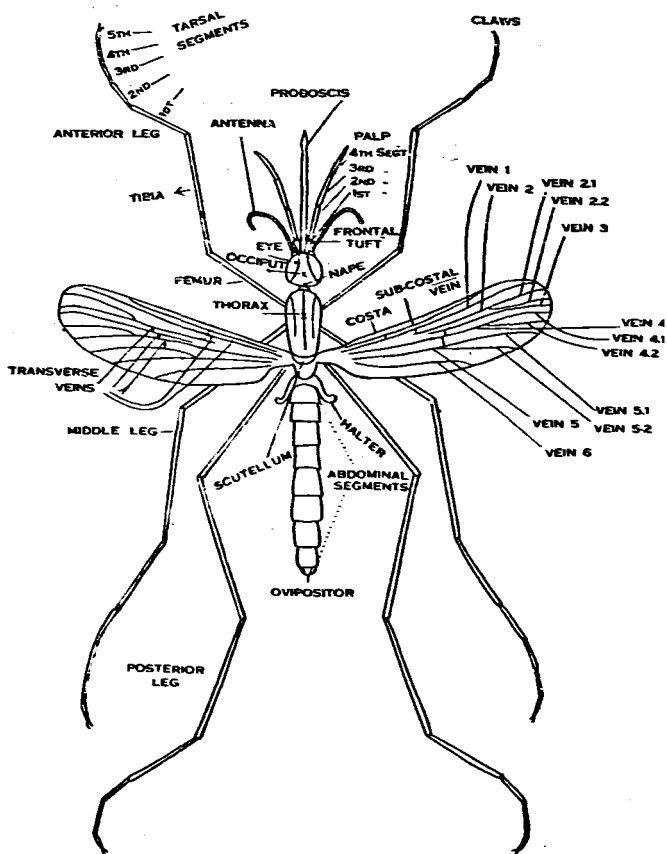


MOSQUITO
REDUCTION
AND
MALARIAL
PREVENTION

BY
CRAWFORD AND CHALAM

OXFORD UNIVERSITY PRESS

**MOSQUITO REDUCTION AND
MALARIAL PREVENTION**



DESCRIPTIVE DIAGRAM *ANOPHELES* (FEMALE)

MOSQUITO
Reduction and
MALARIAL
Prevention

A PRÉCIS

BY

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THIS BOOK IS DEDICATED
TO
LT.-COLONEL S. R. CHRISTOPHERS,
F.R.S., C.I.E., O.B.E., I.M.S.

FOREWORD

THE Authors of this small book are quite correct when they point out the need of a work such as they now put forward. Many books, it is true, deal with anti-malarial work and many with various aspects of the study of malaria, entomological, parasitological, clinical, etc. There are also general treatises on malaria and works on the practical prevention of the disease. But the fact remains that it is very difficult to recommend a book to a beginner that will give him the simple facts and interests he requires to help him in commencing actual practical work in the field. The Authors have met the needs of a manager of a tea garden, or a malarial inspector, or the N.C.O. in charge of a regimental sanitary squad from their own experience of what such persons require. They give a brief but sufficient account of the nature of malarial fever, of the chief facts about mosquitoes and of how to find and identify mosquitoes, especially the Indian species of malaria carriers. They end with an account in some detail of practical steps to be taken in prevention, and, in the form of appendixes, with some helpful

notes on the technique connected with mounting and preserving specimens. The Authors themselves have had the practical experience that qualifies them to write helpfully for others, and I wish their venture every success.

