

MOSQUITO CONTROL.*

By

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Ladies and Gentlemen,

On the occasion of my having the honour to come and speak about Mosquito Control today I shall have, first of all, to tell you, that I am neither a Malariologist nor an Entomologist. Also my address will not deal with any one particular species of mosquito which is the carrier of any one particular disease. The most important viewpoint regarding Mosquito Control derived from my observations is that mosquitoes have been in great abundance all over Thailand, more especially in the city of Bangkok. Since this city has been founded as the Capital, mosquitoes have been gradually increasing in numbers, inasmuch as the locality on which it stands is a low flat land and is full of ditches, klongs and pools. When the number of residents increased, structures and abodes had to follow in the progress; consequently more ditches and pools came into existence without any town planning, and without any laws on building in those days, to enable the authorities to exercise proper control in the way of sanitation. Similarly all other communities of Thailand are now either experiencing, or going to experience the same mosquito problem as does Bangkok. Hence general destruction of mosquitoes and prevention of breeding are now of fundamental importance before they become more dangerous than they are today.

CARRIERS OF DISEASE.

Malarial mosquitoes have been so much investigated that we may say, we can distinguish which species of Anopheline is the carrier of malarial fever, in which country is, and in which country a similar species is not. We even know the probable stages of water, and places of breeding of each species of mosquitoes; so it is not difficult for any one who is interested to turn up the enormous literature dealing with the group, and study it by himself. The many other species of mosquitoes, such as the culicines, which are

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constantly inflicting torments upon and causing nuisance for man and beast in tropical countries, have not been so much investigated as those of the Anopheline. The dangers caused by the Culicine may be many, and investigations have already disclosed that the Culicine, such as the *Culex fatigans*, are the intermediate hosts for *Filaria bancrofti* as well as dengue fever; and that the *Aedes calopus* is the carrier of yellow fever and probably dengue fever also. Through the researches of other Entomologists, mosquitoes are found to be carriers of bacilli of many other diseases, which should call for further investigations. (For differentiation of mosquitoes see Plates I-III).

La Bonadiere has demonstrated the presence of the plague bacilli in a mosquito, but no further demonstration has been made after that.

Mosquitoes have long been looked upon, in Japan and elsewhere, as possible sources of infection in leprosy, but the Indian Leprosy Commission has examined many mosquitoes with negative results. Arning, in the Sandwich Islands, has also examined mosquitoes full of blood sucked from severe cases of cutaneous leprosy, but was never able to find the bacillus either in or on them. Jeanselme's investigations in Indo-China were also negative.

In 1906, however, Goodhue, of Molokai Leper Settlement, at last demonstrated the *Bacillus leprae* in the mosquito (*Culex pungens*). Mosquitoes, therefore, now come within the pale of practical politics.

MOSQUITOES AS PESTS.

Aside from their importance as carriers of disease, mosquitoes are notorious as pests of man, and the early literature on the group is largely devoted to references concerning their enormous numbers and their blood thirstiness in certain regions. They are found in all parts of the world, from the Equator to the Arctic and Antarctic regions.

Until comparatively recent years, but few species of mosquitoes were known and most of the statements regarding their life history were based upon the classic work of Reaumur on the biology of the rain barrel mosquito, *Culex pipiens*. In 1896 Dr. Howard referred to twenty-one species in the United States; now over fifty are known; in 1900, Giles gave a total of two hundred and forty-two for

