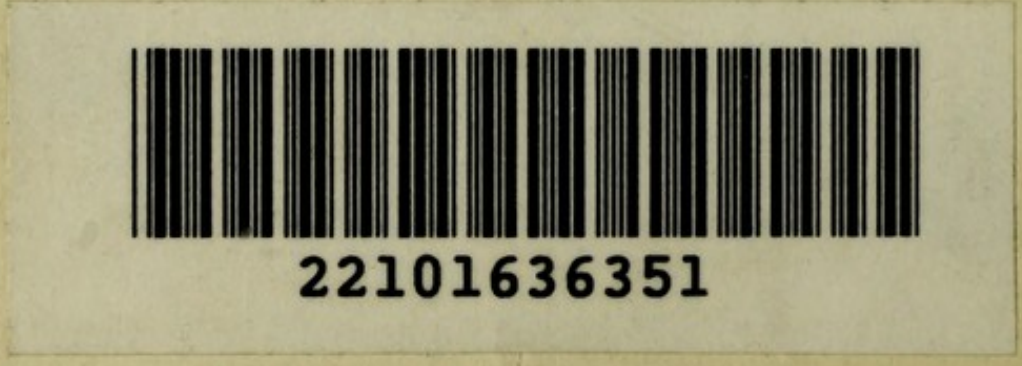
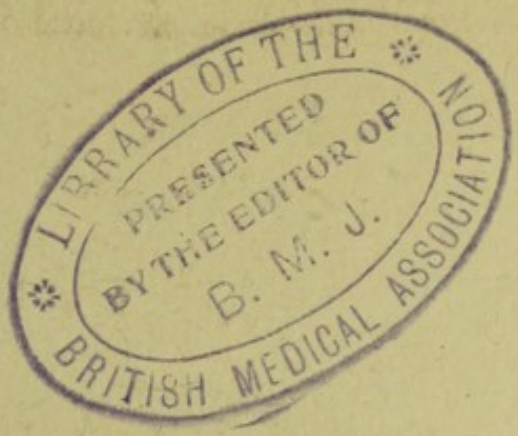
The mosquito : its relation to disease and its extermination / by Alvah H. Doty.

THE MOSQUITO

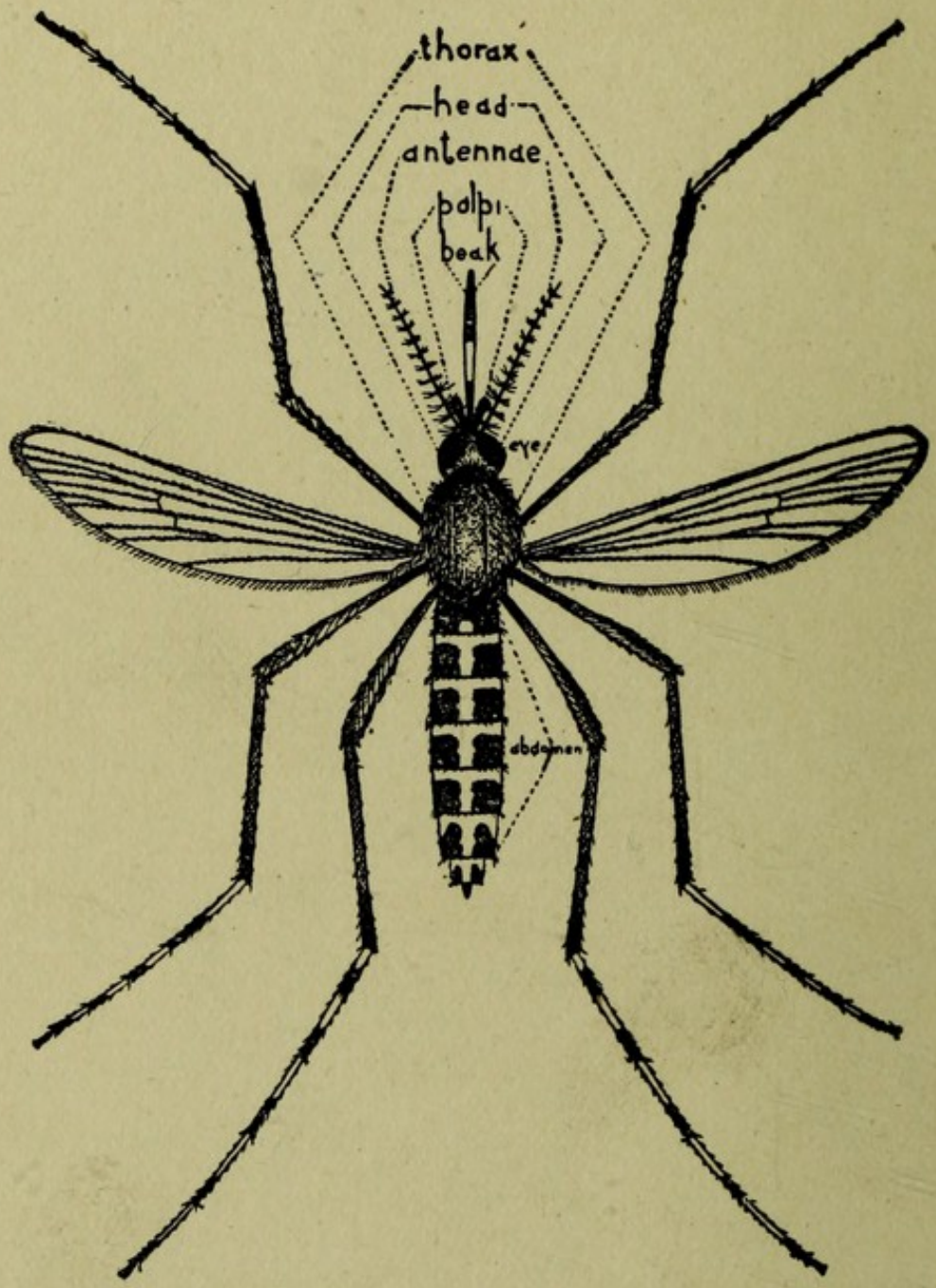
ITS RELATION TO DISEASE AND ITS EXTERMINATION

ALVAH H. DOTY, M.D.




LIBRARY OF THE
PRESENTED
BY THE EDITOR OF
B. M. J.
BRITISH MEDICAL ASSOCIATION

THE MOSQUITO



THE MOSQUITO: FEMALE (Smith)

While the antennæ of the female have hair-like processes (see above), the antennæ of the male consist of well marked and easily recognized *plumes*.

THE MOSQUITO

ITS RELATION TO DISEASE AND ITS EXTERMINATION

BY

ALVAH H. DOTY

FORMERLY HEALTH OFFICER OF THE PORT OF NEW YORK

ILLUSTRATED

NEW YORK AND LONDON
D. APPLETON AND COMPANY
1912

Published September, 1912

Printed in the United States of America

PREFACE

This book has been prepared with the hope that it may stimulate the work of mosquito extermination, so urgently called for.

I have endeavored to bring together, in a plain and practical way, such information regarding the mosquito and its extermination as will be useful to those who may be interested in this work.

For the use of valuable and very accurate illustrations, I desire to express my thanks to Dr. L. O. Howard, Entomologist, Department of Agriculture, Washington, D. C., and to the New Jersey State Experiment Station.

A. H. D.

New York.

CONTENTS

CHAPTER		PAGE
I.	General Considerations	1
II.	Propagation	8
III.	Identification of the Mosquito	23
IV.	Breeding Places	32
V.	Food	40
VI.	Length of Life	42
VII.	Distance which Mosquitoes Travel	43
VIII.	Hibernation	47
IX.	Extermination of the Mosquito	50
X.	Remedies and Agents for the Prevention and Treatment of Mosquito Bites	75

LIST OF ILLUSTRATIONS

PAGE

The Mosquito: Female (Smith). *Frontispiece*

Manner in which the eggs of the Culex pungens, or common house mosquito, are deposited (Howard) 9

Deposit of eggs of the Anopheles (Howard) . 9

Larva (Smith) 13

Usual position of larva in obtaining air (Howard) 17

Position of Anopheles larva in obtaining air (Howard) 17

Pupa (Smith) 19

Culex pungens, or common house mosquito: Female (Howard) 25

Anopheles, or malarial mosquito: Female (Howard) 29

Stegomyia, or yellow fever mosquito: Female (Howard) 33

Culex sallicitans, Salt Water, Swamp or Striped Legged mosquito: Female (Howard) . . 37

THE MOSQUITO

ITS RELATION TO DISEASE AND ITS EXTERMINATION

CHAPTER I

GENERAL CONSIDERATIONS

There are two reasons why the mosquito should be exterminated. First: because it is a common and dangerous medium of infection; second: because its bite is exceedingly annoying, and seriously interferes with the comfort of those who reside in or visit districts infested with this insect; besides, the normal growth of population and land value in sections where mosquitoes propagate in large

numbers, particularly along the Atlantic coast, are frequently affected by these conditions.

