Malaria : lessons on its cause and prevention : for use in schools / by H.R. Carter.

UNITED STATES PUBLIC HEALTH SERVICE

RUPERT BLUE, SURGEON GENERAL

MALARIA

LESSONS ON ITS CAUSE AND PREVENTION

FOR USE IN SCHOOLS

BY

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SUPPLEMENT No. 18

TO THE

PUBLIC HEALTH REPORTS

JULY 17, 1914

WASHINGTON

GOVERNMENT PRINTING OFFICE

1914

ADDITIONAL COPIES

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LIST OF ILLUSTRATIONS.

INTRODUCTION.

Teaching some of the facts about malaria in schools is not new. was done in San Antonio in 1904 after the yellow-fever outbreak 1903, when the writer first had cognizance of it. There are pters on malaria and mosquitoes in most of the textbooks on giene used in the public schools.

This paper is, however, intended to be rather more complete than chapters devoted to malaria in the textbooks mentioned, as the portance of the disease seems to demand. Without question, in ny parts of the United States where malaria is prevalent it is re important and does more injury than all other diseases com- ed, and measures for its control should be emphasized. As the mpaign for the control of malaria is likely to be a long one, it ms very advisable so to educate the rising generation that they y bear their full part in it. Knowledge of malaria, how it is con- ed, and how it may be controlled, if generally spread among all people, will ultimately compel the control of malaria.

This paper was submitted to Surgeon von Ezdorf, Public Health rvice, and has received the benefit of his suggestions, many of ich have been adopted, and the writer only regrets that Dr. von dorf's departure for Vera Cruz prevented his review of the entire per.

It was also reviewed by a very successful teacher and student of dagogy, by whose criticisms it has profited.

I wish also to acknowledge my indebtedness to Miss Ethel Neely, retary of the Virginia Society for the Study and Prevention of laria, who kindly allowed me to examine a course of excellent sons for schools prepared by herself. The arrangement of her urse of lessons—questions and answers—is followed in this paper being better for school use than a connected narrative with the estions subjoined.

These lessons, or rather this catechism, on malaria are presented, en, for use in schools, especially those in the country, either as y are written or as a basis for lessons more suitable for the dif- ent needs of the schools in different sections.

To the Teacher.

It was at first intended to make these lessons only for children d consequently very simple; to make them *true*, however, re- ired either to make them less simple or to trust to the teacher to

explain difficulties, and answer questions that would naturally aris
Now it may be that some of the teachers will not have sufficie
knowledge of the subject to answer the questions which will
asked and give the necessary explanation—for accurate knowled
on even the rudiments of this subject is not so common—and on th
account this little paper is intended for both pupils and teache
The questions marked (a) are intended only for the pupils. Th
others (b) are for the teachers and deal with ideas a little mo
complex than the others, yet not especially so. They contain fact
however, which a teacher must know to understand the subject at a
Some are marked (a)? as the writer was unable to decide whethe
they should be marked (a) or (b).

Teachers, however, will use their own discretion in giving
pupils such of the questions intended for themselves as the age an
intelligence of the class may justify.

Each school should form a field class among the pupils studyin
malaria to find the larvæ of the different kinds of mosquitoes and
identify them and to learn to recognize the different kinds of plac
in which they breed; where the eggs of the different families
mosquitoes may also be found and identified.

Culex mosquitoes will be found in almost any standing wate
especially in rain barrels, in pools and puddles almost anywher
Aëdes (*Stegomyia*) *calopus* will be found in artificial containe
about houses. Anopheles will be found in the clean, shallow, shad
grassy pools described. The first two can be seen at once an
recognized as not being Anopheles by their position, hanging hea
downwards. If one leans over a pool containing Anopheles an
waits a little he will be able to see these larvæ lying flat at th
surface of the water. He must wait a little, however, as they are a
to dive when one approaches them; also they frequently run to th
edge and hide in the grass, so they are sometimes not so easy to s
even when present. The best way to get them is with a dipper an
a white saucer. *Dipping* in the water unless you see larvæ is n
the best way; make a quick stroke, just skimming the water toward
the edges of the pool. Carry it into the grass, because the larv
are in the grass. Do not make this stroke until you have given th
larvæ time enough after you arrived to dive and come to the to
Another way is to press the edge of the dipper suddenly under wate
so that the stream of water running into it may wash the larv
into the dipper. Pour the contents of the dipper into the sauc
and you will see the larvæ against the white ground. The youn
Anopheles are light grey, banded with black and very slender. Th
older ones are red, green, black, etc., the color depending on wh
they eat. They are less slender. All are quick in movement, an

ıough they will dive, yet they also dart along the surface of the ɐr, which the others never do. Some are extremely small.

'he eggs of Culex are easily recognized, being brown rafts half ıarge as the nail of one's little finger. (See fig. 10.) The eggs set on end in the mass. They are common on water barrels. opheles' eggs are in loose groups (see fig. 11), the eggs lying on the water singly. They are very much harder to find and uire a hand magnifying glass. They are usually demonstrated keeping Anopheles mosquitoes in a jar with water at the bottom, the surface of which they will deposit their eggs. Eggs may also found in nature on the surface of water containing many very ng larvæ. Dip this up in a saucer and examine with a hand ss.

Keep them in a vessel with a wide mouth—fruit jar, candy jar, —half full of water or less, with pieces of grass in it extending ve the water. Cover it with mosquito netting and some of them l develop into mosquitoes, and you can tell the kind. The larvæ cannibals, and the big ones eat the others. Anopheles are much der to raise than Culex, and unless one starts with nearly full-wn Anopheles larvæ or pupæ it is difficult to develop the mos-toes from them unless one takes a pan or trough and makes ugh of a marsh to imitate natural conditions. Some of the points difference of mosquitoes and larvæ can be seen with the naked , but a good hand lens is of great assistance and makes the study ch more attractive.