S. R. CHRISTOPHERS

PREFACE

THE Authors, in placing before the public this volume, do so with the hope of filling a need long felt by the worker and inspector in anti-malarial measures. There are at present many tomes and excellent treatises dealing exhaustively with the life, habits and elimination of mosquitoes, and many are written with a view to controlling yellow fever and malaria—but the man who is too busy in other walks of life, or who has not the necessary technical education, cannot readily acquire the knowledge contained in these. We have only introduced such technical names and phraseology in this book as are absolutely necessary for the proper understanding of the subject, and where these are introduced they are explained as simply as possible. It has been our experience that the manager of a tea garden, or a malarial inspector, or the N.C.O. in charge of a sanitary squad dealing with anti-malarial measures begins to take a much keener interest in his work when he has acquired some knowledge of the habits and life-history of the mosquito, and it is primarily in the hope of quickening their interest that this work has been undertaken.

Our thanks are due to Lt-Colonel S. R. Christophers, F.R.S., C.I.E., O.B.E., I.M.S., for his kindness in reading through our work and for his many valuable criticisms, and also for allowing us to include a Synoptic Table of Indian *Anophelini* issued by the Central Malarial Bureau, Kasauli, 1926. We also desire to thank all who by their kind criticism have encouraged us in our work.

BOMBAY,
June, 1926.

J.A.C.
B.S.C.

PREFACE TO THE SECOND EDITION

THE favour with which this work has been received and the demand within a few months for a second edition are evidence that the public is interested in anti-malarial work.

Some of our well-wishers made a few kind criticisms on the first edition of this book, and in this edition we have attempted to meet such criticisms and make necessary additions or amendments. We have added as an appendix a chapter on the action and uses of 'Paris Green', which is a chemical used for killing *anopheline* larvæ, and opens out great possibilities in anti-malarial field work. We have also added as much information as we could gather about the use of larvacidal fish, and have illustrated in a separate chart some of the paraphernalia that will be ordinarily required in anti-malarial field work.

We are greatly indebted to the Indian Research Fund Association for considerable financial help in the publication of the first edition of this book. We should be grateful to all our readers for any suggestions they may offer, bearing in mind the class of persons this work is intended for.

J.A.C.

B.S.C.

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APPENDIXES

APPENDIX I

HOW TO SEND LARVÆ AND LARVAL SKINS
FOR PURPOSE OF IDENTIFICATION
AND DESCRIPTION

FULL-GROWN larvæ are isolated by placing them in tubes. Only one larva should be placed in each tube. When pupation takes place the larval skin is cast in the water complete with all the hairs and chitinous parts; the skin is carefully poured off with a little water into a clean petri dish, the pupa being left in the original tube with some water. The skin is carefully lifted from the water by means of a small slip of filter paper, and transferred to a small tube containing a mixture of formalin and water (about 10 per cent. formalin). This small tube containing the skin is numbered by placing a number on a small slip of paper in the top of the tube; a similar number on another slip is put in the top of the tube containing the pupa, being held in place by a plug of cotton wool; this plug also serves to prevent the escape of the mosquito when it emerges. When emergence has taken place the mosquito is transferred to a clean tube by holding the latter with its mouth to that of the former tube, after removing the plug. The plug is then pushed into the mouth of the tube containing the mosquito, and a few drops of chloroform poured upon it; the mosquito is then mounted in the usual way, and a small label attached to the pin corresponding to the number of the larval skin from which this mosquito resulted. The mosquitoes and the skins can be sent in their respective tubes by post. The small tubes containing liquid should be filled up to the cork, and if possible sealed with wax by dipping the top of each tube into melted wax.

APPENDIX II

HOW TO MOUNT AND PRESERVE MOSQUITOES

APPARATUS REQUIRED:

1. Specimen tubes with corks.
2. Fine double-pointed nickel pins, No. 3.
3. Cork sheets.
4. Cardboard.
5. Forceps with grooved teeth at the tip.