During the early part of the last century the parasitic origin of infectious diseases was suggested, but the limited resources of bacteriology at that period, and other reasons rather discouraged the further investigation of this subject.

About 1880 the great discoveries of Pasteur and Koch, respectively a French and German bacteriologist, gave to the world indisputable evidence of the germ origin of infectious diseases. These savants also devised new and improved methods for microscopic work and the preparation of specimens for examination.

Not long afterward Dr. Laveran, a French army surgeon, on duty in Algeria,

found in the blood of malarial patients the specific organism or cause of this disease. This led to a long and exhaustive investigation to determine the medium through which malaria is transmitted, and resulted in the discovery that the means of infection is a variety of the mosquito known as the "Anopheles." For this, credit is due Dr. Manson and Dr. Ross of England, chiefly the latter, for it was largely through his experiments in India that this important knowledge was obtained. So far as we know at the present time there is no other medium of affection in malaria.

Still further important evidence regarding the danger from the mosquito soon followed. During the occupation of Cuba by the United States in 1900 a commission appointed by the President to investigate the cause of yellow fever, and

the means by which it is transmitted, submitted in their report conclusive proof that yellow fever also is transmitted only by the mosquito, a variety known as the "Stegomyia." It may be added that the germ of this disease has not yet been identified.

Thus it has been found that the mosquito is responsible for the presence of two diseases which in the past, and even now in certain sections of the world, have caused great suffering and an enormous loss of life. Proof has also been secured that the mosquito is the medium of infection in other diseases, and also that the Anopheles and the Stegomyia are not the only varieties of this insect that are agents of infection.

After the important discovery of Manson and Ross the study of the mosquito and

the means by which it can be exterminated were soon under way, and since 1890 rapid strides have been made in this direction, the pioneers in this work being among those who live in civilized countries where malaria and yellow fever are particularly prevalent. The most effective and extensive work was first undertaken in Italy; where as a result of malaria the army was at times almost unfit for service, and there is but little doubt that these conditions were responsible for the beginning of the extensive emigration to this country, as many deaths were annually caused by this disease. Greece has also been a great sufferer in this direction, for at times one-third of its population has been affected. Furthermore, it is well known that the abandonment of the work on the Panama Canal, under de Lesseps,

was due to the great prevalence of malarial fever, which could not be controlled.

The work of mosquito extermination has caused a great change in these conditions and has been followed by the most brilliant successes, particularly in Cuba and in the Canal Zone, where the work has been carried on under the direction of the United States Government, and which has furnished conclusive evidence that the extermination of this insect has long since passed the experimental stage and can be successfully carried out if proper means are employed.

In order to intelligently and successfully carry out the work of extermination, there must be a practical knowledge of the propagation of the mosquito, its habits, etc.; fortunately, this information is now available.

GENERAL CONSIDERATIONS

Although there are many varieties of the mosquito found throughout the world, as well as in the United States, it will be sufficient for the purpose of this book to describe them under two classes: First, the Inland variety, of which the "Stegomyia" and "Anopheles" are types, and, second, the Salt Water Swamp, Atlantic coast, or Striped Legged mosquito.

CHAPTER II

PROPAGATION OF THE MOSQUITO

Mosquitoes propagate only in water. While the eggs of the Inland variety are laid immediately upon its surface, those of the Striped Legged mosquito are probably first deposited on the soft ground of the swamp, although development does not begin until the eggs are floated out by the incoming water. Usually within twenty-four hours the eggs are hatched and the larvæ drop into the water. This constitutes the second stage of development of the mosquito and usually lasts from five to ten days, when the larvæ are transformed into pupæ, the third stage of development; this is of short duration,

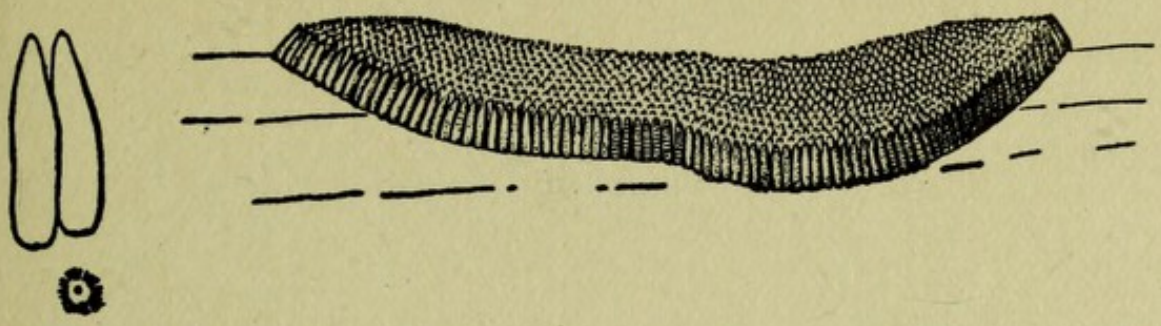


FIG. 1.—MANNER IN WHICH THE EGGS OF THE CULEX PUNGENS, OR COMMON HOUSE MOSQUITO, ARE DEPOSITED (Howard)

FIG. 2.—DEPOSIT OF EGGS OF THE ANOPHELES (Howard) Those of the Stegomyia, and some other varieties of the Inland Mosquito and also the Culex sollicitans are laid similar to these.

not more than two or three days, when at its termination the birth of the full-grown mosquito takes place, for this insect does not afterward increase in size.

From the deposit of the eggs on the water until the release of the winged insects a period of from ten to fifteen days usually occurs, depending largely upon climatic condition.

Eggs.—All mosquitoes do not deposit their eggs in the same manner, nor are they of the same shape or size. Those of the common Inland variety, or house mosquito Culex pungens, are dropped in the form of a raft or float, the individual eggs being shaped very much like a banana, and held closely together with the large end down, from which portion after rupture the larvæ reach the water (Fig.

1). The deposit consists of three or four hundred eggs; therefore, it is not difficult to understand the rapidity with which this insect propagates.

The eggs of the Anopheles, Stegomyia, and some other varieties of the Inland group, as well as the eggs of the Striped Legged mosquito, are deposited separately, and flat upon the water, are different in shape, and much less in number. A deposit of eggs of the Anopheles will illustrate this (Fig. 2).

LARVÆ.—These appear about 24 hours after the eggs are laid upon the water. At first they are so minute in size that they are usually unrecognized by the naked eye, unless specially sought after, although they may even in their early stage be detected by their movements in the water. They increase rapidly in size

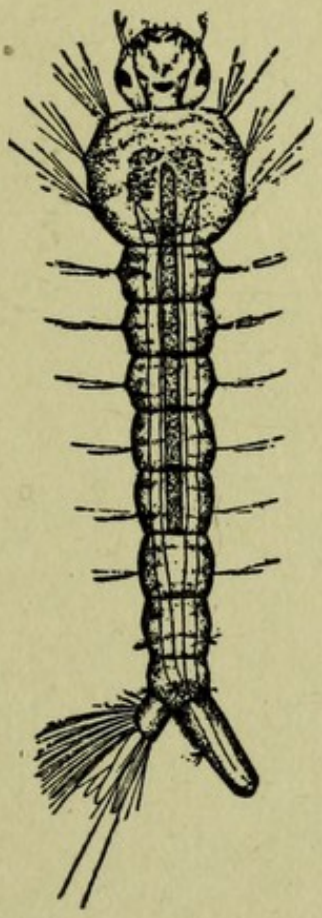


FIG. 3.—LARVA (Smith)

and when full grown are about one-third of an inch in length and about the size of a very large thread. The head of the larvæ is particularly prominent. In mosquito infested districts these little bodies are commonly known as "wigglers."

Although there are some small differences in the larvæ of the various types of the mosquito, their appearance is practically the same and needs no special description (Fig. 3).