The pupils should be encouraged to do such antimalarial work as practicable to them. That directed against mosquitoes is the most ıctical; compositions on subjects connected with the lessons; bal reports—say, weekly—during the malarial season of what h one has done in the way of antimalarial work will increase the erest in this subject. The fuller the knowledge the teacher has the subject, and the more it is explained and developed the more pupil will be interested and will profit.

MALARIA.

SECTION I.—MALARIAL FEVER AND ITS CAUSE.

) Q. *What is malarial fever?*

A disease of man, common in hot, wet countries.

) Q. *What is malarial fever sometimes called?*

Chills and fever, bilious fever, swamp fever.

) Q. *Is this disease found in the United States?*

Yes. Along the coastal plain from Connecticut to Texas, over y all of the Mississippi Valley, and in a number of valleys on the ic coast.

) Q. *What causes malarial fever?*

The presence of certain small organisms in the blood of the n who has the fever.

) Q. *What do you mean by an "organism"?*

Something that is alive and thus has the power to reproduce its . It may be alive as a plant is alive, or alive as an animal is.

) Q. *Is the organism which causes malarial fever a plant or an al?*

It is an animal, and in the blood is said to be an animal parasite.

) Q. *What do you mean by a "parasite"?*

An animal or plant that lives at the expense of another, like the etoe, love vine, rust on corn, or the hookworm, flea, etc. The rial parasite lives in man only by feeding on the blood cells of nan.

) Q. *How do you know that these parasites are found in the blood ose who have malarial fever?*

Because with the microscope we can see them in the red blood of a man sick with malarial fever.

) Q. *What do you mean by red blood cells?*

They are very small bodies floating in the blood, shaped much a biscuit, with thickened edges; they give the blood its red color, are a most important part of it. They are essential to life.

How Malarial Fever is Taken.

(a) Q. *How do these malarial parasites get into the blood?*

A. In one way only: Through the bite of a mosquito. Malari not acquired by eating improper food, by drinking bad water, bathing in the sun, or in any other way than by the bite of a m quito. True, if one already *has* malaria, that is, *has these paras already in his blood*, doing these things will develop it—"bring out"—so that he may have a malarial attack which he could otherw escape, but only if he is *already* infected with malaria.[1]

(a) Q. *Do all kinds of mosquitoes transmit malarial parasites man?*

A. No. In the United States only Anopheles mosquitoes carry m laria, and only some kinds of Anopheles.

(a) Q. *Are mosquitoes born with this power of conveying malar*

A. No. They acquire it only by biting a man who has these pa sites in his blood. The parasites are taken then from a man by mosquito and go back from the mosquito to another man. Where parasites first started we do not know.

(a) ? Q. *How, then, does malaria spread?*

A. Exactly like yellow fever. A female mosquito of a certain k feeds on a man infected with malaria and sucks up blood with ma rial parasites in it. She can not convey malaria to those whom bites for some days (a week or more) after this, but after wait a while (the reason for which will be told later) she injects th parasites into other men whom she bites and infects them w malarial fever.

(a) Q. *What, then, is necessary to spread malarial fever?*

A. Anopheles mosquitoes; malarial parasites and healthy m The parasites may be either already in the infected mosquitoes or infected men, from whom the mosquitoes can get them by biting.

How to tell Malarial Mosquitoes.

(a) Q. *Do both male and female mosquitoes bite?*

A. No. The female bites. It is doubtful if the male bites. it does bite it does so very rarely.

Q. *Can you describe the head of a mosquito?*

A. All mosquitoes have a bill and two *palpi* (*pal-pee*), which close to it, one on each side. Outside the palpi are two *anten* (*an-ten-nay*) which spread apart. The antennæ of the male plumelike. Those of the female are not. (See fig. 2.)

[1] The teacher should here tell the class of the conveyance of malaria to Dr. Pat Manson, jr., in London, by mosquitoes infected in Italy and brought thence to Lond of the experiments of Sambon and Low at Ostia, living all summer in a screened h and keeping well, although drinking the same water and eating the same food, and all respects except housing living like their neighbors; and give them other evidence may be necessary to show that malaria is conveyed only by the mosquito.

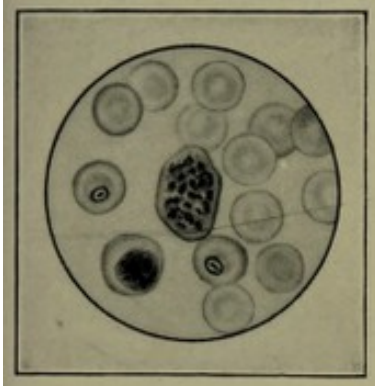

Fig. 1.—Normal red blood cells, and red blood cells containing malarial parasites.

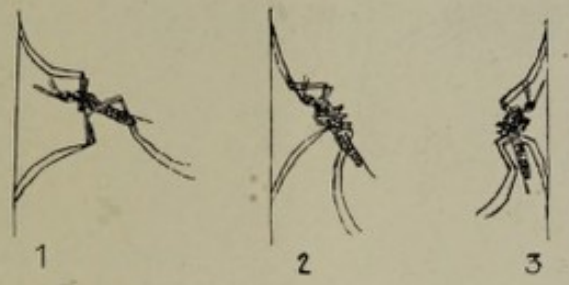

Fig. 3.—Resting posture of mosquitoes; 1 and 2 Anopheles; 3 Culex pipiens. (After Sambon.)