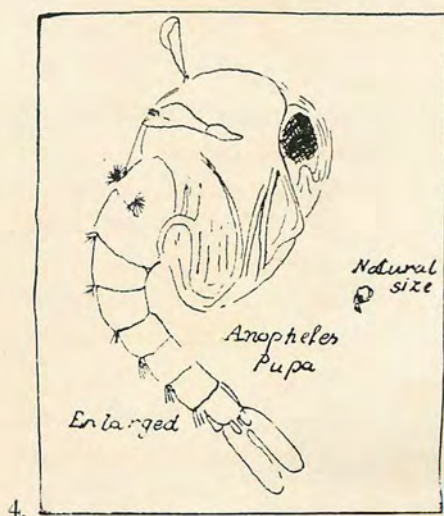
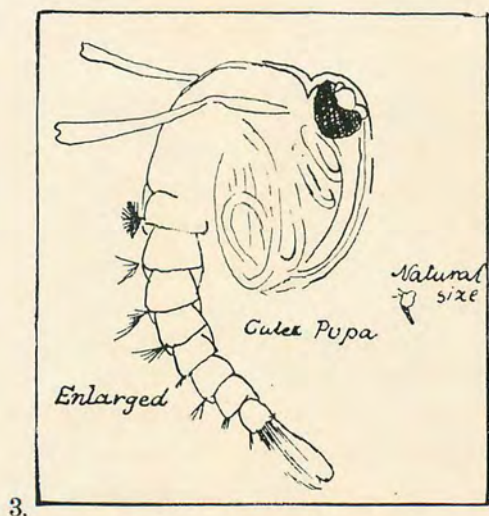
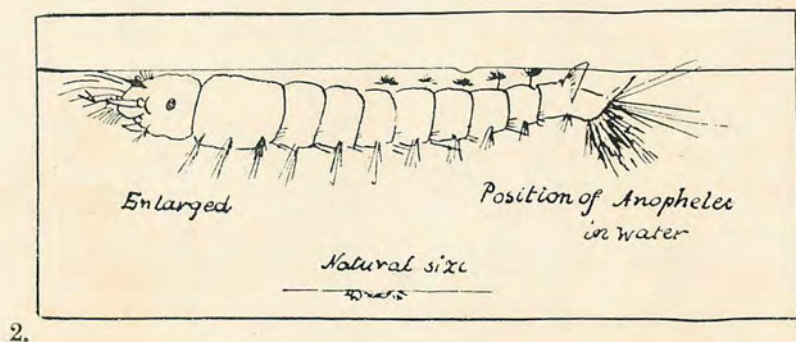
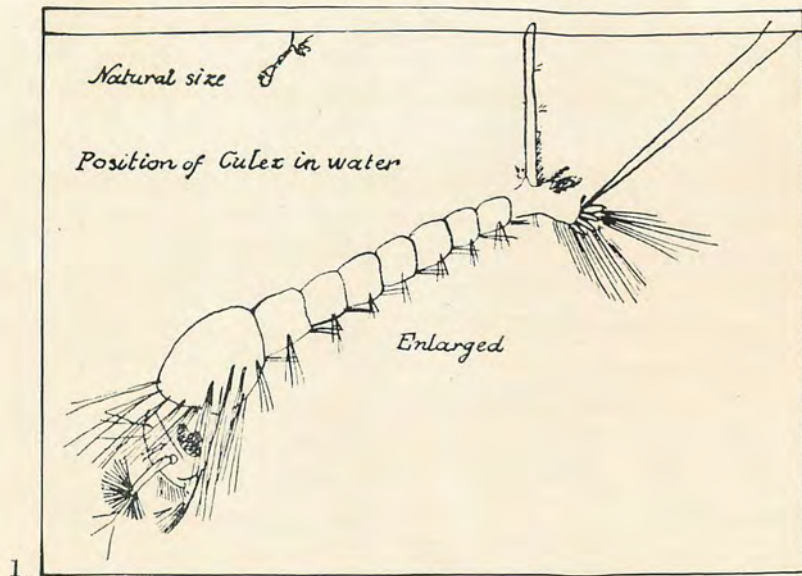


Fig. 1.—Larva of "*Culex*" showing the position at the surface of the water.
 Fig. 2.—Larva of "*Anopheles*," showing the same.
 Fig. 3.—Pupa of "*Culex*."
 Fig. 4.—Pupa of "*Anopheles*."