The activity and habits of the larvæ are very interesting. The phenomena may be studied by placing a glass of water containing larvæ between the eyes and the light. They will then be seen moving about the water in a rapid and jerky way, principally in quest of food, which they secure largely from the organic matter in the water.

Although larvæ cannot live out of water, they must also have air, and if carefully watched will at intervals of about a minute be seen to rise to the surface of the water, above which they extend their lower extremity containing the opening of the respiratory apparatus, through which they receive the air; therefore, it may be said that the larvæ breathe through their tail. Just at this point exceedingly important information is obtained, for those who are dealing with the extermination of this insect, for while the larvæ in securing air are usually at right angles with the surface of the water, with their heads down (Fig. 4), an exception occurs in the instance of the larvæ of the Anopheles, which not only lie close to the surface but parallel to it (Fig. 5).

As a matter of interest it may be stated

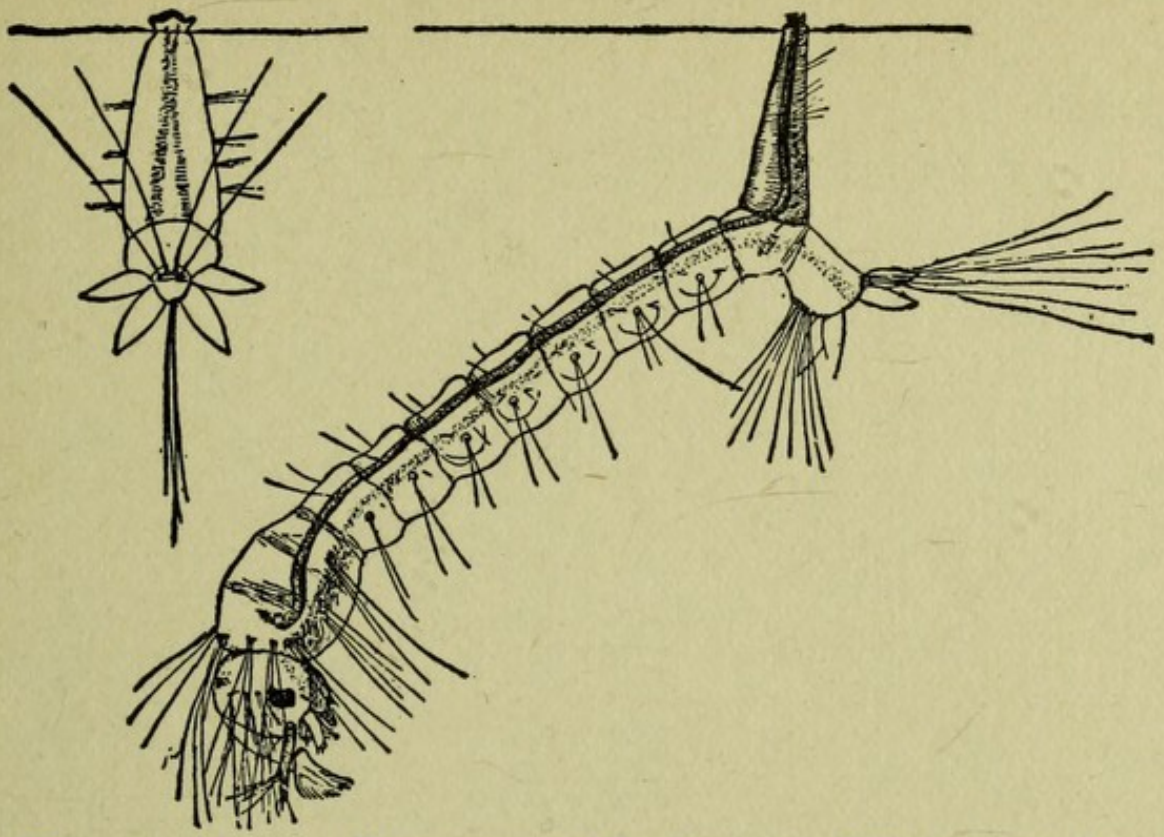


FIG. 4.—USUAL POSITION OF LARVA IN OBTAINING AIR (Howard)

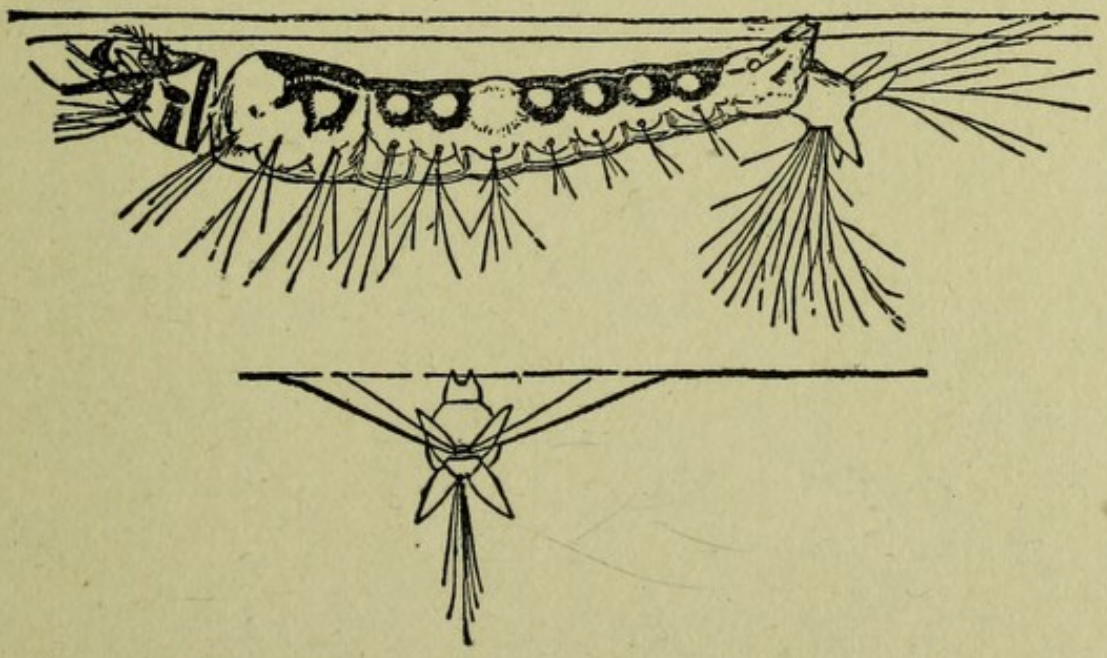


FIG. 5.—POSITION OF ANOPHELES LARVA IN OBTAINING AIR (Howard)

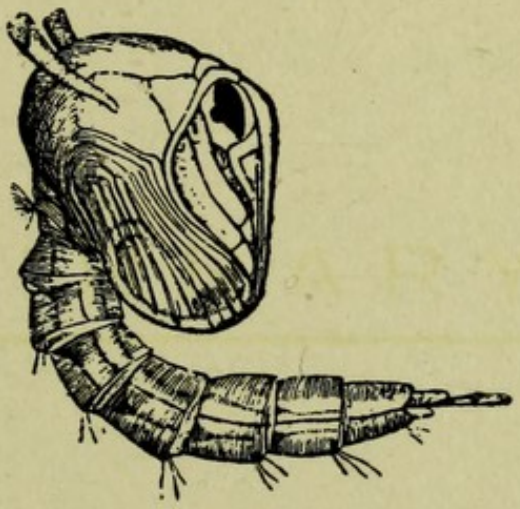


FIG. 6.—PUPA (Smith)

that the larvæ of certain varieties of the mosquito are predatory. The Psorofora Ciliata, popularly known as the "gallinipper," a giant mosquito, is one of them. These larvæ preferably feed on those of smaller varieties, although if they are not present they will eat their own kind.

After an interval of from five to ten days, depending on the variety of mosquito, climatic conditions, etc., the larvæ pass to the pupal stage.

PUPÆ.—These (Fig. 6) may be recognized by an apparent enormous enlargement of the head of the larvæ, and have the appearance of an exaggerated comma; they will usually be seen lying close to the surface of the water. It is probable during this stage no nourishment is required. After a period of about two days the pupæ will be seen to rise above the

surface of the water, where the envelope is broken, and the full-grown mosquito appears; it hesitates only for a short time, evidently to get its bearings and try its wings, then flies away.