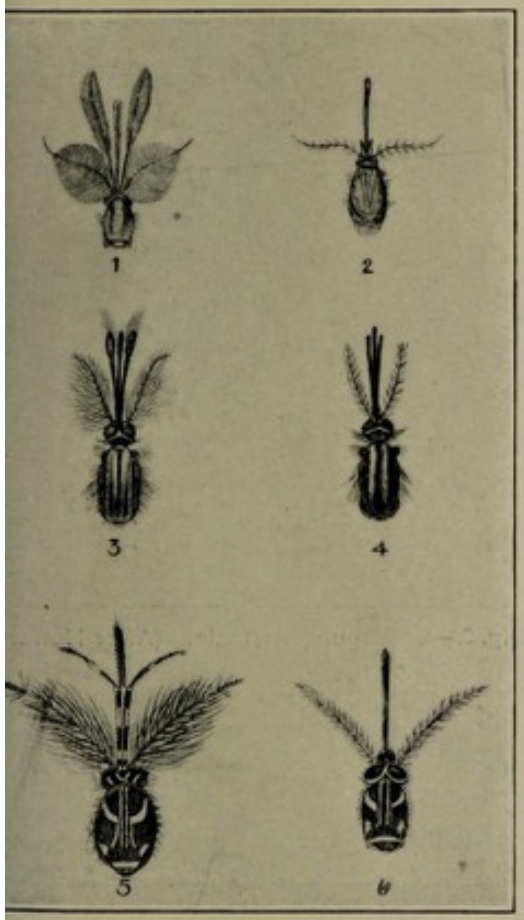

Fig. 2.—Heads of mosquitoes; 1 and 2 male and female Culex pungens; 3 and 4 male and female Anopheles; 5 and 6 male and female Aëdes calopus. (After Stitt.)

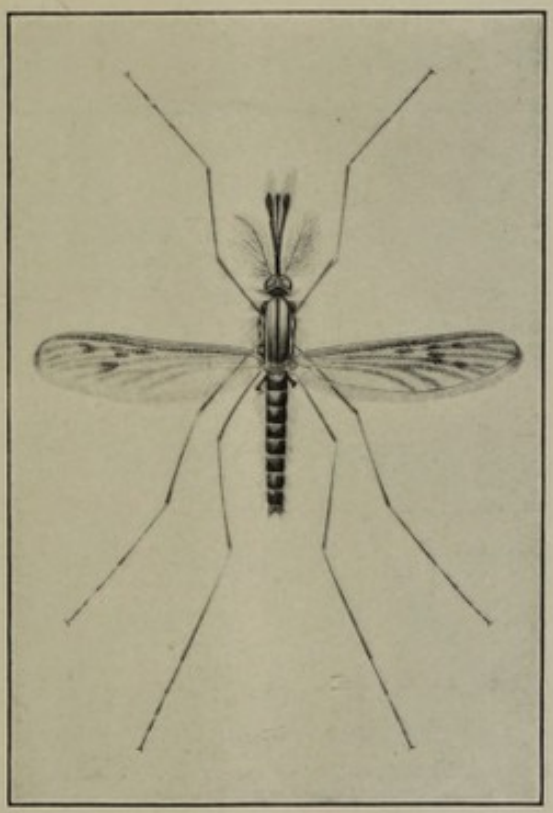

Fig. 4.—Anopheles maculipennis (quadrimaculatus), male. (After Castellani and Chalmers.)

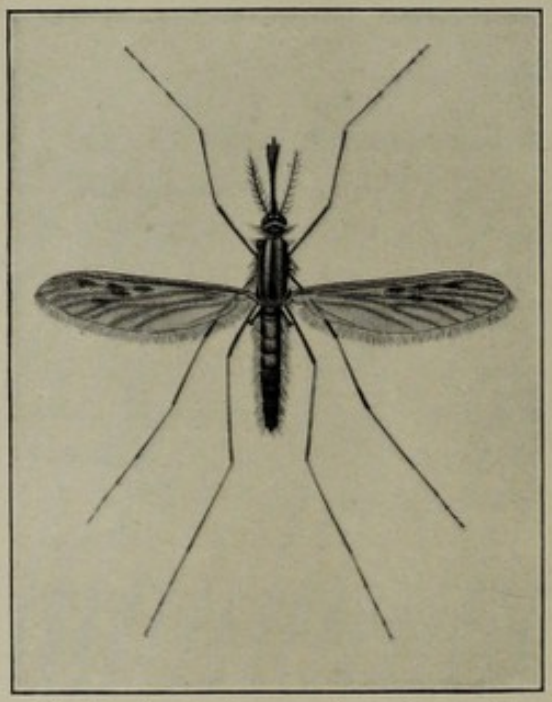

Fig. 5.—Anopheles maculipennis quadrimaculatus), female. (Castellani and Chalmers, after Austen.)

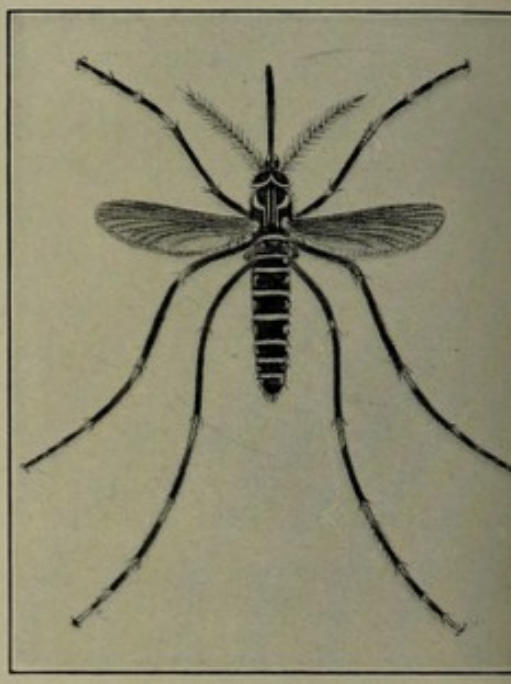

Fig. 7.—Aëdes calopus, female.