First prepare your specimen tubes as follows:

Paste white paper on to a cork sheet, and cut it into small strips just broad enough to go inside the specimen tubes. Attach a strip to the cork of the specimen tube by passing an ordinary pin on either side from the strip to the cork. The cork strip when thus fixed to the cork of the tube should not touch the bottom of the tube, but just clear it. Make a small triangular slit on one side of the cork of the specimen tube, so that a small groove exists between the cork and the glass, and into this groove fix a pledget of cotton wool. The tube is now ready for receiving the specimen. Place the mosquito upon its back on the cardboard. Hold the pin about the middle with the forceps, and push one end steadily through the thorax so that it just emerges from the centre of the dorsum of the thorax. The mosquito is now transfixated to one end of the pin; lift the pin and transfix the other end to the cork strip of the prepared specimen tube. In this way about ten mosquitoes can be mounted and preserved in each tube. Put a few drops of pure carbolic acid on the cotton wool plug. Put carbolic acid on the plug once a month and this will prevent the specimens getting mouldy.

APPENDIX III

HOW TO HATCH OUT MOSQUITOES
FROM LARVÆ

PLACE the larvæ in a white enamelled basin containing some of the water in which they were found. Keep them there till they become pupæ, when they should be removed from the basin to wide-mouthed glass bottles filled three-fourths with water, and over the neck of which a piece of mosquito-netting is tied.

The mosquito-netting retains the emerging adults.

APPENDIX IV

HOW TO MAKE A CLEAR AND PERMANENT
PREPARATION OF LARVÆ

METHOD I:

Put the larva in a test-tube and pour a few drops of caustic potash or soda (2 to 5 per cent.) solution in water.

Boil for a few minutes; when clear, transfer the whole into a watch glass, pour off potash solution, wash in distilled water two or three times. Then transfer the larva to 50 per cent. alcohol, keep for five minutes, then transfer it to 70 per cent. alcohol. Keep there for 5 or 10 minutes, then transfer to absolute alcohol, and keep for 15 to 30 minutes. During all these processes never allow specimen to get dry. It is better to change the absolute alcohol two or three times.

From absolute alcohol place it in a drop or two of clove oil till it is sufficiently clear (about 5 to 10 minutes); when clear, remove with a pin or brush to a slide and put a drop of Canada balsam over it, and with needles manipulate the position in which you want the larva; then cover with a cover slip.

METHOD II:

Put the larva in a watch glass containing 10 per cent. formalin. When dead, transfer it to another watch glass containing absolute alcohol so as to dehydrate it; then transfer it to clove oil or oil of winter-green, and when clear mount in balsam. Two strips of cardboard placed under the cover glass will support it.

APPENDIX V

DAILY ROUTINE OF ANTI-MALARIAL WORK FOR THE MONTH OF

192 .

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Area 'A'							
Area 'B'							
Area 'C'							
Area 'D'							
Area 'E'							
Area 'F'							

APPENDIX VI
QUESTIONNAIRE CARD

Bungalow No.			
Occupant's } Name }			
<p><u>'Are You Troubled by Mosquitoes?'</u></p> <p>On presentation of this card please state 'Yes' or 'No' and sign your name</p>			
Date	Yes	No	Signature

APPENDIX VII

TABLE FOR IDENTIFYING THE FEMALES OF
THE *ANOPHELINES* OF INDIA

N.B.—Always make certain that the specimen examined is a female *Anopheline*. Special attention is drawn to the Notes at the end of the table.

I. WINGS UNSPOTTED

A. DISTINCT WHITE KNEE SPOTS AT DISTAL ENDS OF
HIND FEMORA (Note 7).

A. plumbeus var. *barianensis*

B. NO DEFINITE KNEE SPOTS.

1. Head scales very narrow, linear. Palps very thin.
Anterior forked cell nearly double posterior
(Note 7).

A. aitkeni

2. Head scales expanded as in ordinary *Anopheles*.
Palps not very thin. Anterior forked cell re-
latively shorter (Note 7).

A. culiciformis

II. WINGS SPOTTED

A. TIPS OF HIND LEGS WHITE.

(If not white, see p. 98.)