CHAPTER III

IDENTIFICATION OF THE MOSQUITO

INLAND MOSQUITO

In this class three varieties will be referred to: the common variety, Culex pungens (Fig. 7), found throughout the world, and the Anopheles, and Stegomyia. It is the Culex pungens which is usually found in the house and is chiefly responsible for the annoyance caused indoors, and is therefore known as the house mosquito. It is of medium size, with rather a thin body, and in color ranging from a deep yellow to a dark brown. It has no distinctive feature, for it is practically of one color, having no marking or bands on

the beak or feet. The palpi, or mouth feelers, are short in the female.

This description will in a general way answer for many of the inland mosquitoes, although the Anopheles and Stegomyia need to be specially described.

The *Anopheles,* or malarial mosquito (Fig. 8), is more slender, with longer legs and body; there are three points which serve to distinguish this mosquito from the rest. First, the wings are spotted or dappled with brown or black, which are well marked and constant. Second, the palpi, or mouth feelers, are about as long as the beak in both sexes. Third, when at rest the head of the Anopheles points between the front legs, and the body, and is almost at right angles with the surface upon which it rests, whereas in other mosquitoes the body at rest is parallel to the

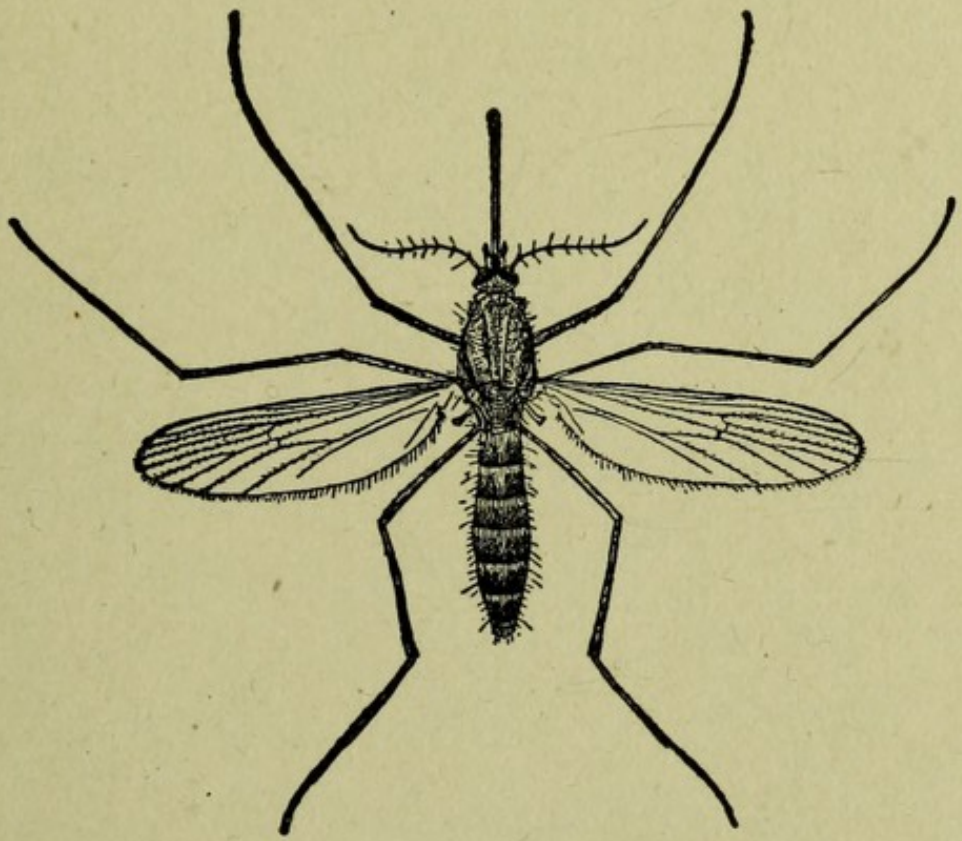


FIG. 7.—CULEX PUNGENS OR COMMON HOUSE MOSQUITO: FEMALE (Howard)

surface. These characteristics of the Anopheles should be carefully remembered, for they are always present and serve to identify it. It will thus be seen that the Anopheles may be detected both as the larvæ and as the winged insect.

The *Stegomyia* or yellow fever mosquito (Fig. 9), which is found only in the southern section of the United States, has the enviable reputation of being known as the most attractive mosquito which has come under observation. It is a comparatively small one, with pronounced and brilliant silver stripes on its abdomen and thorax; the legs are also striped, although not so pronounced as in the case of the Salt Water Swamp mosquito; besides, it has no broad transverse stripe of white on its beak, which is found in the latter.

It is also smaller in size than the salt water swamp mosquito.

Both the Anopheles and Stegomyia are notoriously house mosquitoes, and are most vicious in the late afternoon, evening and probably very early in the morning.

THE CULEX SOLLICITANS, ALSO KNOWN AS THE SALT WATER SWAMP, ATLANTIC COAST, OR STRIPED LEGGED MOSQUITO

Although this variety is the chief source of annoyance along the Atlantic coast, it is not a house mosquito, and usually carries on its attack outside, although it may be brought into the house on the clothing, or otherwise. It is easily recognized without the aid of a glass by the broad white transverse band on the middle of

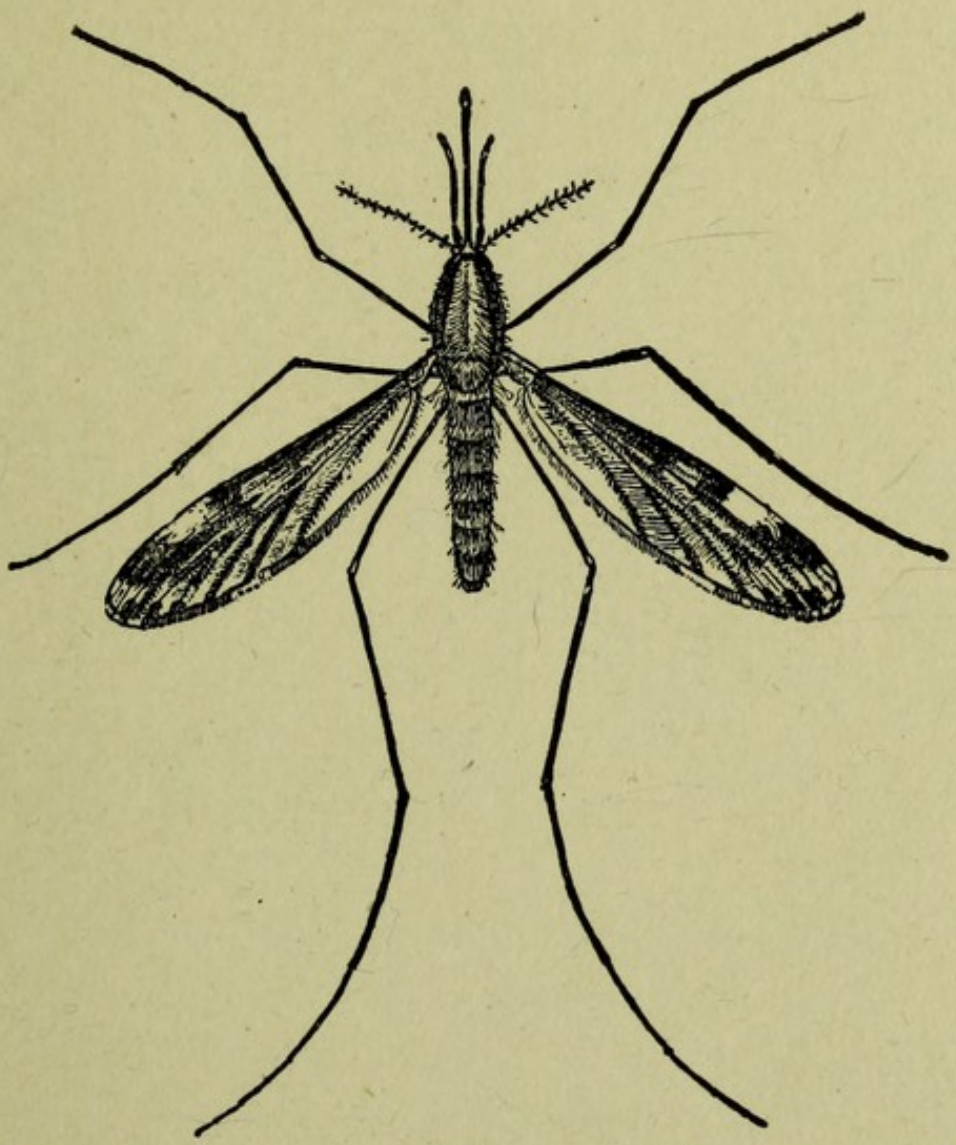


FIG. 8.—ANOPHELES, OR MALARIAL MOSQUITO: FEMALE
(Howard)

its beak and also the distinct white bands on its legs (Fig. 10).

