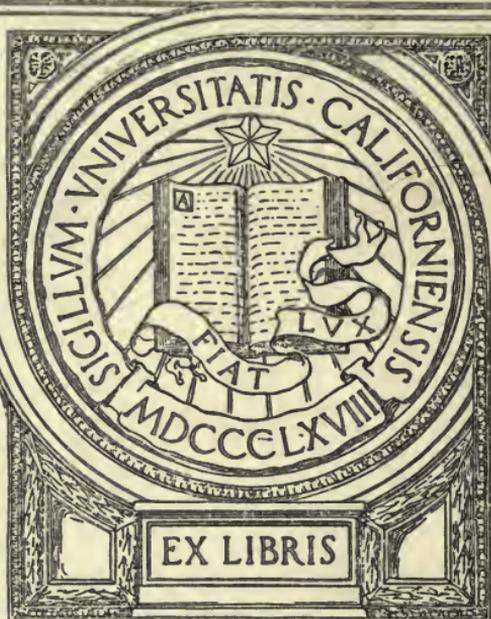


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# Mosquito-Borne Diseases



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*Panama Canal Health dept.*  
**Mosquito-Borne Diseases**

*{ by*  *}*  
*P. W. Ashburn }*

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## MOSQUITO-BORNE DISEASES.

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This bulletin has been prepared by the Health Department for use in the Canal Zone public schools and is to be used as supplementary to the course of study in hygiene for the grammar grades.

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CANAL ZONE  
HEALTH DEPARTMENT

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by  
P. M. ASHBURN.

## MOSQUITO-BORNE DISEASES.

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The most striking difference between the health conditions in the Tropics and those in temperate climates is found in the greater prevalence of insect-borne diseases in the former, and of these the mosquito-borne diseases are the most widespread and, in this part of the world, by far the most important. The diseases now known to be mosquito-borne and which are found here, are yellow fever, malaria, dengue, and filariasis.

We are now to make a brief study of the methods of preventing or combating them, for two reasons: First, because there are few parts of the world where the Government spends so freely of both money and care to protect the health of individuals, and such expenditure is largely wasted unless the people take an interest in and assist the work; second, because it is nowhere so true as in school and public health matters that each person is his "brother's keeper," and you are individually more or less responsible for the health of this school and this community. One careless or evilly disposed person may set at naught the work of many men in bringing about good conditions of health, and without the help of the individuals of a community the most efficient health department works at a great disadvantage. An individual who had yellow fever and failed to take proper

Mosquito-borne diseases.

Reasons for this study.

(1) Local interest.

(2) Individual responsibility.

# Mosquito-Borne Diseases

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precautions might start an epidemic that would cost hundreds of lives. One who carries malaria germs in his blood is a menace to the health of his family, his school, and his community, unless he takes or submits to the proper measures to prevent malaria-bearing mosquitoes from obtaining the germs. An individual who because of his laziness or his ignorance fosters conditions that favor the breeding of mosquitoes is menacing his own health as well as that of his neighbors.

## MOSQUITOES.

Mosquitoes are biting gnats, small insects having two wings, and, like other insects, six legs and a body divided into three parts, the head, the thorax, and the abdomen. On the head of the mosquito are seen two large eyes, and projecting from the part of the face in front of, between and below the eyes, is the proboscis or "stinger." At either side of this are the palpi or feelers, one on each side, and to the outer sides of the palpi are the antennæ or plumes.

These small parts are worth knowing. All persons bitten by mosquitoes have experience with the proboscis, which contains a number of small lancetlike knives. One method of distinguishing *Anopheles* from other mosquitoes is that in them the palpi are almost as long as the proboscis, while in other varieties they are much shorter. Male mosquitoes of all kinds may be distinguished from females by their larger, more feathery, and more ornate antennæ. As males rarely bite persons they are unimportant from a health standpoint.

# Mosquito-Borne Diseases

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The insect that we have been describing is the adult mosquito, but mosquitoes, like butterflies and other insects, pass their existence in four stages. These stages are the egg, the larva, which corresponds to the caterpillar as the mosquito does to the butterfly, the pupa, corresponding to the butterfly's chrysalis, and the adult.

The four stages.