FIG. 1

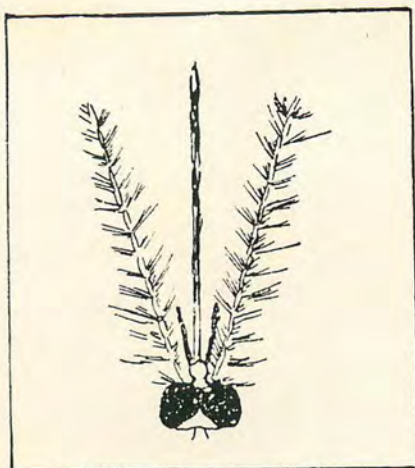


FIG. 2

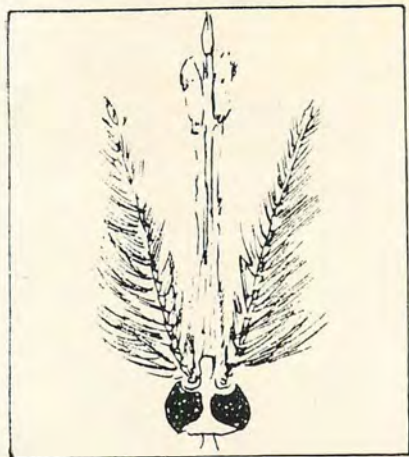


FIG. 3

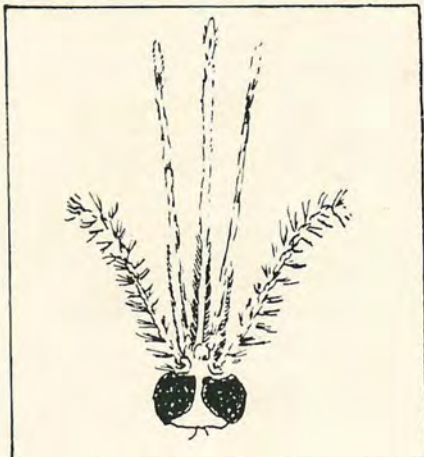


FIG. 4

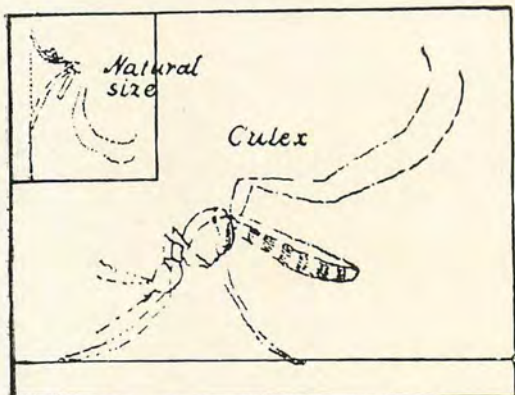


FIG. 5

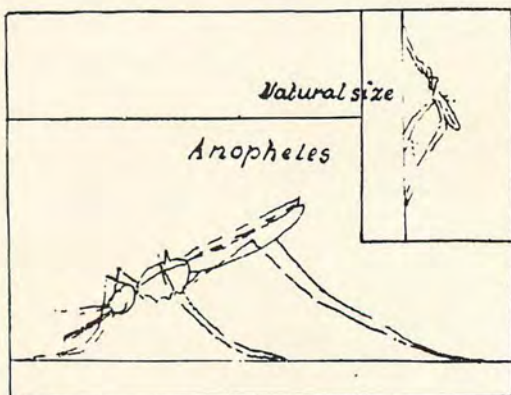


FIG. 6

Fig. 1.—Head of a male "Culex."

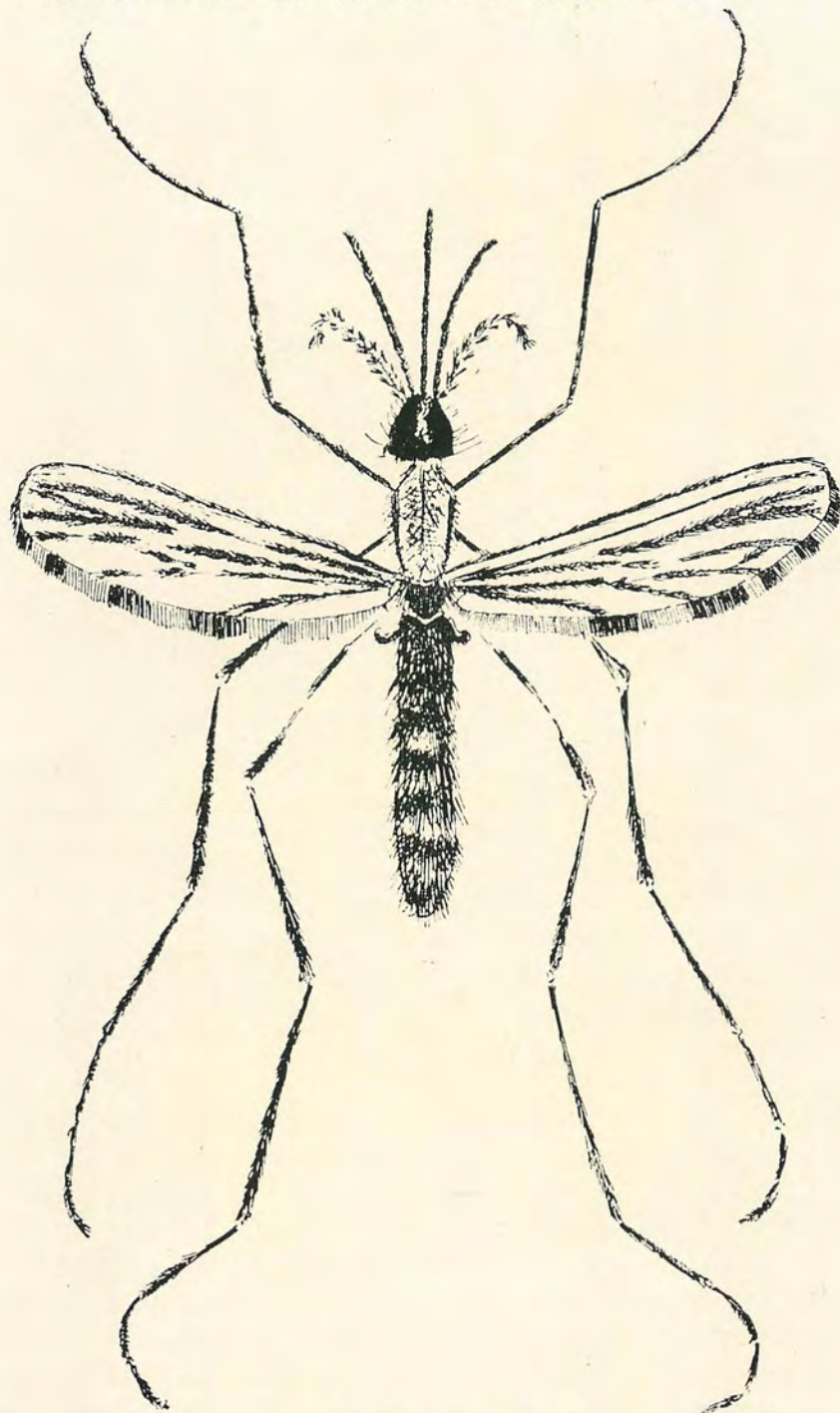
Fig. 2.—Head of a female "Culex."