In order to become familiar with the different varieties of the mosquitoes referred to in this book, the reader should carefully study the various parts of the mosquito referred to in the Frontispiece.

CHAPTER IV

BREEDING PLACES

INLAND MOSQUITO

This variety does not breed in salt water swamp land, but elsewhere it will propagate in almost any receptacle containing water. These are so numerous and so many of them unsuspected that they frequently escape detection, even on the part of those who are making diligent efforts to find them. About the premises they usually consist of old tin, crockery and glass ware, broken roof leaders, cesspools, drains, unused water troughs, rain water barrels, cisterns, etc., unused receptacles about the barn and other outhouses. Urns in cemeteries, statuary in parks or

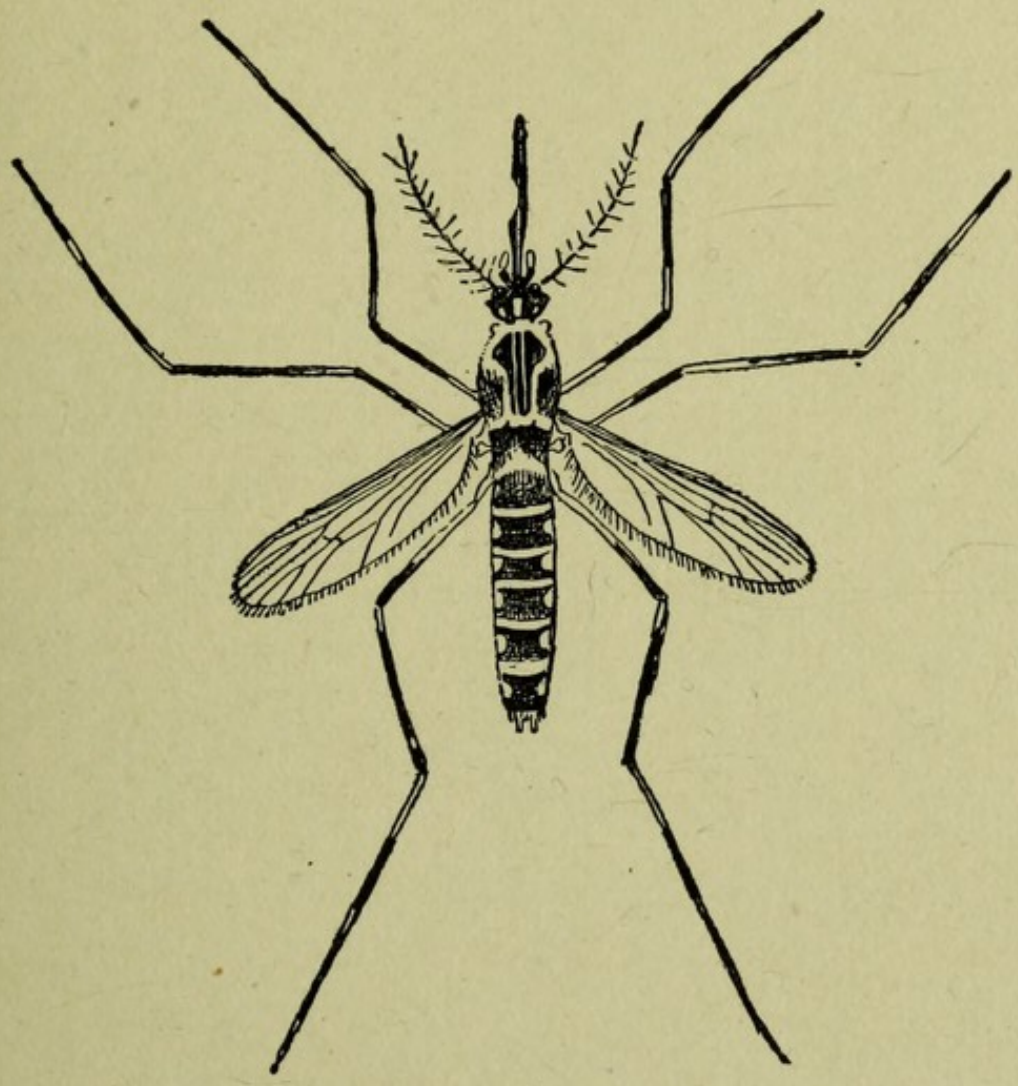


FIG. 9.—STEGOMYIA, OR YELLOW FEVER MOSQUITO: FEMALE (Howard)

elsewhere are also common breeding places; in fact, there is practically no limit to them. A very prolific means of propagation are found in excavations for new buildings, streets, sewers, etc., which are very frequently overlooked; besides there are innumerable places about manufactories, public buildings, water tanks on apartments and tenement houses. If breeding places were always exposed, their detection would be much easier, but in many instances the receptacles are hidden by long grass, weeds, and underbrush, which make their discovery very uncertain.

Contrary to the general belief, mosquitoes do not breed in large bodies of water, unless these are particularly rich in organic matter, as in extensive collections of sewer water. They, however, breed

along their edges in small depressions such as may be formed by the hoofs of animals that come to drink.

While a few varieties of the inland mosquito, probably the Anopheles and Stegomyia, may prefer clearer water for breeding, the more common ones prefer that which is contaminated, containing a large amount of filth, not only to secure rich nourishment for themselves, but also for the future larvæ; therefore, the danger of filthy and stagnant water is apparent.

Rain water barrels and cisterns found in the country are very prolific breeding places, so much so that the Culex pungens is sometimes referred to as the rain barrel mosquito.

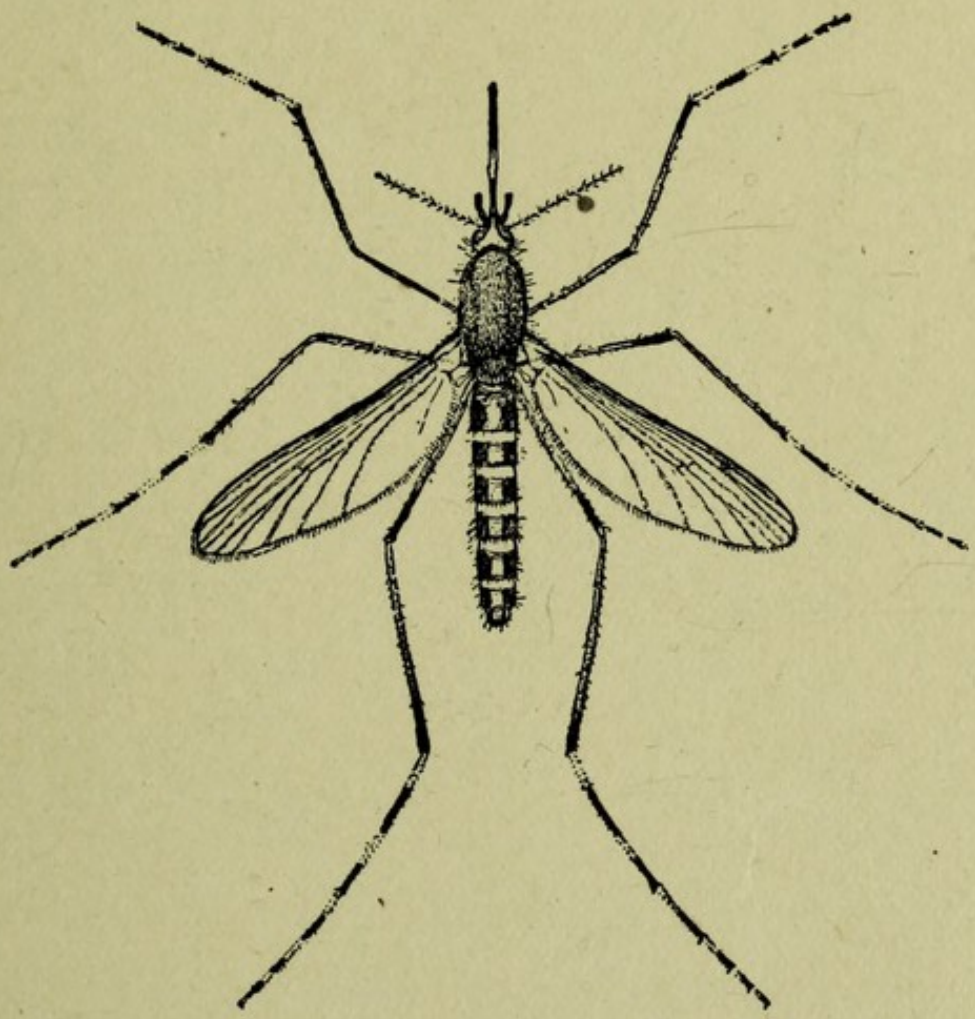


FIG. 10.—CULEX SOLLICITANS, SALT WATER SWAMP OR STRIPED LEGGED MOSQUITO: FEMALE (Howard)