The eggs of mosquitoes are very small, as you see (exhibit eggs). They vary in size, shape, pattern of the shell—some being really beautiful when highly magnified, and in the method or grouping in which they are deposited. The ordinary *Culex* mosquitoes, for instance, deposit their eggs in masses composed of eggs packed side by side in a very neat and regular manner, and these masses float on the water as little rafts or boats (show some). The *Anopheles* mosquito, on the other hand, deposits her eggs singly, and because of the small size of a single egg it is very difficult to see and recognize it. Whether deposited singly or in groups, the eggs are always deposited on water and, as the female mosquito only lays eggs after she has eaten blood, and as she is then so heavy with the imbibed blood that her flight is slow and laborious, she usually goes to the nearest suitable water to deposit them, and it is for this reason that most mosquito infested places are found to be breeding their own mosquitoes.

(1) The egg.

The eggs float for one or two days, after which they open and the young larvæ or "wigglers" escape into the water. Here they live for a week or more. Though living in the

(2) The larva.

# *Mosquito-Borne Diseases*

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water, they are air breathers and they obtain their air by coming to the surface of the water and protruding from it the small air tube that projects from near the tail. This method of breathing enables us to apply

How oil destroys the larvæ.

one of our most valuable measures of mosquito destruction—oil on the water.

If the water be covered with a thin film of oil the breathing tube becomes obstructed by that when the larvæ rise to breathe and the obstruction eventually leads to suffocation. After they have attained an age of a week or more, the time varying with the weather and other conditions, the larvæ change to pupæ or tumblers. The

(3) The pupa.

pupal stage corresponds to that of the caterpillar's chrysalis, and is one of change, and of no food. Sealed in its hard pupal case, the larva changes

(4) The adult.

to a mosquito and in a few days emerges, dries and unfolds its wings, and flies away.

## YELLOW FEVER.

Yellow fever is an acute and deadly disease that for centuries flourished in most of the sea-ports and low-lying towns of tropical America, and which in summer time often visited New Orleans and other cities of our Southern States, and rarely prevailed as far north as Philadelphia.

Yellow fever.

It was so apt to attack a stranger going into the regions in which it prevailed that it was a great factor in preventing much of travel or investment in such regions, with the result that they remain largely undeveloped and but

Retarded progress and civilization.

# Mosquito-Borne Diseases

partially civilized to-day. The same disease was

Factor in building the Panama Canal. partly the cause of the failure of the French to complete the Panama Canal.

For a long time it was so prevalent here and so deadly to persons coming from temperate climates, that the crossing of the Isthmus or a sojourn in Panama was a very perilous undertaking. No advance was made in

Cause not known until 1900. its control until 1900, when a board of medical officers of the United States

Army, working in Cuba, showed it to be conveyed solely by the bites of a certain species of mosquito, known as *Stegomyia* or *Aedes calopus*. Since then, and as a direct result of that knowledge, the dis-

Now under control. ease has been banished from Havana, New Orleans, the Isthmus of Panama,

Vera Cruz, Rio de Janeiro, all places in which it formerly flourished, and from all of the principal commercial centers of tropical America, with the result that those places are now safe for foreigners to visit and live in, the Panama Canal is built, and we are here in as little danger of yellow fever as elsewhere. Though the disease may be introduced again, it will not again be allowed to spread as it used to.

The Army board showed clearly that yellow fever is conveyed solely by the bites of one

How conveyed. kind of mosquito and that food, water, bad air, filth, and contact with the sick have no influence in promoting the disease, except as they favor the breeding of mosquitoes of that kind and expose persons to their bites. The mosquitoes are not able to convey the disease germs until they have obtained

## *Mosquito-Borne Diseases*

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them from persons having yellow-fever. Their mere presence can not cause an epidemic. Furthermore, unless they bite the yellow fever patient within the first three days of his sickness, they do not obtain the germs, which do not occur in his blood after that time. In case a yellow-fever mosquito does bite a yellow-fever patient during the first three days of his sickness, and does obtain the germs from him, it can not transmit them to another person for 12 days more, as during that time the germ is probably undergoing a development in the body of the mosquito, but thereafter it may continue able to transmit the disease for several months. When such a mosquito bites a person who has not had yellow fever that person sickens after an interval of three to five days, which interval is called the incubation period. The person who has had the disease once is said to be "immune," that is, "Immune" persons. he will not have it again, and the mosquito bites do him no harm.