Fig. 3.—Head of a male "Anopheles."

Fig. 4.—Head of a female "Anopheles."

Fig. 5.—A female "Culex," showing the position usually assumed when at rest on a surface.

Fig. 6.—A female "Anopheles," showing the position usually assumed when at rest on a surface.



An Anopheles enlarged.

the world fauna; now about fifteen hundred species are known. According to rough investigations we have found about fifty species in Thailand.

All of the known species of mosquitoes are aquatic in the larvae stage, but in their life histories and habits they differ so much that it is not possible to select any one species as typical of a group.

In Dr. Smith's work in New Jersey it was forcibly emphasized that one of the most important facts, which has been brought out by the intensive studies of recent years, is that certain species are migratory and that they can travel long distances and become an intolerable pest many miles from their breeding places. He found that migratory mosquitoes, developing in the salt marshes along the coast, are the dominant species largely responsible for the ill-fame of the New Jersey mosquito. The species concerned are *Aedes sollicitans*, *A. cantator* and *A. toeniorhynchus*. Dr. Smith decided that the first of these might migrate at least forty miles from their breeding places. It is obvious that, where such species are the dominant pest, local control measures are a useless waste of time and money. Such migratory habits are rare, however, and it is probable that the majority of mosquitoes do not fly any great distance from their breeding places.

The effect of a mosquito bite varies greatly with different species and depends upon the susceptibility of the individual bitten. Some persons are driven almost frantic by the attacks of the pests, while their companions seem almost unconscious of any inconvenience. Usually, irritation and some degree of inflammation appear shortly following the bite. Not infrequently a hardened weal or even a nodule forms, and sometimes scratching leads to secondary infection and serious results.

METHODS OF DESTRUCTION.

The measures aimed at the destruction of mosquitoes naturally fall into two classes: (a) those directed against the egg, larva and pupa of the aquatic stages; and (b) those directed against the winged insect.

For the extermination of mosquitoes the most effective measures are those which destroy their breeding places and thus prevent their multiplication. For the best results, both individual and com-

munal effort are necessary, but the importance of individual effort alone cannot be too much emphasized. The individual, by attacking the problem on his own premises, grounds or estates, can not only do much to rid his own immediate neighbourhood of mosquitoes, and thereby increase his own comfort and guard against disease, but the example thus set will perhaps stimulate his less enterprising neighbours.

If filling in is not practicable, a draining system may give good and permanent results. As a rule the draining of ponds, pools, ditches or marshes is the simpler and cheaper method. Marshy lands may be drained simply by means of ditches. These ditches must be dug deep enough so that they can completely empty the pools under treatment and have sufficient fall to prevent stagnation in the course of the ditch itself. Where a sufficient fall is not available, fishless pools or ditches may be connected with those containing fish or with a neighbouring stream so that fish may freely enter.