1. Femora and Tibiæ not Speckled (Note 1).

(If speckled, see p. 97.)

a. At least the two terminal tarsal segments of the hind legs *completely* white (Notes 2 and 7).(i) Dorsum of abdomen heavily clothed with pale scales, projecting at the sides to form tufts on all segments. **A. pulcherrimus**

(ii) Dorsum of abdomen not so clothed. No lateral scale tufts.

*Fifth vein of wing pale in the greater part of its extent (Note 7).*Ventral aspect of most of the abdominal segments with scattered pale scales. Distal end of first hind tarsal segment never picked out with white (Note 7). **A. pallidus**Ventral aspect of abdominal segments not so. Distal end of first hind tarsal segment variable, usually picked out with white (Note 7). **A. philippinensis***Fifth vein of wing mostly dark. Distal end of first hind tarsal segment conspicuously picked out with white (Note 7).***A. fuliginosus**b. Only the terminal hind tarsal segment *completely* white (Notes 2 and 3). Four white bands on each palp, including apical band (Note 7).**A. karwari**

2. Femora and Tibiæ Speckled (Note 1).

(If not speckled, see p. 96.)

a. Two or three terminal tarsal segments of hind legs *completely* white (Notes 2 and 7).

- (i) Each palp with two broad pale distal bands, and one narrow proximal one (Note 7).

*Three terminal hind tarsal segments completely white (Notes 2 and 7). Palps prominently speckled (Note 4).***A. maculipalpis** var. **indiensis***Two terminal hind tarsal segments only completely white (Notes 2 and 7). Broad white band above this. Palps not speckled (Note 4).***A. theobaldi**

- (ii) Each palp with one broad pale apical band, and two narrow more proximal ones (Note 7).

A. jamesiib. Less than two terminal tarsal segments of hind legs *completely* white (Notes 2 and 7).

- (i) Each palp with four well-marked pale bands, including apical band (Notes 5 and 7).

*Three dark spots only on sixth longitudinal vein of wing. Conspicuous black scale tufts on ventral surface of all abdominal segments. Half of terminal hind tarsal segment only white (Note 7).***A. kochi***Five or six dark spots on sixth longitudinal vein of wing. Only extreme tip of terminal hind tarsal segment white (Note 7).*

Tibio-tarsal joint of hind leg broadly and conspicuously banded with white.

A. leucosphyrus

Tibio-tarsal joint of hind leg without such broad band.

A. tessellatus

- (ii) Each palp with three pale bands, including apical band (Notes 5 and 7).

*Dorsum of most of the abdominal segments thickly clothed with scales.***A. willmori***Scales, if present, restricted to the last few abdominal segments only.***A. maculatus**

B. TIPS OF HIND LEGS NOT WHITE.

1. Femora and Tibiæ not Speckled (Note 1).

(If speckled, see p. 100.)

a. *Less than four dark areas on costa involving both the costa and the first longitudinal vein of wing (Note 7).*

(i) Inner half of costa without any distinct pale interruption (Note 7).

Broad white band on femur of hind leg.

With prominent scale tuft associated with the band. **A. annandalei**

Without such a tuft. **A. lindesaii**

No broad white band on femur of hind leg.

Palps with some pale bands.

A. hyrcanus var. **nigerrimus**

Palps with no pale band.

With prominent scale tuft on ventral surface of seventh abdominal segment.

A. barbirostris

With no such scale tuft.

A. umbrosus

(ii) Inner half of costa with pale interruption (Note 7).

A. gigas

b. *At least four dark areas on costa involving both the costa and the first longitudinal vein of wing (Note 7).*

(i) Front tarsal joints with broad pale bands (Note 7).

(If without, see p. 99.)

Palps with dark pre-apical area equal to, or nearly equal to pale apical band (Note 7).

A. subpictus (**rossii**)

Palps with dark pre-apical area half, or less than half, the length of the pale apical band (Note 7).

A. vagus

- (ii) Front tarsal joints without broad pale bands.
(If with, see p. 98.)