The above facts serve to explain other observed facts that were formerly beyond explanation, namely: (1) A person having yellow fever in a place where it is not endemic—that is, where it does not naturally persist—could be safely visited by nonimmunes. The mosquitoes of that vicinity were not infective. (2) It was dangerous to visit an endemic neighborhood, especially at night. The mosquitoes there were infective and active. (3) A person visiting a yellow-fever port might get the disease in three or four days, yet when a case of yellow fever was introduced into a place previously free from it second-

Some facts now explained.

# Mosquito-Borne Diseases

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ary cases did not occur for 15 days. In the former instance mosquitoes ready to infect were at hand; in the latter, the mosquitoes could not transmit the infection until after 12 days. (4) Yellow fever was known to cling to ships for long periods. This merely signified the continued presence of infective mosquitoes. (5) In New Orleans, and cities farther north, the spread of the disease was always checked by frost. Frost killed or rendered inactive all mosquitoes.

The yellow-fever mosquito is generally known as the *Stegomyia*, though at present the leading American authorities on mosquitoes call it *Aedes calopus*. It is a small, dark mosquito with white strips on its legs and a white, lyre-shaped figure on the back of its thorax. It is silent and rapid in flight, does not ordinarily "sing" or "buzz," is a persistent biter, takes flight quickly, and is very hard to catch while biting. It bites by day or by night.

This variety is more of a house lover than any other, and when a house is found infested with it one can with certainty say that the insects are breeding in or near the house. The larvæ are especially apt to be found in small household containers of water, such as old tin cans, flower pots, water buckets, rain barrels, eave troughs, and cisterns. Therefore the most effective measures for getting rid of yellow-fever mosquitoes are such as get rid of these breeding places close to houses, and among them we may mention the following:

(1) Cleaning up and removing all useless containers, such as old cans, broken bottles, old barrels, and oil tins.

# *Mosquito-Borne Diseases*

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(2) Emptying and cleaning at least once a week such necessary containers as can be emptied, for example, fire buckets, pans under ice chests, and saucers under flower pots.

(3) Screening, completely covering or oiling such large and necessary containers as can not be emptied, for example, rain barrels and cisterns. If such containers are screened the screening must be above the highest level of the water, so that the female can not get at it to lay her eggs. If they are oiled the water will have to be withdrawn from the bottom of the container, or it will have oil on it and taste of oil, and can not be used for drinking.

For protection from adult mosquitoes residence in a screened house is a very important item. In case a screened house is not obtainable, one should at least sleep under a bed net. Screening on a house is not of very great value unless it be properly used and kept in good repair. Proper use means that doors and window screens should be kept closed, that no holes be punctured in screening anywhere, and that defects be corrected promptly.

It is most important that mosquitoes should not be allowed to bite yellow-fever patients during the first three days of illness. Therefore all such persons should be in screened houses and screened rooms. In case yellow fever develops in the person of a resident in any house or worker in any office, that house or office should be closed, sealed, and thoroughly fumigated with sulphur, in order to kill all possibly infected mosquitoes that may be there.

# Mosquito-Borne Diseases

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## MALARIA.

Malaria is the most widespread of tropical diseases; it causes a vast number of deaths throughout the world, and is probably more influential than any other disease in delaying the development and civilization of tropical countries.

Malaria most wide-spread.

There are at least three varieties of malaria which, though they have much in common and closely resemble one another, are caused by three varieties of malarial parasites or germs. These parasites are small moving bodies that

Three varieties.

live in the blood and its red cells. At first extremely small in size, each one grows until it is almost or quite as large as the cell in which it lives, and which it finally destroys. After attaining its full size the germ "segments" or divides

Caused by three varieties of parasites or germs.

into from 8 to 30 smaller germs, which are set free in the blood and attack other red cells, in which they go through the same growth and division. This segmentation and freeing of young germs occurs with considerable regularity and at intervals of 24, 48, or 72 hours, depending upon the type of parasite. At the same intervals occur the ague fits or the malarial paroxysms of chill, fever, and sweat. Occasionally there are many crops or generations of parasites in the blood, so that the fever may be almost continuous, or the chills may come irregularly.

Segmentation of germs.

For a time the parasites go on multiplying in the blood in the manner above described, but there soon begin to appear forms

Special undividing parasites.