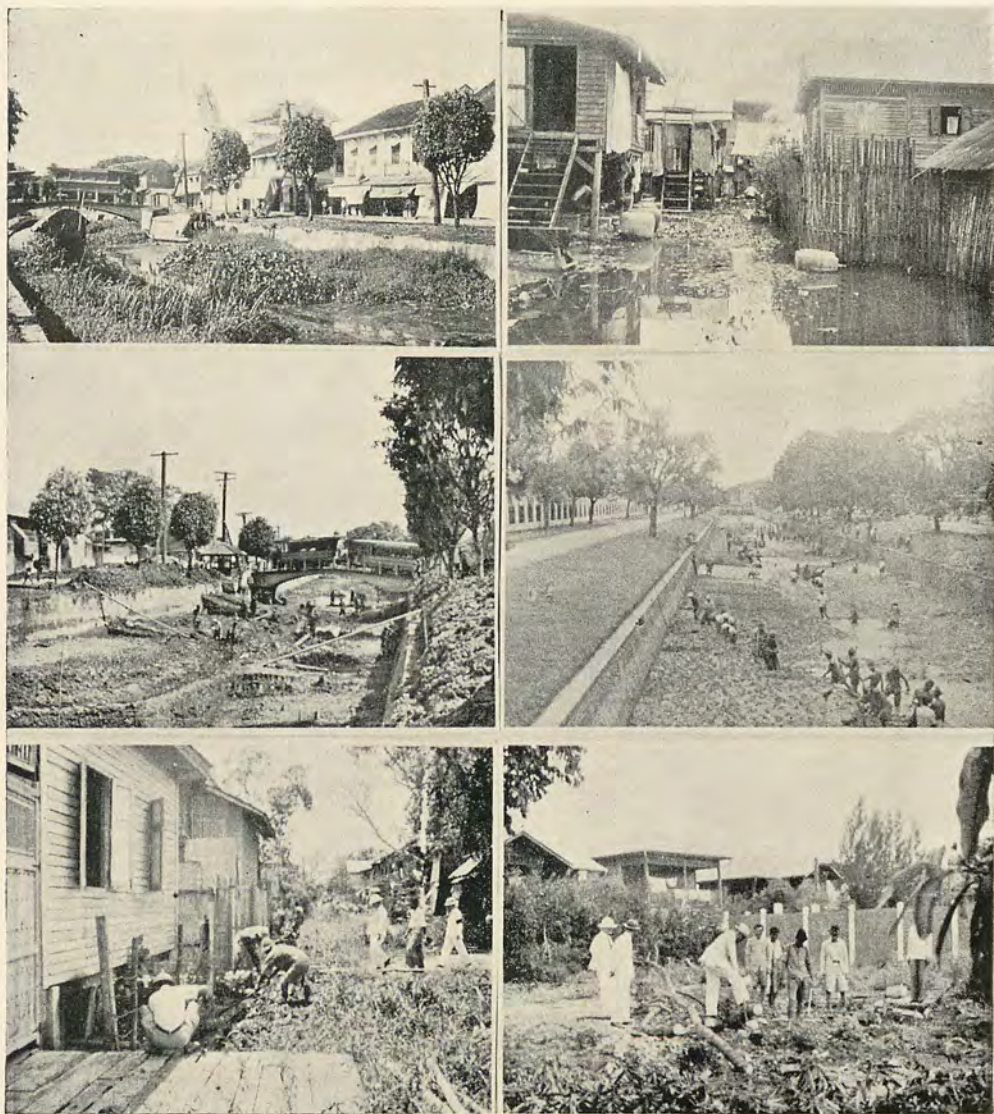
There are two kinds of breeding places for mosquitoes, viz: the Natural and the Artificial Breeding Places (see Plate IV.)

Natural Breeding Places: These mean the natural collection of water which may serve as breeding places, and the best measures, to deal with such, are by filling in or by draining. In this case the breeding places are removed once and for all.

Fish are among the most effective of the natural enemies of mosquitoes, and fish may be admitted to ponds and pools in the manner just described, or the ponds or pools, ornamental lakes, and fountains may be stocked with larvae-feeding fish such as minnows, gold fish or pla-moh. The margins of pools, rivers, and other bodies of water must be kept free of reeds and water plants, so as to permit the fish to reach the edges which are favourite breeding places for mosquitoes. One of the very best means of clearing the land of the numerous small natural collections of water is to place it under cultivation.

Mosquito breeding places in the pools or marches may be suppressed by connecting them with tide water, so that they may be freely scoured by the daily tides. Ditches used as intermediates should have straight sides and must be inspected at frequent intervals, and care must be taken to see that they do not become choked.

Need and Measures for Mosquito Control.



1-2: Breeding Places for Mosquitoes a) Natural ; b) Artificial.

3-4: Large scale operations for Improved Drainage of Canals and Klongs.

5-6: Spraying and Clearing of Localized Breeding Plots.

When radical measures of destruction, such as filling in or draining, are not practicable, application of coal oil may be brought into use. Coal oil upon the surface of the water acts by poisoning and also by suffocating the larvae and pupae. A light quality of oil should be used. (The best oil for the purpose is known as "Fuel oil" in the proportion of, say, about 15-25c.c. to 1 square meter. In case of muddy water a higher proportion of oil should be used, according to how freely the oil spreads to cover the surface of the water). It may be poured upon the surface from an ordinary sprinkling pot, or the surface may be sprayed with a hose. Sufficient oil should be used to cover the entire surface with a thin film. Along the banks of ponds, lakes, and slowly moving streams with shallow margins containing vegetation, which offer favorite breeding places for mosquitoes, the oil may be applied with a mop. As the oil is volatile, it may disappear in a few days. Furthermore, the film, which should be intact to be effective, may be broken by winds. A strong wind will blow all the oil to one side, thereby largely defeating the object desired. It is important to repeat the oiling regularly at intervals of about one week or 12 to 14 days. Oiling, though fairly effective when properly carried out, is only a temporary expedient, and in the end is rather expensive; but in case of necessity in order to effect quick extermination of a large population of larvae the oiling system is advisable.