BREEDING PLACES

CULEX SOLLICITANS

This variety breeds only in salt water swamps and not inland. Those who have not visited these swamps cannot appreciate the enormous breeding surface they supply. The surface of the swamps contains millions of depressions, and it is here that the eggs are deposited, the water being supplied by the incoming tide and rainfall.

It is frequently asked why do not mosquitoes appear in large numbers in certain sections where suitable places for breeding exist. This is probably explained by climatic conditions, insufficient or improper food, or some peculiarity of the place which does not encourage active breeding.

CHAPTER V

FOOD

While mosquitoes are essentially vegetarian, the females, *the only ones which bite,* crave blood, as those in mosquito infested districts will testify. The males do not take blood food. If a mosquito is carefully examined after biting, its abdomen will be found enlarged, and if held before the light, a dark, opaque area will be observed representing the site of the meal. Whether or not it is necessary that the female shall draw blood before it is prepared to lay its eggs has been a subject of much discussion. While this form of nourishment is undoubtedly advantageous, ovulation does not depend

upon it, for experimental work has shown that in receptacles containing larvæ and protected by netting to prevent the escape of the new born mosquitoes, deposits of eggs have subsequently been found on the water; therefore, the latter must supply the sustenance necessary for this purpose. The larvæ are voracious eaters and depend largely on the organic matter in the water, plants, etc., with which they come in contact. When they are removed from water rich in these products and transferred to distilled water, for instance; which contains little or no organic matter, they quickly die. The author has proven this many times by experiments.

During the pupal stage, which is simply preparatory to the birth of the winged insect, it is probable no nourishment is required.

CHAPTER VI

LENGTH OF LIFE

There is no truth in the belief that mosquitoes live but a day, although it is very difficult to even approximately estimate their life cycle; however, careful investigation justifies the statement that the average life of an inland mosquito is about two or three weeks. The Anopheles, and the Stegomyia, of this group, and the Salt Water Swamp mosquito live somewhat longer, probably about a month. The above refers to the female, as the male lives only a few days.

Mosquitoes have a definite function to perform—perpetuation of their species—which requires some time and occupies a large part of the period above referred to.

CHAPTER VII

DISTANCE WHICH MOSQUITOES TRAVEL

Perhaps no phase of the mosquito question has been so thoroughly discussed and so many various opinions expressed as the probable distance which mosquitoes go from their home, or breeding place. Without reference to these various opinions, it may be said in a general way that the Inland variety is not a migratory mosquito, and does not voluntarily go far from home, probably not more than a few hundred feet; however, it must not be forgotten that they may be carried some distance by winds or driven away by smoke, etc. Much practical proof has been pre-

sented in confirmation of this statement; for instance, it has been found in yellow fever outbreaks, particularly in built up communities, and this is where the Stegomyia prefer to live and breed, that the secondary cases are first noticed in the adjoining houses, or in houses opposite to where the original case occurred. These facts are also of interest in the extermination of this variety of the insect, for if they are found in large numbers about the house, it may properly be assumed that breeding places are not far away.

The Sollicitans, on the other hand, is a migratory insect and voluntarily goes far away from home; it may frequently be found miles from its breeding place, either inland or at sea.

It is of great practical importance to know that the Salt Water Swamp mos-

quito is a migratory insect, and that the inland variety is not.

The sudden appearance of a large number of mosquitoes calls for an investigation as to the direction of the wind. This will oftentimes aid in the detection of breeding places.

There is no doubt that mosquitoes are carried long distances by modern means of travel, and it will explain the appearance of these insects in sections hitherto free from them.

Mosquitoes are particularly active at night; it is the time they breed and bite, usually during the early evening and about daybreak, although when enormous numbers are present, as in sections where the Salt Water Swamp mosquitoes propagate, apparently there is but little cessation in their activity.

During the daytime mosquitoes secrete themselves in long grass, underbrush, etc.; therefore, its removal in various ways adds to their destruction. The sudden appearance of large numbers of mosquitoes after a rainfall suggests very strongly that they have been secreted in nearby foliage for protection, unless a strong wind is present.

CHAPTER VIII

HIBERNATION

The perpetuation of the mosquito during the cold weather is a subject of great practical interest, although in tropical countries where there is more or less continuous breeding it is not so important. A knowledge of the manner of hibernation offers an opportunity to more completely exterminate this insect by attacking it during its period of inactivity.

Some very interesting information has been secured in this direction. We know that during the latter part of the fall some of the female mosquitoes of the inland variety find their way to dark, warm and protected places, particularly cellars, etc., also occasionally the living portions

of the house. Here they pass into the stage of hibernation, and in this dormant condition remain until the warm weather returns in the spring, when they again become active, seek a breeding place, deposit their eggs and die.

It was formerly believed that all mosquitoes hibernated in this way; now it is known that the Sollicitans hibernates in the form of the egg, instead of the winged insect. Late in the year the eggs are deposited in the soft earth of the swamp, and remain there inactive until the spring with its increased temperature of the water leads to their development into the winged insect.

Although larvæ have been found alive during winter, they are probably not an important factor in the perpetuation of the mosquito, for it is positively known

that the Inland variety hibernates in the form of the winged insect, and that the Sollicitans passes through this stage in the form of the egg. Almost everyone in mosquito infested districts has occasionally during the winter met with these insects when an apartment has been kept continuously warm or overheated; furthermore, investigators have been able in the spring to wash out and develop eggs removed from sods cut out of salt water swamps.

The hibernation of the mosquito teaches us we may take effective measures during the winter to destroy the Inland variety and also to remove or destroy possible breeding places early in the spring, for if none are available for the deposit of the first crop of eggs, there must be a great diminution or absence of the Inland mosquito during the ensuing year.

CHAPTER IX

EXTERMINATION OF THE MOSQUITO

The extermination of the mosquito has long since passed the experimental stage, and successful results can be secured if proper measures are employed in carrying out this work. While individual energy and the interest which may be taken by a single community in this direction is of value and should be applauded, it does not secure the general result which is desired, for this can only be obtained by an organization which includes under its direction practically the entire territory involved. The treatment of a limited area is practically of no avail where

the Salt Water Swamp mosquito is concerned, for the surrounding territory uncared for will still furnish sufficient mosquitoes for all purposes.

The knowledge we now possess regarding the mosquito, its habits, life cycle, etc., and the positive results which have been obtained in its elimination, must remove all doubt as to its success. Those who undertake the work of mosquito extermination should feel this and persist until it is accomplished. Half-hearted efforts do not secure the desired results; furthermore, the extermination of the mosquito should be in the hands of those who are practically familiar with this subject, or at least some one who has carefully studied the literature connected with it.

So far as possible, breeding places should *be destroyed, and not treated.* This

is one of the cardinal principles of mosquito extermination.

Considerable has been written regarding the value of fishes, birds, etc., in the extermination of the mosquito. It is better that the consideration of this should be dismissed from the mind of those who are practically interested in this subject, for neither birds nor fishes can in any practical degree be depended upon for this purpose. It is as far from modern sanitary methods as the reliance which in some countries has been placed upon the use of buzzards to remove garbage. It is true that in natural streams or collections of water certain fish devour larvæ. While this undoubtedly diminishes the larvæ present and in this way is valuable, it is impracticable to consider the development of either birds or fishes for this purpose,

and it should take no part in the efforts which are employed to get rid of this insect further than their use in fountains or other ornamental structures.