# *Mosquito-Borne Diseases*

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that do not divide. These special forms do the patient no harm, but they are harmful to the community because they do multiply if taken into the bodies of certain species of mosquitoes, and after they have so multiplied and have become located in the salivary glands of the mosquitoes they may be transmitted to other persons. The mosquitoes' salivary glands produce the irritating fluid which the insect injects when it bites, probably for the purpose of causing the blood to flow more freely. In from a week to 10 days after a mosquito has taken in the nonsegmenting type of parasites described above, the young forms are found in myriads in the salivary glands, and when these young forms are injected with the saliva they promptly cause infection.

As in the case of yellow fever, not all mosquitoes are capable of carrying malaria. It is true that more than one species may do so, but they all belong to the same subfamily and are called *Anopheles*. Not all *Anopheles* are capable of carrying malaria, but those that can do so are often difficult to distinguish from those that can not, and, for any person not an expert in making the distinction, it is as well to regard them all as carriers. *Anopheles* may usually be distinguished readily from other mosquitoes by the fact that they stand almost perpendicularly to the surface on which they rest, while most other varieties hold their bodies more nearly parallel to such a surface; the *Anopheles*' head and body are almost in a straight line, most other mosqui-

## *Mosquito-Borne Diseases*

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toes are more "hump-backed"; the female *Anopheles*, the biter, has palpi almost as long as her proboscis, in others they are much shorter.

The larvæ of *Anopheles* may be distinguished by reason of the fact that their siphons or breathing tubes are shorter than those of other mosquitoes and that the larvæ themselves float on or parallel with the surface of the water when at rest, while most other larvæ hang with their heads downward and with their bodies forming almost a right angle with the surface of the water.

Like the yellow-fever mosquito, the malaria-bearing *Anopheles* appears to be a lover of man. Unlike it, though, this rarely breeds in houses or in such artificial water containers as cans, bottles, and barrels. It prefers to breed in the open, in streams, shaded pools, swamps, flooded hoof tracks, and other depressions. It prefers clean water in containers of natural earth, with a growth of *Algæ* or green fluffy growth, and a place shaded during a part of the day. Although capable of long flights, *Anopheles* seldom do fly more than a quarter of a mile, and if not allowed to breed within that distance of houses and places where persons work or congregate, they are not apt to become a very serious menace. Within an area of a quarter of a mile all breeding places should be eliminated if possible, and the Health Department here undertakes work over that extent. Breeding places may be gotten rid of by filling them, if mere

# *Mosquito-Borne Diseases*

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puddles or depressions, or emptying them weekly by sweeping, draining them if swamps or seepage areas, exposing them to sun and drying if mere overgrown low spots, exposing them to rapid movement

Prevention of mosquito breeding.

if sluggish streams or pond edges. In the case of sluggish streams the rapid movement is obtained by "training" them and making them narrow, smooth, and straight, so that they drain rapidly. Lake edges are exposed to wave action by the removal of floating logs and débris and of growing grass and other water plants that tend to check such action. Such breeding places as can not be gotten rid of should be kept harmless by the killing of larvæ. For this purpose we may encourage

Use of fish.

the natural enemies of larvæ, among which may be mentioned especially the varieties of small fish that eat them.

Most notable of these are the "millions," very small fish introduced here from Barbados. There are other varieties of fish though that are also very satisfactory. It is possible, too, that tadpoles and certain water bugs may also destroy larvæ, but they are not as dependable as fish. The natural enemies of adult mosquitoes, especially swallows, bats, dragon flies, toads, and frogs, should also be given encouragement and protection. When bodies of water can neither be gotten rid of nor kept safe by means of fish and such natural phenomena as current, wave action, and brilliant sunshine, they should be oiled, and the oilers with their pumps, and the oil-dripping barrels and cans are familiar sights to you all. Occasionally it is found more convenient to

# Mosquito-Borne Diseases

kill the larvæ with "larvacide" or some other poison, but such things also kill the fish.

The rest of the system of control of malaria includes the same measures of protection from mosquito bites as we discussed under the head of yellow fever. Like the yellow-fever patient, the one with malaria should be protected from mosquito bites in order that he may not spread his disease. The period in which he is dangerous to the public, however, is apt to be after the first week of his sickness and he may then continue dangerous for months. Fortunately, though, we have a medicine

that will control this danger. Every person taking a sufficiency of quinine has his blood practically freed from parasites, and, both for his own sake, in order that he may get well, and for the public's sake, in order that he may not infect others, it is important that every person having malaria should take quinine for weeks or months.

