Nature of Terrain

| X | A | B |
|---|---|---|
| 05 Cultivated fields | | |
| 06 Meadow, pastured | | |
| 07 Meadow, unpastured | X | X |
| 08 Rocky | | |
| 09 Woods | | |

III Natural Water Collections

11 Marsh ____
12 Pond or Lake __X__
13 Puddle ____
14 River or Stream __X__
15 Rocky crevice ____
16 Swamp __X__
17 Tidal Flat ____

IV Artificial Water Collection

18 Cranberry Bog ____
19 Excavation ____
20 Quarry ____
21 Sand Pit ____
22 Root Hole __X__
23 Tree Hole ____
24 Well ____
25 ____

V Water Containers

26 Artificial Pool ____
27 Barrels ____
28 Bird Baths ____
29 Cesspools & Overflow ____
30 Cistern, (Open) ____
31 Dump __X__
32 Flower Pots ____
33 Water Tanks (Open) ____
34 Water Troughs ____
35 ____

## VI Vegetation at Water Edge

| | Pond | Stream | Swamp ~~Other~~ |
|---|---|---|---|
| 36 None | | | |
| 37 Cat tails & Reeds | X | X | X |
| 38 Pickerel Weeds | X | | |
| 39 Arrow Head | X | | |
| 40 Bulrush | | | X |
| 41 Marsh Grass | | | X |

## VII Vegetation in Water

| | Pond | Stream | Swamp ~~Other~~ |
|---|---|---|---|
| 42 None | | X | X |
| 43 Lily Pads | X | | |
| 44 Algae | | | |
| 45 Duckweeds | X | | |
| 46 Water Mosses | | | |

## VIII Character of Water

| | Pond | Stream | Swamp ~~Other~~ |
|---|---|---|---|
| 47 Brown | X | | X |
| 48 Colorless | | X | |
| 49 Muddy | | | |
| 50 | | | |
| 51 Floatage | | | |

## IX Character of Bottom

| | Pond | Stream | Swamp ~~Other~~ |
|---|---|---|---|
| 52 Earth | | X | |
| 53 Leaves | X | | |
| 54 Mud | | | X |
| 55 Rock | | | |
| 56 Sand | | | |
| 57 Vegetation | | | |

## X Trees

| | A | B |
|---|---|---|
| 58 Evergreen | X | |
| 59 Hardwood | | X |
| 60 Willows | | |
| 61 Fallen Trees | | |
| 62 Burned Trees | | |

## XI Weeds and Undergrowth

| | A | B |
|---|---|---|
| 63 Bushes | X | |
| 64 Hedges | | |
| 65 Weeds over 3 feet | | |
| 66 Weeds under 3 feet | X | X |
| 67 Recently Burned | | |

## XII Animals in Area

| | A | B |
|---|---|---|
| 68 Cattle | | X |
| 69 Chickens, Young | | X |
| 70 Chickens, Adult | | X |
| 71 Ducks, Domestic | | |
| 72 Ducks, Wild | X | |
| 73 Hogs | | |
| 74 Horses | | X |
| 75 Mules | | |
| 76 Partridge or Pheasants | | |
| 77 Pigeons | | |
| 78 | | |

## XIII Buildings in Area

| | A | B |
|---|---|---|
| 79 No Houses | | |
| 80 Less than 5 houses | X | |
| 81 6-25 Houses | | |
| 82 26-100 Houses | | X |
| 83 More than 100 Houses | | |
| 84 Factories | | |
| 85 Poultry Houses | | |
| 86 Stables | | |
| 87 Other Outhouses | | |

## XIV Mosquito Control Measures

| | A | B |
|---|---|---|
| 88 Diking | | |
| 89 Ditching | | |
| 90 Filling | | |
| 91 Oiling | X | |

## XV Prevalence of

| | |
|---|---|
| 92 No Mosquitoes | |
| 93 Mosquitoes Scarce | X |
| 94 Mosquitoes Numerous | |
| 95 No Larvae | |
| 96 Larvae Scarce | |
| 97 Larvae Numerous | X |

DATE OF SURVEY May 26, 1939.

MADE BY Charles Dwyer.

DATE OF CHECK June 17, 1939

CHECKED BY George Clark

simply copying the number from the upper right-hand corner and adding to it the number directly beside the Point marked on the map. The Collection Point number will appear not only on the Survey Form but also on labels accompanying collections made at the same point so that each specimen will be readily identified as to its place of collection.

LOCATION

After the number of the Collection Point is recorded at the top of the page, the next item to be filled in is the location of that collection point. This consists of the name of the town or city, the name of the property owner and his address, as well as the address of the Collection Point.

Center Point of area is to be described on the form in a few words, such as: Gulf Gasoline Station, crossing of Route 9 and Route 32, etc.