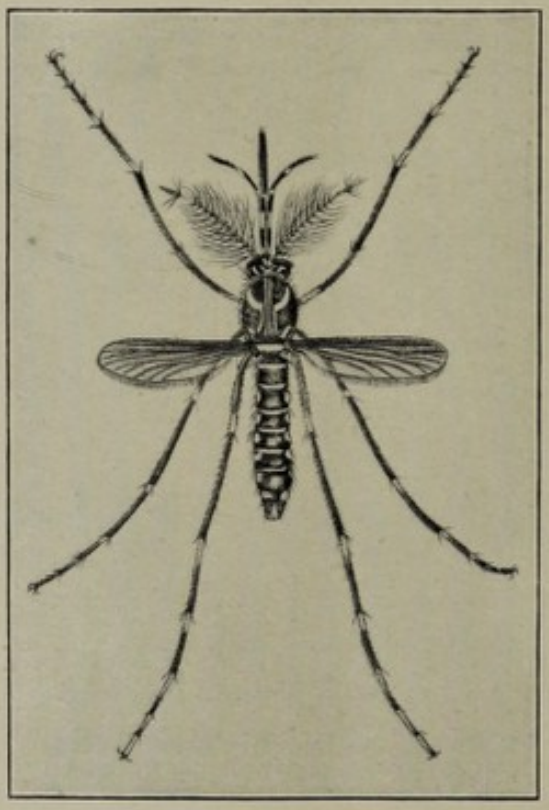

Fig. 6.—Aëdes calopus, male.

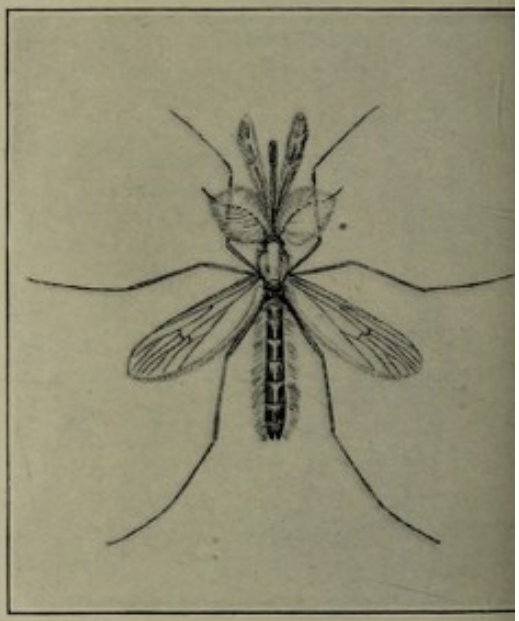

Fig. 8.—Culex pungens, male. (After Howar

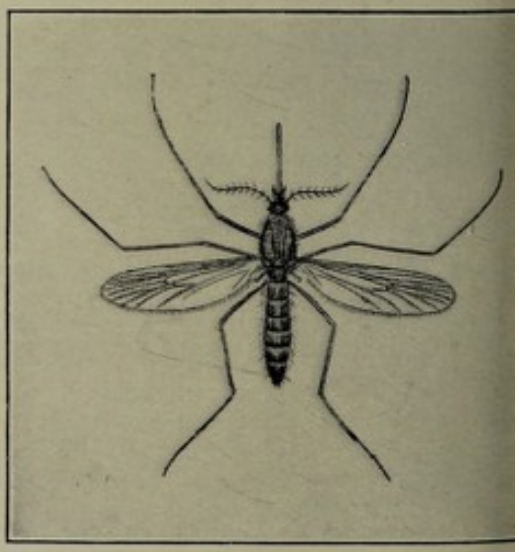

Fig. 9.—Culex pungens, female. (After Howard.)

Q. *How then can you tell the male from the female?*
A. The male has "plumes on his head."
Q. *How can you tell the Anopheles, malaria-bearing, mosquitoes om the Culex and other kinds in the United States which do not nvey malaria?*
A. One way is by their heads. Anopheles have straight bills id palpi nearly as long as their bills. The females of the other nds have short palpi, except one kind which has a curved bill. he males of both Culex and Anopheles have long palpi, and one n not tell the species of the males in this way.
(a) Q. *Are there any other differences?*
A. The malarial mosquito is slight and graceful. The wings are nerally spotted or dusky.
(a) Q. *Is there any other difference to note?*
A. Yes. The way of resting on a wall. Anopheles rests in a raight line, frequently standing on her head. The others rest humped up." This is the only way that can be used to tell the live osquito, and is the one usually used in practice.
(a) Q. *Can you tell something of her habits while feeding—on an, I mean?*
A. She rarely bites in the daytime in the United States. The ay mosquito of the South is *Aedes* (or *Stegomyia*) *calopus*—the llow-fever mosquito. Anopheles is shy and easily driven off, and ill rarely bite one who is moving about, hence is most apt to bite ie who is asleep. Her bite is less painful than that of other mos- uitoes, and she does not sing so loudly. On this account, when osquitoes are much complained of they are rarely Anopheles, and iere can be many Anopheles about without much complaint.