## DENGUE.

Dengue is a short, sharp, often painful disease that in most instances shows a skin eruption somewhat like that of measles or that of scarlet fever. It is practically always attended with fever, and is here frequently called six-day fever. It is conveyed by one variety of *Culex* and possibly by other common mosquitoes. It almost never causes death and is much less common here than in many places because of the general use of screened houses and the general warfare against mosquitoes.

# Mosquito-Borne Diseases

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The measures described for the control of both *Stegomyia* and *Anopheles* are necessary for the control of *Culex* and they should be generally applied.

Prevention.

## FILARIASIS.

This is the infection or infestation of the body with a "hair-worm," or filaria, whose larvæ then circulate in the blood as small worms about one-eightieth of an inch in length. The disease is only slightly and remotely dangerous to life, but it often causes serious deformity of the kind known as elephantiasis, in which parts, a foot and leg, for instance, become enormously enlarged, principally because of great thickening of the skin and subcutaneous tissues by blocking of the lymph flow from them. The mosquito, *Culex* and possibly other varieties, is necessary in the transmission of the disease, as the worm undergoes part of its development in the insect's body. The means of prevention are those discussed for the diseases described above.

Definition.

## QUESTIONS.

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### MOSQUITO-BORNE DISEASES.

1. What do we mean when we speak of mosquito-borne diseases?
2. What are those diseases?

### YELLOW FEVER.

1. What is yellow fever?
2. Does yellow fever no longer exist?
3. How is it possible to prevent it?
4. Why was that not done long ago?
5. How is the disease conveyed?
6. Can it be conveyed in no other way?
7. Can it not be transmitted by water, food, soiled or infected articles, by bad air, contact with the sick, or by filthy conditions?
8. How can we tell the *Stegomyia* from other mosquitoes?
9. How can these mosquitoes best be gotten rid of?
10. What are their breeding places and their young?
11. Why are *Stegomyia* mosquitoes more readily gotten rid of than other varieties?
12. Why should containers be emptied weekly? Why screened? Why oiled?
13. Do all *Stegomyia* mosquitoes carry yellow fever?
14. Do all that bite yellow fever patients carry yellow fever?
15. Why is this?

## *Mosquito-Borne Diseases*

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16. Does the mosquito carry the yellow fever germs directly from one person to another?

17. Does a person, when bitten by an infected mosquito, get sick at once?

18. How long may the mosquito that has obtained the germ from a yellow fever patient continue dangerous?

19. What interesting observations are explained by answers to the last three questions?

20. From what you now know, can you suggest other means, than the destruction of breeding places of mosquitoes, for combating yellow fever?

21. How may these measures be carried out?

22. Is yellow fever preventable by the means we have considered?

### MALARIA.

1. What is malaria?

2. Is there only one kind of malaria?

3. State in what manner the symptoms differ.

4. Describe briefly the parasites causing malaria.

5. How do malaria parasites obtain entrance to the blood?

6. Where does the mosquito obtain the parasites?

7. Can it then immediately transmit them or does an interval have to elapse, as in the case of yellow fever?

8. Have we any means of destroying the parasites in the blood?

9. Is there only one kind of mosquito that carries malaria?

10. How may *Anopheles* mosquitoes be distinguished?

# *Mosquito-Borne Diseases*

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11. How may male mosquitoes be distinguished from females?

12. How may *Anopheles* larvæ be distinguished from those of other mosquitoes?

13. How long does it take for mosquitoes to develop from the egg to the adult?

14. What kind of breeding places do *Anopheles* mosquitoes prefer?

15. How can we get rid of *Anopheles* mosquitoes?

16. How may we destroy their breeding places?

17. What is meant by "encouraging the natural enemies of mosquitoes"?

18. How may we prevent *Anopheles* from biting us?

19. How may we prevent *Anopheles* obtaining infection even if they bite persons having malaria?

## DENGUE.

1. What is dengue?

2. Is it dangerous?

3. What causes it?

4. How may dengue be prevented?

## FILARIASIS.

1. What is filariasis?

2. How does this worm get into the body?

3. What mosquitoes carry these worms?

4. How large are these worms?

5. Is filariasis dangerous?

6. How may we avoid or prevent filariasis?











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