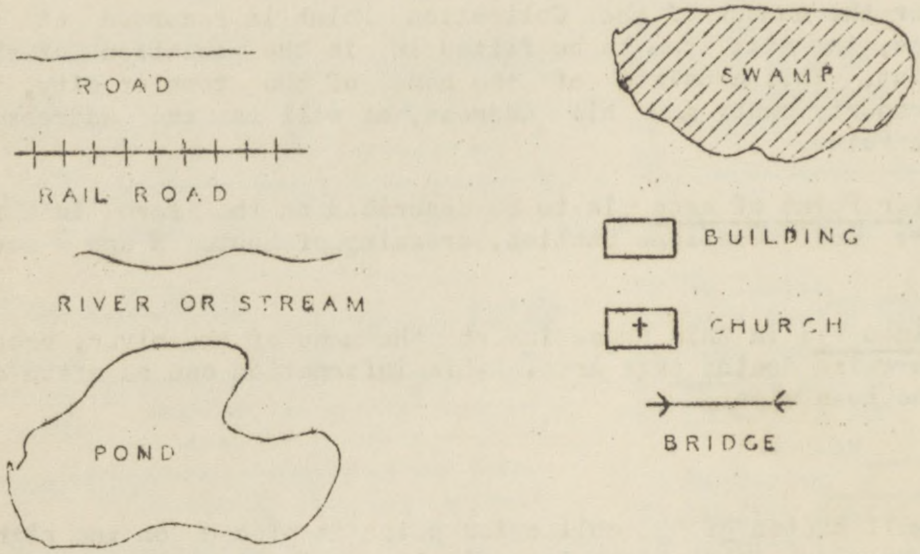
Drained by: In this space insert the name of the river, brook, stream or pond which drains this area. This information can be often obtained from the town maps.

SKETCH

A small sketch of the collection point is placed on the right-hand side of the page. This sketch is a simple pencil line picture of the collection point area and is to contain only such identifying landmarks as are needed to locate the collection point. The purpose of this sketch is to enable a second person to visit the same collection point and to be able to identify the center point as well as the boundaries of the collection point area.

The sketch is to be placed on the form in such a way that direction NORTH will always be at the top of the page. This will place EAST on the right-hand margin of the page and WEST on the middle of the page. Mark the center of the collection point with the letter "X". This "X" is to be placed in the middle of the sketch. A circle is to be drawn about the "X" outlining the boundary of the collection point. It is important to remember that a collection point extends for 100 yards in every direction from the center.

Various simple emblems are used to picture the landmarks. A road is drawn as a simple line. When a road reaches the edge of the sketch, the name of the town to which that road leads should be placed there. In addition, route numbers should be used to label a road whenever possible. A railroad is drawn as a straight line with short cross-secting lines at regular intervals. The letters "R R" may be placed along side such a line. A river or stream is drawn as a curved line following the actual curving of the river or stream bed. Such a river or stream should be labelled with the name, as Roaring Brook, or Mill Stream. If the name of the river or brook is not known, then, the words "river" or "brook" alone should be inserted. A pond is represented by a more or less circular outline following the natural contour of the pond. The name of the pond should be placed within the outline of the pond. Churches may be labelled by using small squares with a cross on top of them. Schools may be labelled by small squares with the letter "S" in them. Buildings may be pictured by small squares with the appropriate designation which will identify them to a person visiting that area. A swamp or marsh may be indicated by drawing in diagonal lines or shading and labelling the same area as "swamp" or "marsh".



EXAMPLE OF SYMBOLS TO BE USED IN SKETCH.

Above all, the sketch should be simple and outlined in form containing only such information as is necessary for a second person to find the Collection Point described.

DESCRIPTION OF THE AREA

Outstanding features of the description shall be indicated by placing an "X" mark opposite the proper items in lists I-XV. Some of these lists have only one column in which marks are to be placed. In these lists record information only for the area within 100 yards of the center point.

When there are two columns, the information to be recorded shall be:

Column A: Information in regard to the area included in the collection point (that is, within 100 yards from the center point).

Column B: Information in regard to the area outside and immediately adjacent to the collection area, but not farther away than one quarter of a mile (440 yards) from the center point of the collection area.

When there are three columns, headed respectively, "Pond", "Stream", and "Other", information should be recorded only in the appropriate column if there is only one kind of water collection in the area. For example, if the area is in a marsh and no pond or stream is present, the information should be recorded in the column headed "Other". When there is either a pond or stream as well as other types of water collection, two columns should contain information. In some cases all three columns will have to be filled in. No information in regard to the area outside the collection point (that is, more than 100 yards from the center) shall be recorded in these lists. If two streams are present in the same point, the characteristics of one will be the same as the other. Therefore, when there are two or more streams, enter the information in the column "Stream". The same condition holds for ponds. Enter all the information concerning ponds under the column headed "Pond".