Breeding of Mosquitoes.

(a) Q. *Where do these mosquitoes breed?*
A. In water—in still water and in the pools and grassy edges of unning water.
(a) Q. *How do these mosquitoes breed?*
A. They lay their eggs on the surface of the water. These eggs oat, and in a few days hatch into larvæ, or "wiggle-tails." These ve in the water, and in time turn to pupæ, or "tumblers," which urn into mosquitoes. There are four changes in the development f mosquitoes just as for butterflies; the eggs for both; the larvæ a place of the caterpillars; the pupæ in place of the crysalis, and ie mosquitoes in place of the butterflies. For mosquitoes all these hanges must take place in water, and for Anopheles will take from 2 to 16 days in summer weather—longer in cool weather.

(a) Q. *Can one tell the larvæ of Anopheles?*

A. Yes. The Anopheles larva lies at the top of the water and parallel to it, for all the world like a basking pike. The larvæ of other mosquitoes hang from the top, head downward. If the latter are touched, they will always dive. If the Anopheles larva is touched, while it may dive it will generally "scoot" along the top of the water. They are not a bit alike, and once seen no one will ever mistake one for the other.

Q. *Is it important to recognize the larvæ of Anopheles?*

A. Yes; it is far more important to recognize the larvæ of Anopheles than the mosquitoes themselves, because this enables us to find their breeding places and hence to destroy them.

(a) Q. *In what kind of places do Anopheles breed?*

A. They prefer to breed in *clean* water, in small, shallow, shady pools with grassy edges; if with grass growing in them, so much the better. A marshy piece of ground with many small pools, among bullrushes and sedge, is an ideal place. The grassy edges and quiet pools formed by obstruction on small streams are also favorite places, as are cattle tracks. They have no objection to running water unless running swiftly.

(a) Q. *Do they breed in such places only?*

A. They *occasionally* breed in almost any collection of water, unless it is very foul; shallow wells, water barrels, tin cans, etc., especially if they have leaves or grass in them or the green algæ—"frog moss." Generally, however, they avoid barrels, cans, and other artificial containers unless they have grass, moss, etc., in them.

(a) Q. *How long must a pool last to breed Anopheles?*

A. Since it takes usually about 14 days for the egg to produce the mosquito, if a collection of water dries up completely in less than 14 days, it is not apt to breed mosquitoes.

Malarial Parasites in Man.

(a) Q. *When a mosquito injects malarial parasites into a man's blood what becomes of them?*

A. The parasites which she injects enter the red blood cells. They are then extremely small. They grow by feeding on the blood cells and get bigger and bigger. Then their edges become scalloped (see picture). Then they divide into a number of wedge-shaped pieces, meeting in the middle something like the slices of a pie. Then the blood cells break up and set the young parasites free, and each one of them starts off as a new parasite on its own account and tries to enter another red blood cell and repeat the process of its mother parasite.

(a) Q. *Into how many parts does a parasite divide?*

A. Into from 8 to as many as 24 or 32, according to the kind, so they may increase very rapidly.

Fig. 10.—A raft of Culex ova. (After Deaderick.)

Fig. 11.—Patterns assumed by Anopheles ova. (After Deaderick.)

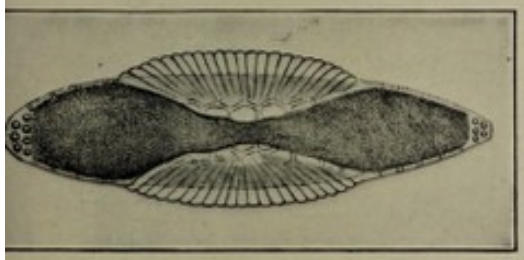

Fig. 12.—Egg, Anopheles maculipennis (quadrimaculatus). (After Ludlow.)

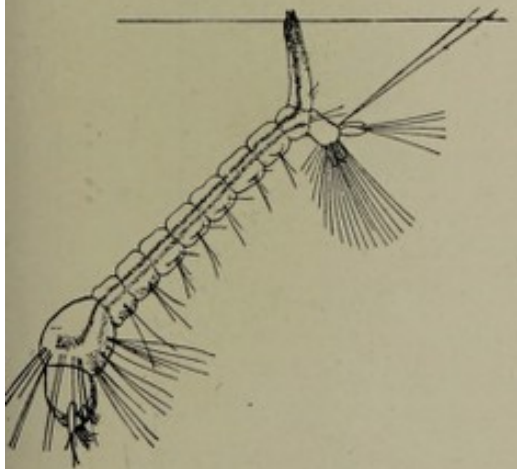

Fig. 13.—Larva of a Culex mosquito. (After Howard.)

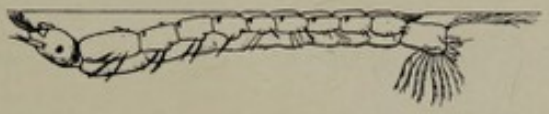

Fig. 14.—Larva of Anopheles mosquito. (Castellani and Chalmers. Modified after Howard.)

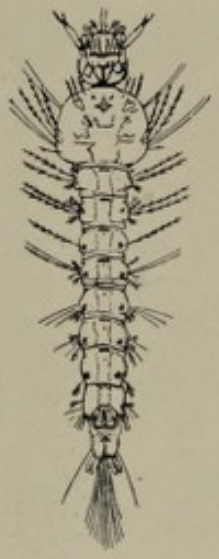

Fig. 15.—Larva of Anopheles maculipennis (quadrimaculatus). (Castellani and Chalmers, after Nuttall and Shipley.)