Besides coal oil, kerosene-pyrethrum emulsion, according to Dr. Joseph M. Ginsburg, is another good mosquito larvicide, which has been tested. He found that:

1. It can be safely used on breeding waters where oil is objectionable;
2. When properly diluted, it gives a complete kill of larvae and pupae;
3. It is harmless to fish, water fowl, and plant life;
4. It can be readily prepared at a cost lower than that of fuel oil, but its lasting quality is less than that of oil, and more larvicide is required to cover a given area in proportion to fuel oil.

Paris Green powder is another recommendable larvicide, but it is effective only against the Anopheline.

Artificial Breeding Places: The permanent elimination of artificial breeding places for mosquitoes in a city depends first of all upon providing a good quality and sufficient quantity of potable water by means of a modern closed system. This will permanently do away with the necessity of cisterns, tanks, jars, and tubs for the storage of water about the premises. When domestic storage is a necessity, care must be taken to prevent the mosquito from gaining access to the water. The water jars should be provided with closely fitting covers. Wooden covers are not satisfactory, for they rarely fit accurately enough to keep out the mosquito, and this defect is enhanced by the warping of the wood, which usually makes an old cover unfit for use. More satisfactory than the wooden cover is one made of light vulcanized sheet iron, over sheeting closely tied over the rim of the jars.

Cisterns and tanks should also be provided with accurately fitting covers, as recommended above. Whatever the form of the cover employed, it should not be removed except for cleaning or refilling. The water should be drawn from a spigot or tap placed 4-6 inches from the bottom of the container.

In case of emergency, as in time of epidemics of diseases, for which mosquitoes are responsible as carriers, where the permanent measures for preventing mosquito breeding have been neglected, the surface of the water in the jars, tanks and cisterns may be covered with some neutral non-volatile oil which does not impart a taste to the water, such as paraffin oil.

Among the artificial breeding places for mosquitoes may be mentioned chicken pens in poultry yards, tin cans, cocoanut shells or broken bottles, flower pots, water buckets and similar places, which should be disposed of.

DESTRUCTION OF MALARIAL MOSQUITOES.

Methods of destruction of Malarial mosquitoes are similar to those adopted against the Culicine but one should have special observations about their life history and habits, viz: *A. minimus* breeds in the shady springs, while the *A. maculatus* breeds in open springs, hence in case of discovery of either of these two species, a reversion of their breeding places should be effected. The common plants used

for reversion of the breeding places for *A. maculatus* in South America or Java are the *Difersifolia* (Mexican Sun Flower).

SCHEME ON MOSQUITO CONTROL WITHIN THE AREA OF
BANGKOK MUNICIPALITY.

As I have already said, in this address I do not wish to emphasize any one particular species of mosquito. My aim is to speak about the Control of Mosquitoes in general. I am going to disclose to you what the New Government of Thailand has done and is still doing regarding Mosquito Control within the area of the Municipality of the City of Bangkok, where mosquito torments and nuisances have been the greatest annoyances of the general public for over 150 years. The most important factor of mosquito breeding is the natural and artificial collections of water, and to effect a quick remedy for this within the vast area of the Municipality of Bangkok, which stands on a low flat land, is not an easy task. It will cause no little grievance to the individual, if immediate steps are taken regarding the dumping or draining of ponds, pools, or ditches which abound in the individual estates and private residences to a much higher percentage than that of the public places. But from the studies of the mosquito life cycle we know that the winged insects remain alive only for the short period of from one to three months: therefore, if we are able to destroy the larvae before they develop into mosquitoes, these winged insects will gradually die out.

In order to obtain good results in the prevention of mosquito breeding within the area of the Municipality of the City Bangkok careful surveys have been made regarding breeding places for mosquitoes, and destruction work was carried out at once by either dumping or draining of the places. In case where an immediate permanent remedy cannot be effected, temporary prevention by the oiling system has been adopted.

1. ORGANISATION AND ADMINISTRATION.

The work of the Mosquito Control within the area of the Municipality of Bangkok is allotted to many of the local Administrative bodies such as:

*Department of Health.**Municipality.*Director General of Department
of Public Health

Lord Mayor of Bangkok

The City Health Division

Public & Municipal Works Division

Survey Section

Section for digging & peeling klongs & ditches

Larvicide Section

Section for dumping & filling

Drainage Section

Health Education &
Publicity Section

Drain washing & cleaning Section

ADMINISTRATION.

In order to enable the work of the Mosquito Control, in such a vast area as the Bangkok Municipality to progress in the most satisfactory way, the Municipality is divided into 16 districts, for separate control, and, when one is fully controlled, an official for maintenance is appointed in charge of the district.