I Contour

Indicate by marking the proper word the location of the center point of the collection area. Mark only one item. Choose that term which most represents the greatest portion of the terrain. Observe the surrounding area and obtain a general idea of the region. Then shift your attention to the collection point and fix it in your mind in relation to the whole region. In this way, you will have obtained the best idea as to whether the collection point is on a hilltop, on a hillside, in a valley, or on the level, as a marsh along the coast.

II Nature of Terrain

Mark one or more item in both columns "A" and "B". In considering this group, it must be remembered that we are interested only in general characteristics and not in minute detail. For example, if a corner of a cultivated field extends within the collection point for about ten feet and the rest of the collection point is a pastured meadow, place an "X" opposite meadow pastured and do not mark cultivated field.

III Natural Water Collections

Record only collections within the collection area. Mark as many items as necessary. Ponds and lakes are any fresh water body which is definitely larger than a simple widening of a stream or river. No distinction is made between a pond and a lake; and none is made between stream and river, as in many parts of the state these terms are used interchangeably.

A puddle is defined as any shallow small collection of water, usually temporary, and is likely to occur after heavy rains. If a puddle is found on or between rocks, it is listed as a Rocky Crevice. A marsh and a swamp may be either fresh or salt. A marsh is land which is covered with water and marsh grass but has no trees. A swamp is marshy ground covered with trees.

IV Artificial Water Collections

Record only water bodies within the collection area. If other types of collection are found, write in the appropriate word or words in item #25. Note only such items that contain water at the time the survey is made. Such items as "root hole" should be noted if they are potential or actual breeding places.

V Water Containers

Record only containers found within the collection area. If other types of containers are noted, write in the appropriate word or words in item #35. In recording such other items, write in the common name as tin can, auto tire, etc.

VI Vegetation at Water Edge

Applies only to collections of water within the collection area. If there are two streams in the area, make description apply to the one occupying the greater proportion of the collection area. If there are two ponds, choose the one which has the longest shore line in the area. Write in beside the heading"Other" the type of water collection about which information is being recorded in the third column.

VII Vegetation in Water

Follow procedure outlined under VI.

VIII Character of Water

Follow procedure outlined under VI. If the water is of another color than indicated, write in color in item #50. Mark item "Floatage"only if enough is present to break waves or otherwise give protection to mosquito larvae.

IX Character of Bottom

Follow procedure outlined under VI.

X Trees

Information should be recorded both for the collection area (Column"A") and the area surrounding (Column "B"). Do not mark an item unless ten or more trees of the particular variety are present in the area.

XI Woods and Undergrowth

Mark items in both Columns A and B.

XII Animals in Area

Mark items in both Columns A and B. If other animals or birds are seen in numbers of five or more, write in the kinds in item #75.

XIII Buildings in the Area

Mark items in both Columns A and B.

XIV Mosquito Control Measures

Mark items in both Columns A and B.

XV Prevalence

Make an estimate of the number of mosquitoes and larvae present in the collection point. Scarce indicates ten or less. If more than a dozen mosquitoes or larvae are seen, place an "X" opposite the item Numerous.

Date and Signature. Sign and date the form as soon as all of the items have been correctly marked. It is important to fill in the date so that when a check survey is made later, account of the interval of time can be made.

Definition of Terms. Most of the terms are common terms, and do not need definition. Those which need definition are listed below:

6. Meadow - any uncultivated grass-covered field with few or no trees.
11. Marsh - is distinguished from a swamp in that the latter has trees whereas the former has none.
13. Puddle - any shallow small collection of water, usually temporary.
15. Rocky Crevice - a collection of water between or on rocks.
16. Swamp - land covered with water and trees
22. Root Hole - a hole left as a result of uprooting a tree.
23. Tree Hole - a hole in the trunk or branch of a large tree.
37. Cat tails & reeds - tall reeds growing in marshy, swampy areas or in shallow ponds. In the spring are short but later are over 4 feet tall; they are also called "punks".
38. Pickerel Weed - flowers have purple or blue spikes. The plant is found in same places as cat tails; usually 3 feet.
39. Arrow-head Leaves - are arrow-head in shape. Plant is less than 2 1/2 feet tall.
40. Bulrush - are rush-like plants, similar to cat tails but smaller. Usually grow in clumps.
41. Marsh grass - any grass which grows in marshes or swamps
44. Algae - may be green, blue, or brown, grows on submerged rocks and logs. Varies greatly in size. They are delicate and hair-like in structure.
45. Duckweed - small floating plants in still ponds. Form green water blankets made up of thousands of little plants floating on surface. The plant is about 1/4 inch wide and has several rootlets hanging down from the undersurface. These rootlets do not reach the bottom of the pond.
46. Water mosses - are a slender, very dark green mass with long streamer-like branches, which wave from stones in swift currents or grow upon stones and wood on edges of ponds.
51. Floatage - floating debris, tree trunks, and branches in sufficient quantity to break waves and protect mosquito larvae.
58. Evergreen trees - cedar, fir, hemlock, pine, spruce, or any tree belonging to this family.
59. Hardwood trees - trees which have broad leaves.