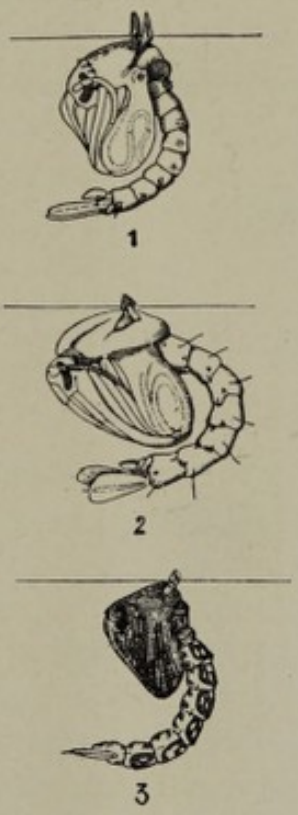

Fig. 16.—Pupae; 1 Culex; 2 Anopheles; 3 Aëdes calopus. (After Howard.)

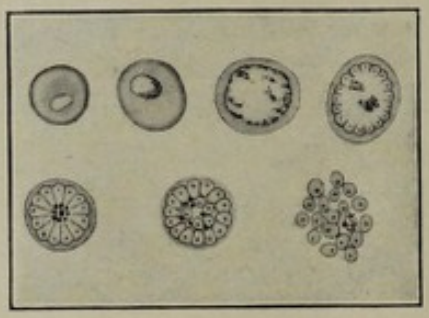

Fig. 17.—Parasites of tertian malaria. (After Thayer and Hewetson.)

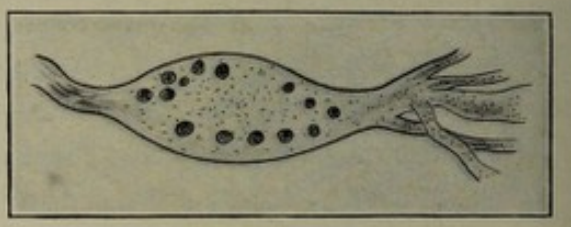

Fig. 21.—Stomach of mosquito with oocysts. (After Craig.)

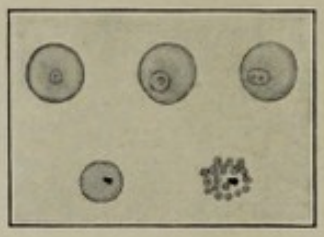

Fig. 18.—Parasites of estivo-autumnal malaria. (After Thayer and Hewetson.)

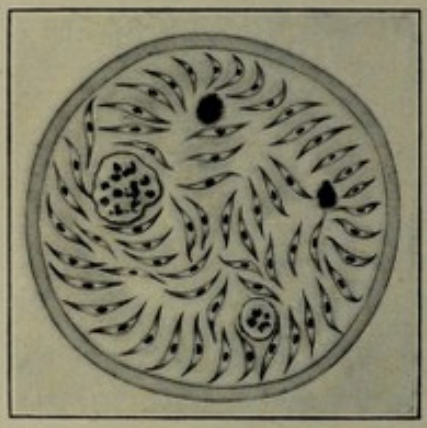

Fig. 22.—Sporozoites in oocyst. (After Craig.)

Fig. 19.—Parasites of quartan malaria. (After Thayer and Hewetson.)

Fig. 20.—Fertilized female malarial parasite (Zygote) (After Craig.)

Fig. 23.—Sporozoites. (After Craig.)

) Q. *Are there different kinds of parasites?*
. Yes; there are at least three kinds, each of which produces a
rent form of malarial fever.
) Q. *How long does it take from the time the parasites enter a*
lood cell until they divide into daughter parasites?
. It depends on the kind of parasite. One kind, the *tertian*,
s about 48 hours, or two days. Another, the *quartan*, 72 hours,
hree days. A third, the *estivo-autumnal*, from about 24 to 48
s. This last form is much less regular in its time than the other
; indeed, two different forms may be included under this name.
roduces the worst kinds of malarial fever.
) Q. *What causes the chill and fever of the man with malaria?*
. When the infected red blood cells break up they liberate not
the bunch of daughter parasites, but a small amount of poison
h the parasites have formed, and, when a large number of them
his at the same time, this causes the chill and fever of the sick
, which occur just after the cells break down. It has been esti-
ed that at least 150,000,000 of parasites must divide at the same
to liberate enough poison to produce a chill—generally many
s more than this.
) ? Q. *Do all parasites in the red blood cells divide into others,*
ou have described?
. No. Besides the sexless forms which divide and produce chills
e are two other forms of the malarial parasites in the blood
. These are the male and female forms of the parasites. These
ot seem to affect the health of the man in whose blood they exist,
it is by means of these that the mosquito becomes infected when
sucks them up.
) ? Q. *How does the mosquito become infected with malarial*
sites?
. By biting a man who has these male and female parasites in
blood. If she sucks up both kinds—male and female—she may
me infected.
) ? Q. *What takes place then?*
. If the mosquito sucks up only sexless parasites with the blood
will not become infected, no matter how many she takes. If,
ever, the proper kind of mosquito takes up the male and female
ms of the parasite they join together in her stomach and pass
her stomach wall, where they grow. After some time the bodies
s formed break and set free many young parasites, some of which
lly find their way to the mouth of the mosquito. There the para-
s are mixed with her saliva and are injected into a man when she
s him; then they enter the blood cells and start their life all over
in.