As it has already been stated, there are two classes of this insect to be dealt with in the work of extermination, the Inland and the Salt Water Swamp mosquito. This must be fully understood in order to secure successful results, as each class requires the employment of different means of extermination, for their breeding places are distinct from each other.

The extermination of the Inland mosquito depends on the destruction or removal of all breeding places. This involves an exhaustive inspection to detect their presence, particularly those which are often concealed, and for this reason seriously militates against the success of

this work, for the inland mosquito breeds in the most unsuspected places. Unless there is full appreciation of this, the desired results will not be obtained. It should be thoroughly borne in mind that the breeding places cannot be specifically enumerated, for any receptacle which will hold water may be used for this purpose. Many who are exceedingly careful in their examinations about the house will forget about the barn, out-houses, laundry, kitchen, etc., where may be found unused pails or other receptacles, which are prolific breeders. Water barrel and cistern, if they cannot be changed for more modern methods of collecting water, should be fitted with tight wire gauze covers, and should be frequently inspected and the water examined, for mosquitoes frequently gain access to these receptacles

through defects in construction, etc., and breeding may occur. Larvæ are exceedingly sensitive, and the approach of a person to a rain-water barrel, for instance, will cause their immediate disappearance to the bottom or lower part of the receptacle; therefore, under these circumstances a dipper plunged into the barrel and brought up without larvæ does not by any means prove they are not present. This must be repeatedly done with great care and patience, provided there is not sufficient light to detect them with the eye. In the country small pools and ground depressions are to be dealt with. As a rule, these cannot be drained, but if possible should be filled in; if this cannot be done, then the use of petroleum is called for.

As already stated, mosquitoes do not propagate in large bodies of water. They

prefer small receptacles where there is quiet, rich nourishment and vegetation which afford protection. However, careful inspection must be made along their borders, for here in small depressions or holes may be found many breeding places.

Cities and large towns are more free from mosquitoes than the country simply because in built-up sections there are fewer breeding places; still, in the city many breeding places are found. The various parks are breeders; so are water tanks on the roofs of buildings. The latter are frequently overlooked because it is believed that mosquitoes do not fly sufficiently high. This is not the fact. There are many receptacles about factories, public buildings, etc., which should, but do not, receive careful inspection.

There is much connected with this work that comes directly under municipal control which unfortunately receives little or no attention, such as cesspools, sewers and their connections, and more particularly new construction or repair work, which form many openings or depressions, used and unused receptacles for public use, etc., which are not often considered. Careful attention to this is very important in many ways and should call for prompt action on the part of municipal officers. It is not only a duty on their part, but is a public education, for it stimulates action in the same direction on the part of individual property owners.

The use of petroleum oil must be regarded as only a temporary measure, for it does not remove breeding places and deals only with the larvæ which are pres-

ent. Its application is therefore justifiable only when the breeding places cannot be removed or destroyed. *Partly* refined petroleum oil should be selected for this purpose, for the crude oil does not spread quickly or evenly over the surface of the water, and the refined oil is not so effective and is more expensive. Petroleum oil of the required kind may usually be purchased for three fifty to four dollars a barrel. The effect of this oil on the larvæ is mechanical and destroys them, not by poisoning, as many believe, but by suffocation. When the lower end or tail of the larvæ is projected above the surface of the water for air it passes through the stratum of oil on the surface and the opening is closed or plugged and the respiratory apparatus rendered useless; the larvæ die of suffocation within twenty minutes. Al-

though many agents have been suggested as substitutes, petroleum oil is the most practical and effective agent for this purpose. Experiments have shown that larvæ will live for some time in comparatively strong solutions of carbolic acid, corrosive sublimate, permanganate of potassium, etc. Besides, their use for the purpose of larvæ destruction would in various ways be dangerous, particularly to animals who may come in contact with water mixed with these agents, while petroleum oil is cheap and harmless and can be depended upon to kill the larvæ promptly. It should be applied about every ten days, in order to protect against new crops of larvæ. A pint of oil for an estimated water space of twenty-five or thirty feet in diameter is a generous allowance. Although various forms of

spray apparatus have been devised for its application, there is no more effective means of distributing it than by the common garden sprinkling pot, with the holes in the expanded nozzle enlarged for the free exit of the oil. Rubber boots are a very necessary requisite for those who apply this agent.

The inflammable character of the oil should not be forgotten, and the general supply should be carefully protected against danger.

An important factor in the work of extermination, particularly in connection with the Inland mosquito, consists in the removal of tall grass, underbrush and other growths which generally harbor the mosquito during the daytime; this, however, should be restricted rather to unnecessary growths, for it is hardly prac-

tical or proper to advocate the removal of flowers or other cultivated plants, which serve to beautify the premises, although so far as possible the principle should be carried out, for if there is no abiding place for the mosquitoes during the daytime many of them are destroyed.

While extended coöperation and organization are necessary to success in the extermination of the Inland mosquito, it is imperatively so when dealing with the Salt Water Swamp mosquito, for here the breeding places are often continuous for miles; therefore, the work of the individual owner is of little avail unless he controls the whole or greater portion of the swamp to be treated.

There is but one way of exterminating the Salt Water Swamp mosquito, and that is by *drainage*. This has already been ex-

tensively done and has furnished ample proof as to the success of the work. Salt water swamps consist of land which is constantly exposed to water regularly by tides and occasionally by rain. It is soft and spongy, and so water-soaked that there is but little escape for surface water, which is more or less constantly present, and furnishes places for the development of the larvæ.

Drainage allows of the prompt escape of the surface water by relieving the soaked or spongy ground, which is drained into the sea and is permitted to contract and to become harder and firmer, so much so that it can be driven over, while previous to ditching it is hardly able to support a man's weight. The removal of the water from the surface of the swamp kills the larvæ, for experi-

ments have shown that they cannot be resuscitated if deprived of water even for a short time. This is aided by exposure to the sun, and indicates the value of removing or burning the various swamp growths.

Experiments have also shown that a ditch properly dug draws water from seventy-five to one hundred feet on each side. This knowledge is valuable in deciding upon the distance which should intervene between the ditches. They should be deep enough to go below the strata involved, and wide enough to allow of free exit of their contents. The sides of the ditch should be straight up and down; in this way they are far more effective and the wash of the water tends to keep them in their original condition, or may even enlarge them. A ditch, carefully construct-

ed and kept clean, and well cared for, will remain intact for an indefinite period. Instances are reported where they have been operative for twenty or thirty years.

The drainage work under the direction of the author on the Staten Island marshes consisted of the construction of ditches about two feet deep and ten to twelve inches wide, and at intervals of from one to three hundred feet, depending upon the character of the swamp. In some instances it was necessary to dig them even closer together. They were made to discharge into larger ones, by which their contents could be carried to the sea. Natural creeks or waterways were utilized for this purpose, when they existed; otherwise, drains about four feet wide were constructed for this special purpose.

No system of drainage for the extermination of the mosquito will obtain successful results unless the ditches are kept clean and free from débris, which is principally brought in by the tide; otherwise they become clogged and form breeding places. The growth along their edges should be frequently removed, in order that the ditches may be freely exposed to the air and sun and more easily seen. It is far more effective and economical to continue the care of these ditches during the winter.

The removal of the salt water hay or other growths found on the swamp is a valuable aid in exterminating the Sollicitans, for it allows of greater exposure to the sun, which more rapidly dries the ground, and in this manner more promptly destroys the larvæ, particularly where

ditches are in operation; it also takes away the protection which this growth gives to the winged insect, and in this way also aids in their destruction.

It is hardly necessary to state that the use of petroleum oil is practically worthless in the extermination of the swamp mosquito on account of the vastness of the breeding places and the need of the application of this agent about every ten days; besides, it offers no permanent results in the extermination of the mosquito and would be detrimental in the preparation of this land for agricultural purposes.

The expense of draining swamp land depends largely on the character of the swamp, for in sections where more ditches are required the expense is relatively greater. A good workman after some experience will be able to ditch about

seventy-five to one hundred feet daily. These men can usually be secured for two dollars per day. Therefore, if the space between the ditches is decided upon, an approximate estimate of the expense can be made. It is generally understood that swamp land can be drained for about ten dollars per acre.