In conclusion the form is a record of the collection point and must be accurate to serve its purpose. Foremen will be held responsible for all survey forms in their district and are expected to teach the crew member how to fill in a survey form. Each field worker will be given a mimeographed copy of "Instructions for Filling in Survey of Collection Point". Instill an active interest and a spirit of cooperation in your crew and the work will be better and more easily done.

# DAILY WORK OF CREW

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Organization of Field Crews. The W.P.A. field workers are divided into twenty crews, one for each district in the state. The number of crew members in each crew varies directly with the number of towns in the corresponding district. Each crew is in charge of a foreman. In all there are twenty foremen and eighty-five crew members. In the absence of the crew foreman the assistant crew foreman is the person in charge.

The state is divided into four areas. Each area is under the direct supervision of the Area Supervisor who is responsible for the crews in his area. Each area contains from four to six districts.

Duties of Area Supervisor. The area supervisor is responsible for all W.P.A. workers in his area. His work consists of periodical visits to each district.At these visits he supervises the administration of the district. He likewise checks workers in the field. During these visits he leaves supplies for the coming week and picks up such collections as have been made since his last visit.

The supervisor holds the crew foremen responsible for work in their districts. He checks the district records,survey sheets, volunteer and W.P.A. collections. Once a week the supervisors attend a conference in the central office in Boston. At this time they pick up supplies for the forthcoming week, receive instructions concerning problems which haven arisen and leave collections which they have picked up from the field.

Duties of the Crew Foreman. Each crew is under the direction of a foreman. This foreman owns an automobile which he uses to contact local Boards of Health, Boy Scouts, Y.M.C.A. and other summer camps, and schools. One of the duties of the crew foreman is to act as contact man between the Mosquito Survey and such organizations as are to do volunteer collecting.Enlistment of volunteer collectors by public speeches and demonstrations is one of his most important duties.

Supervision and checking the work of the crew forms a second important item in the foreman's duties. He checks the crew in and out in the morning and afternoon, gives them supplies at the beginning of the day and collects the specimens in the evening. All specimens are inspected for the presence of larvae or adults and for correct labeling and filling of the vials. Survey sheets are checked for completeness. The foreman keeps each crew member's collections separate and turns these over to the supervisor with a report as to the number of collections made by each man each day of the week.

The third important duty of the crew foreman is keeping accurate and complete records. The foreman is to make a copy of the survey sheet; the original is kept and filed at the district headquarters and the copy sent to the central office in Boston. It is the foreman's duty to see to it that each crew member sends in the required weekly report and that he himself submits summary reports for the work of the crew each week.

Duties of the Assistant Crew Foreman. The assistant crew foreman is responsible in the absence of the crew foreman. Each assistant foreman owns and operates an automobile in which he transports the crew. The assistant foreman goes over a designated route and drops off crew members at designated points, one in each town. Thereafter, he proceedes to the farthest and usually the largest town where he collects, as other members of the crew, with the exception that he goes from point to point in his automobile.

Duties of the Crew Member. The chief duties of the member are the collection of adults and larvae and the establishment of collection points by filing of survey sheets. Crew members meet at a designated point at each district at a given time. They are transported to the towns which are to be covered during that day's work and are dropped off one by one in different towns. They proceed on foot between collection points and at the end of the day are picked up by the assistant crew foreman at a designated point.

In certain instances some crew members will be requested to contact summer camps in an effort to enroll volunteers. Such instructions will be given by the supervisor or foreman.

Transportation. There are two automobiles in each district. One automobile is used by the crew foreman principally for volunteer work. Whenever possible the crew foreman will so arrange his schedule that he will cover the same town in which his crew is collecting. In this way he may be able to assist in the transportation of the crews.

The second automobile is operated by the assistant crew foreman and is used for the transportation of the crew. The assistant crew foreman is not to transport the crew from point to point. As outlined above, one crew member is dropped in each town which the crew is to cover on any particular day. The schedule is so arranged that every crew member will cover on the average one town per day.

Compensation for injuries sustained in line of duty cover the worker to and from work, provided he does not stop for any purpose whatsoever. The state is not liable for any injury sustained by the worker, because of reckless or fast driving. Hitchhiking is forbidden, and any worker found to be breaking this regulation will be warned that a second offense means dismissal.

Hours of Work. The crew will meet at a place designated by the foreman before nine o'clock in the morning. By nine o'clock the crew will have received such supplies as it needs for the collections that day. According to W.P.A. regulations the crew works five six-hour days per week. One hour, between twelve and one, is allowed for lunch; this enables the worker to rest during lunch time. On returning at the end of the day, the assistant foreman arranges his schedule in such a way that he picks up the last crew member at three o'clock. This is in accordance with W.P.A. regulations, and the return trip from this time onward is on the worker's time.