2. RESULTS OF THE SURVEY.

The work of the Mosquito Control within the area of the Bangkok Municipality, which has an extension of approximately 49 square kilometres, began on the 5th April 2481. The work was commenced by the Publicity Unit, enlisting the assistance of the Juvenile Corps, which first got into touch with the general public with all possible information regarding the work of the Mosquito Control; then followed the Survey Unit, which made a general survey of the area concerned; if mosquito breeding places were detected, reports were made to other units to effect co-operation in the work of destruction.

The result shows that the places where larvae abound are the individual ditches, next come the individual low-lying lands, then

come the public drains, public ditches, canals, wells, ponds, individual drains, water jars and the public low-lying lands in respective order of importance, while no less mosquitoes are bred from vessels containing water and lying on the ground.

The keepers or breeders of larvae for feeding fishes might also have allowed the larvae, which had been in their possession for several days, to develop into mosquitoes.

3. *Application of Larvicide.* There are several systems for this, but for the city of Bangkok crude oil and solar oil of the following preparation are used

| | | |
|-----------|---|-------|
| Crude oil | 1 | part |
| Solar oil | 2 | parts |

This preparation is sprayed upon the surface of water, where larvae abound, every 7 days to 14 days. The result of this proves very satisfactory, if the oil film is not damaged by rain before the oil has killed the larvae. The satisfaction is that on each application of this larvicide more than 90% of the larvae are killed before the stage of development into the winged insect is attained; but, of course, if rain keeps falling for several successive days, the work of spraying oil has to be temporarily stopped.

Though oiling is only a temporary expedience, it is most commendable for the moment, for, if we are going to wait for the completion of the dumping and draining work, the poor people will have to suffer from mosquito torments and annoyances for many more years. As regards the accomplishment of the Mosquito Control, up to the standard required, it is up to the energy and efficiency of the Municipal Engineer, and it is hoped that oiling will gradually be dispensed with.

4. *Control of vegetation and Digging and Peeling of canals and ditches.* To effect proper digging and peeling of all water ways and ditches is a big and expensive task, which involves a financial problem that cannot be solved at once; hence it is scheduled that, for the present, all water ways and ditches are to be so controlled that they do not act as mosquito breeding places. As regards the proper control work, the officials have already commenced, together with the construction of new public roads, laying drains and filling low-lying lands which will have to be done, section by section.

Within the period of one year, *i. e.* from the 5th April to March 2482 digging and peeling work has been done as follows:

| | | |
|---------|-----|---------|
| Peeling | 135 | ditches |
| Peeling | 24 | canals |
| Digging | 1 | canal |

Canals and ditches thus dug or peeled will always be maintained in their new condition; and consequently considerable annoyances have been dispensed with from the collection of rain water in the compounds of private residences.

5. *Dumping of Low-lying Lands.* From reports made by the survey unit on low-lying lands 15 were recorded as being included in public properties and 1764 in individual properties. Now all those 15 in the public properties, and, through the advice of the officials, 542 of the individual have been filled.

In dumping or filling one place the control-official does not forget to observe the level of the adjoining place, and is always very careful to see that the good work of one place does not cause damage to another.

6. *Construction of Drainage.* Owing to the fact that there are within the area of the Bangkok Municipality numerous low-lying lands where water collects and which thus become breeding places for mosquitoes,—and because it is a big and expensive task to fill them all, especially in individual properties, the construction of drainage is, therefore, of fundamental importance and necessity within the whole area of the municipality.

First of all drains should be constructed along the public roads, branch roads and side lanes to enable the people to open drains from their houses into them. If durable drains cannot be laid at once, temporary ones should be substituted. Two temporary earth drains of a total length of 900 metres have been constructed and 23 sub-soil cement drains of a total length of 3141 metres have been laid.

7. *Drain washing and cleaning.* Washing and cleaning drains, that have not enough inclination of slopes, is an important task, as waste water that flows into the drains also carries with it other rubbish which deposits at the bottom of the drain, and, if not washed away in due time, becomes filthy and entices mosquitoes. Unrepaired damage drains are also no less important mosquito breed-

ing places; these are very numerous within the Municipal Area both in public and individual properties. It is from here that enormous numbers of mosquitoes have bred, and they have not been attended to until the Organization of Mosquito Control has come into existence. Now all the public drains are washed and cleaned every 7 or 10 days, as it has been theoretically and practically established that, although mosquitoes may have laid their eggs and the larvae development stage has been attained, there is no chance for the larvae to develop into mosquitoes before they are washed away and destroyed.

As regards individual drains no satisfaction has yet been obtained, for most of the owners or possessors of these drains will wash or clean them once when suggestions come, and then leave them off again without repeating the process every 7 or 10 days as suggested. If conditions are going to keep on like this, it is but only rational that the laws will have to be enforced.