Unless very long distances are to be dealt with, hand work is far preferable to ditching machines in many ways, for it is more economical and far less troublesome.

There is an important factor in connection with the drainage of swamp land for the extermination of the mosquito which is commonly overlooked, *i. e.*, its value as a preliminary step in the preparation of this land for agricultural or business purposes. Even without drainage, a growth

occurs on the swamp known as salt water hay, which is in demand for packing and other purposes; this yields a profit of from six to ten dollars per ton. Under ordinary conditions it is very difficult to harvest it, owing to the spongy and uncertain condition of the ground, but after drainage the latter becomes firm and hard, and trucks may be driven over it, and the hay secured with but little difficulty. Therefore, drainage for the extermination of the mosquito is a preliminary step toward the reclamation of the land for other valuable purposes. Under proper treatment this land is unequalled for raising celery, onions, and other garden produce.

In the treatment of swamp land, either for the extermination of the mosquito or for agricultural or building purposes,

diking must in some instances be resorted to; this is perfectly feasible and practical, and is chiefly relied upon in Holland, where the ground yields the most valuable results.

In the work of mosquito extermination frequent examinations should be made of the insects on the wing, in order that the varieties present may be known. Glass test tubes with light cotton plugs to prevent the escape of the mosquito should be left in various houses, with the request that as many as possible of these insects be captured, particularly at night, and placed in the test tubes. These should be promptly collected. Anopheles are often first detected in this way.

Winter work in connection with the extermination of the mosquito consists in the inspection and care of the ditches in

the swamp land, efforts to destroy the hibernating inland mosquito, and preparation for active work in the spring.

The means by which the hibernating mosquito is dealt with consists chiefly in the treatment of cellars, where it is known this variety commonly hibernates. Although a number of agents have been suggested for the destruction of the hibernating mosquito, there is but one the author can recommend, *i. e.*, sulphur dioxide gas, generated by burning common rolled sulphur. *This gas will destroy all insects and vermin with which it comes in contact.* Unfortunately, it bleaches various fabrics, injures gilt and metal surfaces and damages various other articles, and for the above purpose its use is hardly justifiable throughout the house, although it is commonly employed in house disin-

fection where infectious diseases have occurred.

In preparing the cellar for the use of this gas every opening must be closed and sealed, not only to secure its full effect, but to prevent its escape through the house; this may be done with strips of newspaper and ordinary flour paste.

A method of generating sulphur dioxide gas may be improvised as follows: Two or three bricks are laid on the bottom of an ordinary wash tub, upon which is placed a large sized tin pan, or some metal receptacle, for the sulphur. Water should be placed in the tub to a height just above the bricks and covering the bottom of the pan. This arrangement prevents danger from fire during the combustion which might occur if the pan containing the burning sulphur rested directly on the

floor; it also protects the bottom of the pan. In order to secure so far as possible the complete combustion of the sulphur, it must be broken into small pieces, over which alcohol should be rather freely applied; methyl, or wood alcohol, which is quite cheap, will answer the purpose. It may be lighted preferably by a taper or by dropping a lighted match on the mass. This should be done while the operator is standing in order that the face may not be too close to the receptacle. When prepared in the manner above described, there is almost complete combustion of the sulphur. As soon as the sulphur is ignited the apartment should be promptly vacated and the exit tightly sealed and remain closed for about four hours, then opened and the gas allowed to escape. *It must be remembered that the latter is not*

respirable in the human being and is extremely irritating to the respiratory tract and should be guardedly dealt with.

Two pounds of sulphur should be burned for every thousand cubic feet of space in the apartment. If the cellar is large, two or three receptacles should be used in order to secure the better distribution of the gas. It is sufficient if this treatment is carried out twice during the winter. In thus treating the cellar the care of the furnace, hot water apparatus, etc., must be considered, for they cannot be reached for a number of hours after the room is closed. The removal of groceries and articles of food which are uncanned or exposed should also be considered.

It is questionable whether or not stables should be subjected to the use of this agent, although mosquitoes may hibernate

in them. These buildings are, as a rule, not so tightly constructed as to prevent the escape of gas throughout the structure; therefore, if horses or other live stock are present and it is not convenient to remove them they might be killed or seriously injured. The stable may also contain valuable harnesses, carriages and other equipment which are metal trimmed, etc., besides hay and other foodstuffs, which are exposed and may be affected by the gas. As the destruction of the hibernating mosquito depends so largely upon the interest and coöperation extended by house owners, it is probably best to confine this work to cellars until its value is more fully understood and accepted.

CHAPTER X

REMEDIES AND AGENTS FOR THE PREVENTION AND TREATMENT OF MOSQUITO BITES

Undue consideration given to remedies or agents employed to relieve the discomfort caused by mosquito bites, or to protect against this annoyance, is to be deplored, for it tends to obscure the importance of exterminating this insect by destroying its breeding place, which is the logical and proper means of dealing with this condition. Innumerable remedies, however, have been suggested and employed for this purpose, some of which are believed to give temporary relief.

Almost any kind of smoke will drive

away mosquitoes or will stifle them if they are subjected to it sufficiently long.

In mosquito infested districts this has given rise to the practice of burning wood, leaves, etc., under the name of "smudge," which is often used with good effect by campers, although the mosquitoes apparently wait until the fire has subsided and then renew their activity with increased vigor.

Pyrethrum, or Persian insect powder, is sometimes burned within the house to secure relief from mosquitoes which have found their way inside; however, in order to carry this out effectively it would be necessary to burn about a pound of this powder for every thousand cubic feet of space in the apartment to be treated. Just what real benefit would be derived from this is difficult to understand, par-

ticularly as fresh air is essential to comfort and proper respiration.

Various solutions or preparations are recommended for use about the sleeping apartment or to be applied to the skin to prevent the approach of the mosquito.

Among them are spirits of camphor, oil of pennyroyal and oil of peppermint.

The following is a favorite mixture:*

Oil of citronella,	1	ounce
Spirits of camphor,	1	"
Oil of cedar,	½	"

To avoid the odor of the citronella in the above preparation, which is objected to by some, the following may be substituted:*

Castor oil,	1	ounce
Alcohol,	1	"
Oil of lavender,	1	"

* Howard.

It is said that the following mixture retards the evaporation of the oil of citronella in instances where its effects are desired:*

Oil of citronella,	1	ounce
Liquid vaseline,	4	"

A small amount of one of the above solutions or mixtures may be put on a towel and hung over the head of the bed, or applied to the face and hands; as they evaporate quickly, it may be necessary to repeat them during the night.

The following remedies are commonly employed to relieve the discomfort caused by the bite of the mosquito. They are to be applied directly to the bite. When not in fluid form they are to be moistened:

Ammonia, alcohol, glycerin, iodin, indigo, soap, naphthalin, moth balls, also

*Howard.

clean fresh earth. All of these agents have earnest admirers.

The most reasonable and practical means one can employ to prevent the entrance of mosquitoes within the house is the use of wire screens properly constructed, and adjusted over all windows, doors and other openings. Curiously enough, even though this is understood, there are few houses where the screens are properly made or fit tightly over all openings, and there are spaces commonly present, and which, though small, allow these insects to enter. Neither are bed screens carefully selected or adjusted.

If these conditions were carefully attended to the annoyance caused by the mosquito within doors would be reduced to the minimum.

THE END

"Heartily recommended to all who have to care for the sick."—*Newark (N. J.) News.*

A Text-Book of Nursing.

For the use of Training Schools, Families, and Private Students. Compiled by CLARA S. WEEKS-SHAW. Third Edition, revised and enlarged. With many Illustrations. 12mo. Cloth, $1.75.

This book, first introduced to the public by Prof. Edward L. Youmans, to whose most kind encouragement and assistance it owed its existence, is now for the second time revised and brought up to date under the supervision of his niece, Dr. Alice C. Youmans. It follows the same practical lines as the earlier editions and, until something more comprehensive is offered, it is hoped will continue to be of use to nurses both amateur and professional.

ITS HIGH STANDING.

"A valuable book."—*New York American.*

"It covers the whole subject."—*Philadelphia Press.*

"Well written, practical, and authoritative."
—*Detroit Free Press.*

"It has the recommendations of the highest medical authorities."
—*Chicago Tribune.*

"Has long been known among nurses as the most reliable and comprehensive work of its kind."
—*New York Commercial Advertiser.*

D. APPLETON AND COMPANY, NEW YORK.