Collection of Specimens. The crew member in each town will proceed on foot from public roads to the designated collection points as shown on the town maps. During his first visit to such a collection point a survey sheet will be made out completely. The crew member will thereafter proceed to collect adult mosquitoes as described in detail in "Instructions for Catching Adult Mosquitoes". In general the adults are caught either by a net carried by the crew member or by simply placing the killing tube over the resting mosquito for a few minutes until the mosquito is killed. The adults are then placed between layers of cellulose in a pill box. A label is filled out folded and placed inside the box.

He will likewise collect larvae by the method described in "Instructions for Collecting Larvae". Water containing the larvae is dipped from water collections with a large white dipper. The larvae are then carefully sucked up into a medicine dropper and transferred into a small vial. After the crew member has collected several such larvae, he will fill the vial to about one inch from the top, add five drops of formalin and cork the vial. For easy identification the formalin has been dyed a light blue. No other solution should be used in attempting to preserve the larvae. Before the cork is inserted into the vial, the identification slip is marked with the number of the collection point and date of collection and inserted inside the vial. A label is filled out, folded, rolled about the vial and secured with a rubber band. If no specimens of either adults or larvae are found, the crew will fill in a pink label for the collection point. The collection of adults and larvae at any one collection point should not take more than fifteen or twenty minutes. Upon completion of work at one collection point, the crew member proceeds on foot to the next point.

If there are more than one type of water collections in a collection point, a collection of larvae is to be made in the different kinds of water. Each collection is to be placed in a separate vial and separately labelled. For example, a pond, a running stream and a tree-hole are three different types of water. Collection should be made from all three, the specimens being placed in three separate vials, each with its own label.

Establishment of Collection Points. From time to time the crew member establishes new collection points. New collection points are to be not less than about 1/4 to 1/2 mile distant from one point to another, unless there is a marked difference between the adjacent points. A survey sheet is to be made out for every new collection point.

Precautions. Members of the Project are not permitted to enter areas used for water supplies. This includes water sheds as well as reservoir areas. Entry into any areas used for water supply unless special permission is granted by persons in charge is not allowed.

Workers are urged to be careful in walking through or across private property. Permits for entry on private property are necessary before collections can be made. Such permits have already been obtained for collection points to which members are sent.

Every man is held responsible for his equipment, and except for fair wear and tear he will have to replace any equipment which is damaged or lost through carelessness. Rain coats, nets with handles, large white enamel dippers, search lights, medicine droppers, killing tubes, vials, pill boxes, labels and necessary solutions are furnished each man.

Since the survey is being carried out in an attempt to locate the carriers of Equine Encephalomyelitis, it is urgent that each one of you realize the importance of the work that he is doing. Accuracy in filling out forms and throughness in searching for specimens are essential. Remember that a mistake on your part or a falsification on the part of a man in your crew may result in misinformation being collected in the central office. Such misinformation may lead to otherwise avoidable illness and suffering on the part of some child. Each field worker is on his own responsibility and is expected to do his best. If at any time he has any doubt as to what should be done, such matters should be at once referred to his superior.

INSTRUCTIONS FOR COLLECTING ADULT MOSQUITOES.

Adult mosquitoes prefer shaded areas to bright sunlight. They are more apt to be found in woods, weeds, or inside buildings that in an open field or meadow. Many species prefer damp areas, such as cellars, marshes or swamps. During the day the adults can be found, resting under leaves, on shaded tree trunks, between weeds, or in some sheltered place where strong winds, sunshine or rain are not likely to disturb them.

Mosquitoes are more numerous towards dusk than during the middle of the day, and some species are almost entirely nocturnal in their biting. Only females bite, some species do not bite all animals, but limit their feeding to particular ones, wheras other species will bite almost any animal.

Often male and female mosquitoes swarm over water. At such times it is easy to catch large numbers with the sweep net. After the mosquitoes are in the net, the uncorked killing tube, which contains carbona absorbed in gum rubber, is inserted into the net. The mosquito usually rests on the net; the mouth of the killing tube is carefully place over the mosquito and held against the palm of the other hand for a few seconds until the mosquito is easily shaken off.

Search should be made among bushes, inside buildings, and on animals for adult mosquitoes. They may also be collected directly by placing the killing tube over them as they settle down upon objects, upon the hand of the collector, or upon animals. The tube is held in place until the mosquito is easily dislodged on gentle movement of the tube. In all cases, the mosquitoes are allowed to die in the killing tube and are then transferred to the pill box and protected from injury by placing them carefully between layers of cellulose. Mosquitoes caught on animals should be put into separate containers, and the name of the animal should be written on the label. Fold the label three times and place inside the pill box. At all times it is important to injure the mosquito as little as possible, as specimens without wings, or legs are often impossible to classify.