(a)? Q. *How long does this change take?*

A. From 7 to 14 days in the summer. It takes longer in co weather than in hot.

(a)? Q. *Is the mosquito dangerous to man until this change completed?*

A. No. Until the parasites reach her saliva the mosquito can n inject them into the person she bites. She is not dangerous, eve if she has bitten a man with malarial fever, until the time necessa for this to happen has passed.

(a) Q. *Do the parasites growing in the mosquito make her sic as they do a man in whom they grow?*

A. No. The mosquito seems to be as well as ever.

SECTION II.—PREVENTION OF MALARIA.

) Q. *Can malarial fever be controlled or prevented?*
. Yes.[1]
) Q. *What can be done to lessen or get rid of it?*
. There are several methods which can be used.
irst. By getting rid of the Anopheles mosquitoes which carry it.
econd. By not letting these mosquitoes get to well people to bite
n.
hird. By so treating men having malarial parasites in their blood
they will not infect the mosquitoes.
ourth. By so protecting healthy people that even if they are
en by infected mosquitoes they will not develop malarial fever.

First Method.—Getting Rid of Anopheles.

) Q. *How do you get rid of Anopheles?*
. By destroying their shelters and their breeding places.

(1) DESTRUCTION OF SHELTERS.

) Q. *What do you mean by their shelters?*
. Anopheles live almost exclusively out of doors, and as they
not bear the hot sun they shelter themselves in the brush and high
ds all day and come out at dusk to feed.
) Q. What should be done to these shelters or hiding places?
. All brush and high weeds near one's house should be cut down
hat mosquitoes can not shelter themselves close to it.
) Q. *What should be done with the brush about their breeding*
es?
. This should also be cut down.
) Q. *Why?*
irst. So we can see the breeding places to destroy them.
econd. So the sun can get in and dry up some of the breeding
es.

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[1] The control of malarial fever is a very different problem from its elimination or
ng completely rid of it. The methods of work necessary to do this are simple, but
arry them out may well be beyond the economic limit allowable. To control it,
ever, that is to so lessen its amount that it does little injury in a community, is
oftener possible. It is at last a question of economics.

Third. The less brush left to shelter mosquitoes the better, if they are exposed to the hot sun many of them die.

(2) DESTRUCTION OF BREEDING PLACES.

(a) Q. *How do you destroy their breeding places?*

A. In two ways:

(1) By draining or filling up the pools, marshes, etc., which they breed.

(2) By oiling such pools as we can not drain or fill.

(a) Q. *How does draining or filling up pools prevent breedin*

A. By leaving no water in which they can breed.

(a) Q. *How does oiling the pools prevent breeding?*

A. It kills the larvæ.

(a) Q. *How does it kill the larvæ?*

A. The oil forms a layer on the surface of the water. Now, t larvæ must have air to breathe even if they do live in the water, a they come to the top to get it, and as they can not get through t layer of oil to get air they die. Try it on a water barrel with wigg tails and see.

(b) Q. *How often should this oiling be done?*

A. Once in 12 or even 14 days would be often enough, but it is b done once a week on the same day of the week, so that it will not forgotten. Use enough oil (coal oil or kerosene) to form a layer over the surface, so that you can see it.

(a) Q. *Can all pools be oiled advantageously?*

A. No. If there be much grass in the pool the oil will not form layer all over it. If the pool be large, that is a pond, the wind w blow the oil over to one side so that the surface on the other side is covered. On large pools and grassy pools oil can not be depended

(a) Q. *Is there any other way besides oiling in which the water pools, ditches, etc., can be made unfit for breeding Anopheles?*

A. Almost anything that makes the water foul and bad smelli will prevent Anopheles breeding in it, such as soapsuds, dyestu gas tar, refuse from mills, etc.

(a) Q. *What of water in barrels, drinking troughs, cans, etc.?*

A. Where water is often disturbed, as in chicken and horse troug Anopheles are not found or very rarely found; nor are they co monly found in barrels or in artificial containers of any kind, they are sometimes, and if the water is not needed it is best to tu it out or oil it, as it *may* breed Anopheles, and *will* breed otl mosquitoes, which are a nuisance even if they do not give malaria.

(a) Q. *Have Anopheles larvæ other enemies besides man?*

A. Yes. The "top minnows" that are so abundant in some of small, sluggish streams eat large numbers of them. In places wh

minnows can get at them Anopheles larvæ are rarely found. re there is grass or brush in the water frequently the fish can get to the larvæ. These "top minnows" are our most efficient s in our fight against these mosquitoes. Big fish are of little e—indeed, do harm by eating the minnows.

Second Method.—Preventing Access of Anopheles to Well People.

) Q. *How do we prevent Anopheles mosquitoes getting to healthy le to bite them?*

(1) By screening the house; (2) by mosquito bars.

)? Q. *How should a house be screened against Anopheles?*

The screen should be No. 16 wire or No. 14 painted over to lessen ize of the mesh. All windows should be screened and all doors, ney are left open after dusk. All holes of all kinds by which quitoes can enter the house should be screened or closed, including chimney. Screen doors should open outward. People should indoors after dusk, where mosquitoes can not reach them. pheles rarely enter a house in broad daylight. Screens with holes hem, or that do not fit tight, may do harm rather than good and mosquito traps."

)? Q. *How may such screens do harm?*

Because Anopheles mosquitoes try to *enter* a house all night long thus have time to find the smallest opening in the screening. y try to *leave* the house at first light, and if they can not find the out before broad daylight they are trapped in the house and hide ark places, closets, under the bed, etc., and thus accumulate in the se.