8. *Control of Ponds and Wells.* Many persons think that mosquitoes come from stagnant and filthy water only, but as a matter of fact mosquito larvae are often found in a large number of ponds and wells which have good and clean water. Moreover, those, that are overgrown with water weeds, are the best places for mosquito breeding; therefore, if such are found, advices are given to the owners to do away with all the vegetation in these places and to keep them clean.

According to records from the surveying work, 2,104 ponds and wells within the Municipal Area were found to serve as breeding places for mosquitoes; in consequence of suggestions made, 1,114 have been controlled, while the rest are under the pledge to do it on a later occasion.

It is, therefore, believed that better improvement regarding these ponds and wells may be effected, if constant suggestions are made. It is also suggested that larva feeding fishes should be kept in ponds and wells. If any ponds or wells are not of any use, it is better that they are filled than be left to serve as breeding places for mosquitoes.

9. *Control of Water Receptacles.* Water receptacles, such as jars, cisterns, tanks, etc., have not yet been thoroughly inspected;

only in an exemplary survey in various districts 6,292 cases have been inspected; every one of these contained considerable numbers of larvae, most of which will develop into mosquitoes and will bite and suck blood from the inmates of the house, where they are bred, or from the people of the near neighbourhood.

Suggestions have been made to the possessors of these receptacles regarding proper covers to prevent mosquitoes from gaining access into them, as already mentioned, but at a later investigation only 107 cases have complied with the suggestions given. It is, therefore, very probable that the authority will have to act more strictly by exercising legal enforcements for the control of these receptacles.

The encouragement for installing town water in individual residences in order that the people may acquire the habits of using water straight out from the taps and not holding it in any kind of receptacles, is another step that the Municipality should take into consideration.

OFFICIALS.

The administrative functions of Mosquito Control within the area of the Municipality of the City of Bangkok are, as already said, allotted to various local units of administration; each unit comprises officials and workers, sufficient to carry out the work which may aggregate as follows:

| | | |
|-----------------------|------------|--|
| Medical Officers | 2 | } These figures may rise or fall accord- ing to demand of services. |
| Engineer | 1 | |
| Sanitary Inspectors | 9 | |
| Assist. Med. Officers | 2 to 8 | |
| Clerks | 2 to 7 | |
| Juvenile Scouts | 10 to 40 | } |
| Workers | 170 to 270 | |

Besides the above named officials, the Chiefs and the Assistants of the City Health Division and the Public & Municipal Works Division are superintending the work and issuing orders for the close co-operation of the various units.

FINANCIAL POSITION.

In the work of Mosquito Control, within the Bangkok Municipal Area, the Municipality has been encouraged by the Government with a budget of Tes. 72,000.00 for the first 6 months.

Later the Municipality has passed another budget for Tes. 80,000/- on Mosquito Control for one year.

Even at this figure the average expenditure for each of the 600,000 inhabitants within the Municipality is less than 2 satangs per month, little enough in consideration of the considerable relief of the people from disease, torments and annoyances from mosquitoes. If this enterprise can be maintained up to its completion, the City of Bangkok will, no doubt, be free from mosquitoes, which have been the pests of the inhabitants of this Capital for more than 150 years.

CONCLUSIONS.

From this address it may be summed up as follows:—

1. Mosquito Control is one of the most important works for the Public Health; but more attention has been drawn towards the species that are carriers of malarial fever, while the species that are intermediate hosts of other diseases, or those that cause annoyances or inflict torments, have gained but little attention or international interest. A few, however, may have attracted some attention, such as the carriers of yellow fever; but these are of interest to a few countries only.

If close investigations are made, besides the malarial mosquitoes, others may be of as much importance and bring no less danger to man.

2. It is quite obvious that the inhabitants of the City of Bangkok are the people who have most suffered, though not much from malarial mosquitoes, but from the enormous hosts of other species, which, besides carrying diseases, have been constantly causing inconvenience and annoyances by biting and sucking man's blood; it is well realised that this state of suffering is now being experienced or is going to be experienced by the other Communities of Thailand; hence arises the question of whether mosquitoes should be controlled.

3. As the result of the work of controlling mosquitoes for a period of one year within the Bangkok Municipal Area, a great number of klongs, ditches, drains, garden ditches and low-lying lands have been much improved in the way of sanitation. Larvae, which formerly have been in great abundance in the numerous breeding places, have now much decreased in number, and if this controlling

work can be carried on to its final stage, the people of this Capital will, no doubt, be more healthy.

It may be added that the average expenditure, for the control of mosquitoes, of approximately a little more than 13 satangs per annum for each person, or a little over 1 satang per month, is much cheaper than the cost of medical attendance and hospital bills, when infected with diseases conveyed by mosquitoes. Besides, if not being annoyed by mosquitoes, one may sit down to work late into the night and consequently much improve both national and family economics.

4. As regards to whether or not there will be any other better methods for controlling mosquitoes than the ones we are now using, depends upon the further studies and researches of the administrative bodies of the Organisation.