## INSTRUCTIONS FOR COLLECTING LARVAE

Mosquito larvae are found near or at the surface of undisturbed and quiet water collections. These water collections may be a pool in a stream, a pond, a marsh, a puddle, a tin can, a dish under a flower pot or any other water collection. Some species of mosquitoes prefer to lay their eggs in fresh water, others in brackish water. Several species will lay eggs only in clear water; others are not so particular and will lay their eggs in almost any water.

Mosquitoes prefer to lay their eggs in sheltered spots between water plants, floating debris, at edges of pools where waves or direct sunlight are not too strong. Under favorable conditions mosquito eggs hatch into larvae in about 3 or 4 days. The larvae rapidly increase in size and in about a week to ten days change into pupae from which the adult mosquito emerges in about two or three days.

In approaching a water body where collections of larvae are to be made it is important to move as cautiously as possible as vibrations transmitted to the larvae cause them to leave the surface and drop towards the bottom.

Larvae are collected by dipping up water from any collections found within the bounds of the collection point. If the water is seen to contain larvae, these are removed from the dipper by means of the pipette equipped with a rubber bulb, and dropped into the specimen tube. Not more than twenty-five larvae should be obtained from any one collection of water. Larvae should be placed in separate containers when the character of the water collection is different. For instance, if larvae are found in tree-holes, tin cans, and other containers, and in roadside ditches, in addition to the water of a pond or stream, collections from each should be put in a separate container and the source designated on the label. Fill vial to one inch of the top with water and add five drops of the formalin to kill and preserve the larvae.

Carefully cork each vial after inserting into it the identification slip - on which are marked the number of the collection point and the date of the collection. Fold the outside label once, roll it about the vial and secure it with a rubber band. During transportation the vials should be shaken as little as possible so as not to destroy identifying characteristics of the specimens.

ORGANIZATION OF COOPERATING AGENCIES

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I would like to spend some time talking about some of the cooperating agencies with which we are working in this project so that as you go around you will have an understanding of the groups you are meeting. Because one of the most important of these groups will be the boards of health, I should like to give you a brief picture of the organization of boards of health in this State. Some of you may know a great deal about it; some may not.

There are 351 cities and towns in Massachusetts, and each one of these is a completely autonomous political unit and runs its own affairs except in matters that have been subject to State legislation. Among other things, each one of these cities and towns is its own boss in regard to all matters of public health. The Massachusetts Department of Public Health is in a large measure simply an advisory body. We have no powers to do anything except make investigations unless we are given power by legislative act. The legislature has seen fit to turn over to the Department of Public Health the supervision of public water supplies in the State. If we have reason to believe that a public water supply is unsafe for the people in the town to use, we can demand that the local water board or private water company shall make certain changes so that the people of that particular community shall have a safe water supply. The legislature has also seen fit to turn over to our department the regulation of pasteurizing plants. I could mention other powers which we have but they are not numerous and these serve as examples. Contrary to the belief of half of the citizens of this State, therefore, we have no authority over local boards of health in the general run of health matters. We have wide authority for going into any city or town to make an investigation of anything that we think is affecting the health of the people. But when we have made that investigation, we can only make a report to the local board of health giving our recommendations. If they see fit, they can act on them. We have been able to obtain action by the local board of health by persuasion or simply by calling their attention to the situation.

Because all of you Senior Information Recorders are going to be dropping into the offices of these boards of health, I want to have this clear understanding that we have no authority, and that we want to maintain the splendid feeling of cordiality and cooperation which we have built up with these organizations ov er a period of years. So one of the worst offenses one of you can commit is to make someone on a local board of health angry with you. It is not our province to enter into arguments with any of those people. I hope that you will bear this in mind in your relationships with the local boards of health.

Now a few words in regard to how these boards of health are organized. There are a few large cities which, because of special charters which have been granted by the State legislature, have a particular kind of health organization, and this particular kind is a department headed by a commiccioner of health, and that commissioner has full authority on all health matters. He makes the decisions on what should be done in regard to health, and usually he has a sufficiently large personnel so that all phases of public health in his community are cared for by these employees of his health department. Starting with Boston and Springfield we have half a dozen of the cities which have this particular kind of health department. And you see, the man in authority is commissioner of health.

A large percentage of the communities of the State, however, do not have a health commissioner, but have a board of health consisting of three members elected in town meeting or any other way in which the town elects to carry out the appointing of officers of the town. These three members of the board of health, then, are the final authority in all health matters in that town; their decision is final in regard to health matters. Of course, in the larger communities there is a sufficient amount of work so that it is necessary for the board of health to have certain employees to carry on the work. Many of them have an agent who carries on the routine work, reserving for themselves the formulation of plans of work and the principles on which the board of health operates. In many cases, then, you will be dealing not with the board of health but with the agent of the board of health; and when you go into the board of health office you will ask for the agent of the board of health. In some of the smaller communities, where there is no necessity in having a full-time man working at this, usually one member of the Board of health is designated as agent and he takes care of the work of the board of health, consulting with the other two members of the Board from time to time on matters of major importance.