) Q. *How should mosquito bars be used?*

They should be of fine bobbinet, with no holes in them and *with lit up the side.* They should not go over either the head or the piece of the bedstead at night, but be tucked under the mattress round and never allowed to hang down to the floor. They give e protection, but far less than good screening.[1]

Third Method.—Preventing Infection of Mosquitoes.

)? Q. *How can we treat men with malarial parasites in their d so that they will not infect mosquitoes?*

In two ways: (1) By treating everyone who has these parasites is blood until he is *cured* completely, not just partly well, to pse later. This is the doctor's business. (2) By keeping these ple in a screened house, or at least under a mosquito bar at night, ng as they have these parasites in their blood.

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[1] ow to screen houses against mosquitoes may be found in reprints of the United s Public Health Service, No. 170, Feb. 27, 1914, and No. 180, Apr. 10, 1914.

(a)? Q. *Do people have parasites in their blood only when t have malarial fever?*

A. No. A man may have parasites in his blood and be infec to mosquitoes which bite him and yet show no signs of sickn People are apt to have parasites in their blood for some time—d weeks, or even months—after an attack of malarial fever.

(a) Q. *How do you explain that?*

A. (1) It takes a large number of parasites to make enough poi to produce fever, the number differing for different people, and may have many parasites and yet not enough to produce fever. The sexless parasites which divide are the only ones which proc fever, and there may be only a moderate number of these in o blood and yet enough male and female forms to infect mosquit These last, you know, are the only forms which do infect mosquit

(b) Q. *What are the people called who are well and yet are in tive to mosquitoes?*

A. They are called "carriers," and spread malaria in a commu just as a sick man does.[1]

Fourth Method.—Immunizing People Against Malarial Fever.

(a) Q. *How can we protect the healthy men so that even if t are bitten by infected mosquitoes they will not develop mala fever?*

A. By the use of quinine.

(a) Q. *How is this done?*

A. If quinine is taken by anyone in small doses during the mala season it will generally prevent him from having malarial fever.

(a) Q. *How much must be taken?*

A. Generally in the United States 4 to 5 grains every day wil enough. Where the fever is bad as much as 7½ grains may be ne sary, but even 2½ or 3 grains a day will prevent a great many fe It is best taken after meals in one dose or in divided doses.

(a) Q. *Must the quinine be taken every day?*

A. No. It can be taken in larger doses, as 8 grains twice a w or even every five days. The first plan we think is the best.

(a) Q. *Does the quinine taken in this way injure those who tak*

A. No. It has been taken thus by many people for a numbe years, and none are known to have been injured by it.

(a) Q. *Does it make the people who take it feel badly?*

A. There are a few people whom even a very small dose of qui makes feel badly, but generally it does not. There are very

[1] There seems to be a field for especially useful work on this line in the Temp Zone among the "carriers" and people with latent malaria during the winter there are no active Anopheles. This has not been utilized except on a small sca the Tropics, where most of the antimalarial work has been done, and, indeed, is less applicable there. The destruction of the "seed parasites," so to speak, betwee malarial seasons seems very desirable.

ple who can not take enough to prevent malarial fever. Some-
es when quinine makes one feel badly at first the bad feeling
l disappear if he continues to take it.

a) Q. *What is the dose for children?*

A. About one-half as much as for grown people; less for small
ldren.

a) Q. *What is the best preparation for children?*

A. The tannate of quinine is much less bitter than the other prepa-
ions. Made up into chocolates it is not especially disagreeable
take. It is also less apt to make grown people feel badly than
er preparations.

a) Q. *What is the dose of the tannate of quinine?*

A. About two and one-half times as much as of the ordinary
d—the sulphate.

a)? Q. *Do people prevented from developing the fever by these
all doses of quinine ever have parasites in their blood?*

A. Yes. Unfortunately sometimes they do. To what extent this
urs and to what extent the quinine prevents the parasites from
eloping in the blood is not yet determined.[1]

(b) Q. *Are all people not protected by quinine liable to develop
larial fever when bitten by an infected mosquito?*

A. No. Some men seem to be naturally *insusceptible* to malaria.
ey are probably very few. In other men the having had a num-
of attacks of malaria produces an insusceptibility, or at least a
ered susceptibility, to the disease, and they do not under ordi-
y circumstances develop it. We frequently find in a malarial
ntry families in which the children are having fever, while the
people are not. They have had many attacks in past years, and
now not susceptible to malaria. Sometimes a severe accident
a spell of sickness may render them susceptible again.

(b) Q. *Is malarial fever liable to relapse?*

A. Yes. Untreated, or imperfectly treated, it is almost sure to
apse, and to relapse several or even many times. The infection
quently lasts over from one season to another, the man being well
months between the attacks. It has been known to relapse after
o years' interval. Many of the attacks of fever in a malarial
ntry are relapses and not new infections. All those that occur in
winter and up to June or July, are probably relapses.

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[1] Reprint No. 175, United States Public Health Service, gives a short account of the
inine prophylaxis" of malaria.

DIAGRAM SHOWING METHOD AND MEANS OF PREVENTING MALARIA.

PREVENTION OF MALARIA.

- **I. Getting rid of Anopheles**
  - (1) Destruction of shelters
    - (*a*) Cutting down brush and weeds.
  - (2) Destruction of breeding places
    - (*a*) Draining and filling.
    - (*b*) Oiling.
    - (*c*) Introducing fish.
- **II. Preventing access of mosquitoes to well men.**
  - (1) Screening the house.
  - (2) Mosquito bars.
- **III. Preventing the infection of mosquitoes.**
  - (1) Treating infected men until completely cured.
  - (2) Keeping such men under mosquito bars and in screened houses.
- **IV. Immunizing people against malarial fever.**
  - (1) Quinine.