You will find that there is a great deal of variety in the way health matters are administered in different communities. In small towns where there are no particular health problems, often no agent is officially designated. We will usually give you the name of the individual whom you are supposed to visit when you go to the community to pick up any samples collected by volunteer collectors or to take containers to them.

Now going down one step further in the size of the communities, we find that there are certain of the smaller communities that do not elect a board of health. In this case all the functions of the board of health are performed by the board of selectmen. The board of selectmen is really the governing body of the town in all kinds of matters and in the smallest of the towns there will be practically no full-time employees,- a town clerk and one or two others necessary for the keeping of records. In that case you will be dealing with some member of the board of selectmen since there is no board of health except as its duties are administered by the board of selectmen.

That gives you, then a mental picture of these organizations that you are going to be contacting. That is just a beginning. There are other agencies that are cooperating in this survey with us, and I would like to just run rapidly through some of them so you will have some idea as to what they are and how they are cooperating.

The State Department of Agriculture is interested in this survey because this has a livestock angle as well as a human angle, and you have already heard Mr. Galusha and Doctor Peirce speak in regard to the livestock angle of this survey. They are interested because they want the domestic animals in Massachusetts to be protected against this disease. And we may find that animals other than horses are affected as we study the matter further.

Now the Reclamation Board is, we may say, for administrative purposes, in the Department of Agriculture. The Reclamation Board is formed in this manner. One member is appointed by the Commissioner of Public Health, one by the Commissioner of Agriculture, and the third member agreed upon by the two Commissioners. These three members administer the work of the Board. Mr. Wright, it happens, is one of the members of that Board. The Board was set up in the Department of Agriculture so far as paid employees of the Board are concerned. Mr. Stratton, the Secretary for the Board, has his desk in the Department of Agriculture. So, we have contact with the Department of Agriculture in this way.

The State Department of Conservation comes into the picture because they are interested in the welfare of the wild life of the State; and before we get through with this study, we may find that there are numbers of wild animals and birds affected by this disease. As you know, the pigeon and pheasant can die of a disease caused by the equine virus, and we don't know how many other animals and birds may be affected. The Department of Conservation has animal and bird refuges in different parts of the State. They control a large area of park and forest land in certain parts of the State, and it is only by their permission that we can send you to these areas. You will carry with you a copy of a letter from the Commissioner of Conservation saying that the workers on this project have been given permission to work on State reservations, State parks, animal and bird refuges, etc.. That is something you will have to pull out if you are stopped in one of these restricted areas and asked what your business is. Those of you who will go into lands controlled by the Metropolitan District Commission will likewise carry a letter from the Metropolitan District Commission giving you permission to enter on these lands. The Metropolitan police are being informed that this project is going on and that they may expect you to appear in these reservations.

We are obtaining the cooperation of some of the other Departments of the State government. Suffice it to say that the superintendents of the tuberculosis sanatoria under the State Department of Public Health will be cooperating in this, and you will have to contact certain men to pick up what has been collected on the grounds of those sanatoria. There are institutions in a number of other State Departments. For instance, in the Department of Mental Health there are some sixteen institutions, scattered in various parts of the State; and they have already been visited by our State District Health Officers who explained the survey to them and their employees, and they have already begun collecting mosquitoes and mosquito larvae. After your crews are working in the field and you can let them function independently, the Senior Information Recorders will be free to come and go to make these other visits we have planned for you. There may be in some of your areas some of these institutions of the Department of Mental Health. There are also institutions under the Department of Public Welfare,--some five or six institutions. You will have the names of all these. I just want to call your attention to these before you go into the field. There are also the institutions under the Department of Correction. You will be expected to visit these from time to time during the summer, whatever number of times it is necessary in order to see that they keep supplied with containers and that you pick up the material which they have collected.

Now in addition to those, there are some twenty camps of the Civilian Conservation Corps in this State. The machinery for getting the cooperation of these camps has not been finished, but I expect within the next week or so to have all of these camps set up collecting specimens in the areas in which the boys are working.

There will be a certain number of summer camps run by Boy Scout, Girl Scout, Y.M.C.A. and other groups cooperating in this, and you will have a list of those. So there will be plenty of people for you to drop around to see.

That gives you a brief resume of the cooperating organizations, and it will make it possible for you to have an idea of the people you will be meeting from time to time.

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Technical Director, Mosquito Survey

Analysis of Data On reaching the laboratory, specimens are turned over to the entomologists who identify each and every one. On the back of the label accompanying a collection of specimens the identifying data is written. These labels are thereafter sent to the filing room where they are filed first by county, then by town and finally by collection point number and date. The information on the label together with the identification data on the reverse side of the label are transferred to large summary sheets.A special code is used for this purpose.One sheet is devoted to each collection point. In this way we are able to tell at a glance when collections are made and what specimens have been found. A pink label is entered in the same way as a white label.

This system of recording serves as a check on the field worker as we are able to tell exactly what each man is doing and what specimens he has collected.

Every week the data on each collection point sheet is summarized. These summaries are then transferred to a town sheet and totaled.In this way we know how many collections and how many specimens of the different species of mosquitoes have been found in every town every week. Similarly,the volunteer collections are summarized on a separate set of code sheets. The volunteer and W.P.A. collections are added onto combined total sheets every week. It is this last set of sheets,which is used in the final punch card analysis.

Every week area supervisors, crew foremen and crew members send in a report. We are able to check these reports with the records for the specimens as summarized above. In addition,these weekly reports enable us to rate all the field workers as to their relative standing in the state. These ratings are sent to the supervisors and foremen.

The analysis of the data collected and recorded as noted above is rather complicated. It is, therefore,impossible to give more than a bare outline as to what shall be done with it. For example, maps will be made showing the distribution of the more important species.Some of these will show the seasonal distribution of species. Other maps will serve to compare salinity and salt marsh mosquitoes. Some maps will compare elevation, population, number of horses and collections with the distribution of those mosquitoes which have been shown to transmit Equine Encephalomyelitis in the laboratory. Further comparisons between the distribution of the disease and the distribution of mosquitoes will be made. Tables, charts and diagrams will be constructed from the data accumulated during the survey.

There are two statisticians, a senior and junior draftsman, and three tracers besides the entomologists who will take part in the analysis of the results.The final report of the Survey to the Department of Public Health and also to the Legislature will be made by the Technical Director.

We urge each man to remember that in the published final report the name of every town will be included together with data as to what mosquitoes have been found. Field workers will be able to point with pride to those towns where they have done a good job. On the other hand, those who have done a poor job will be able to find a permanent record of this in the final report.

Summary of Procedures At the completion of this training course you, as supervisors, foremen and assistant foremen will be returning to the field to carry out all the measures which you have been taught. It will be your duty to train and teach your crews. The quality of work done in your districts will depend to a large extent upon how well you have absorbed the material given in this course and upon how well you are able to train your crews.

Immediately upon your return you will find a crew awaiting you, and for the ensuing week you will be busy training these men. It is not sufficient to give them the sets of instructions with which we have provided you. The men must be trained by verbal explanations and field demonstrations.

In teaching the crew tell them as much as you yourself know about mosquitoes. Take them into the field and show them how to collect specimens. Give each man an outfit and supervise his attempts at collecting.

By the end of the first week the men should be adequately trained to collect specimens. By this time they should also have been taught how to survey collection points. In teaching this portion of the work, actual collection points should be used for teaching material. During the second week of the field work, you will start to survey all collection points in your area, making routine collections as you proceed. Thereafter, the number of collection points should increase rapidly, until there are ten or more per town.

The equipment furnished each man consists of the following: rain-coat, flash light, net with handle, killing tube, bottle of chloroform, pill boxes, dipper, vials, bottle of formaldehyde, labels, survey sheets and carry kit. Every man is held responsible for the equipment issued him and at the end of the Survey he will be held accountable for any equipment which is lost or damaged beyond fair wear and tear.

Be prompt in starting your crews at nine o'clock in the morning. Be sure the men know what towns they are to cover each day, and that they have copies of necessary maps and equipment. If any rearrangement in schedule is necessary, notice of this should be made to your immediate superior. The crew foreman is to instruct the assistant crew foreman where he is to drop the crew members. The assistant foreman arranges with the crew members where they will be picked up at the end of the day. A collector's route should be so arranged that he can reasonably walk from the place where he is dropped in the morning to the place where he is picked up in the afternoon. A reasonable walking distance will vary from town to town and will average from six to ten miles.

New collection points should be established as they are needed. Such collection points should be within reasonable walking distance, but not closer than 1/4 to 1/2 mile from one another. Both larvae and adults should be collected at every collection point.

Specimens must be carefully handled to prevent such injury as would make them unidentifiable. Only formalin (or alcohol for volunteers) should be used for the preservation of larvae. Carbon tetrachloride and chloroform are to be used in refilling the killing tubes. All collections must be carefully labelled, and the label securely fastened with the rubber band to the vial or inserted in the pill box between the casing and the drawer.

As all of you know, the object of this Survey is to find mosquito carriers of equine encephalomyelitis. In order to prevent needless suffering and perhaps even death, true facts must be recorded. Substitution of specimens or falsification of survey sheets or labels may lead to misinterpretation of actual conditions and thereby result in unnecessary suffering. Lastly, obtain the cooperation of your men. A good foreman does not order his men; he leads them. Convince your men of your own sincerity and interest in the work. Make your men willing and cooperative workers, and the results you will achieve will be better than if you tried to order or force your men to do their work. The seriousness and the responsibility of the work assigned to you as supervisors, crew foremen and assistant crew foremen requires your constant effort and application. Do your best and make the Survey a success.

The lecture was closed with a question period.

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