Tips of palps black.

Dorsum of thorax with hairs or narrow false scales.
Sixth wing vein with very indefinite markings
(Note 7). **A. turkhudi**

Dorsum of thorax with obvious true scales. Sixth
wing vein with very definite marking (three dark
spots) (Note 7). **A. multicolor**

Tips of palps not black.

Third longitudinal wing vein dark (Note 7).

*No pale spots on wing veins other than those on
costa (Note 7).* **A. rhodensiensis**

Pale spots present on other veins.
A. culicifacies

Third longitudinal wing vein light (Note 7).

*Each palp with two almost equal broad pale distal
bands and a narrow proximal one (Note 7).*

Proboscis pale in apical half. Sixth wing vein
with three dark spots (Note 7). **A. aconitus**

Proboscis not so. Sixth wing vein with two
dark spots (Note 7). **A. minimus**

Palps not so.

Inner quarter of costa without pale interruption
(Note 7). Scales present only on the extreme
front of dorsum of thorax. **A. listonii**

Inner quarter of costa with pale interruption
(Note 7). Scales present over most of
dorsum of thorax.

*Longest pale area on costa less than half
the length of longest dark area (Note 7).
Tarsi of hind legs usually narrowly but
distinctly banded with white.*

A. jeyporiensis

*Longest pale area on costa very little short-
er than longest dark area (Note 7).
Tarsi of hind legs not banded thus.*

A. superpictus

2. Femora and Tibiæ Speckled (Note 1).

(If not speckled, see p. 98.)

a. Each palp with four well-marked pale bands, including apical band (Notes 5 and 7).

(i) Tibio-tarsal joint of hind leg broadly and conspicuously banded with white. **A. leucosphyrus**

(ii) Tibio-tarsal joint of hind leg without such broad band. **A. tessellatus**

b. Each palp with three well-marked pale bands, including apical band (Notes 5 and 7).

(i) Each palp with two broad distal and one narrow proximal band (Note 7). Palps speckled (Note 4).

A. stephensi

(ii) Each palp with one broad apical and two narrow more proximal bands (Note 7). Palps not speckled (Note 4). **A. ludlowii**

NOTES TO PRECEDING TABLE

- Note 1.* A faint mottling is not considered as *speckling*. Seen under the microscope the spots constituting speckling are always clearly defined areas of pale scaling.
- Note 2.* Tarsal segments *completely* white are counted from the tip of the leg, *stopping at the first dark band*.
- Note 3.* In this case there are usually white areas forming bands higher up the tarsus.
- Note 4.* *Speckling on the palps* refers to white spots on their dorsal surface, usually between the middle and proximal pale bands.
- Note 5.* *Beware of speckling imitating a fourth band.*
- Note 6.* Species entered in more than one place in the table may show sometimes one appearance and sometimes another, or an appearance which may be overlooked. In either case the table will work out correctly.
- Note 7.* The *first tarsal segment* is that nearest to the tibia. *Terminal segments* are those at the tip of the leg. *Hind tarsal segments*, etc., are those of hind legs. *Front tarsal segments*, etc., are those of front legs. By *apical band* is meant one involving the extreme tip. *Distal* means situated furthest from the body. *Proximal* means situated nearer to the body. The *costa* is the anterior border of the wing. The *first longitudinal vein* runs parallel with the costa. The *second longitudinal vein* lies behind the first, and divides into two branches. The *third longitudinal vein* lies behind the second, and is unbranched. The *fourth longitudinal vein* lies behind the third and divides into two branches. The *fifth longitudinal vein* lies behind the fourth and divides into two branches. The *sixth longitudinal vein* lies behind the fifth, and is unbranched. The *anterior forked cell* is the part of the wing lying between the branches of the second longitudinal vein. The *posterior forked cell* is the part of the wing lying between the branches of the fourth longitudinal vein.

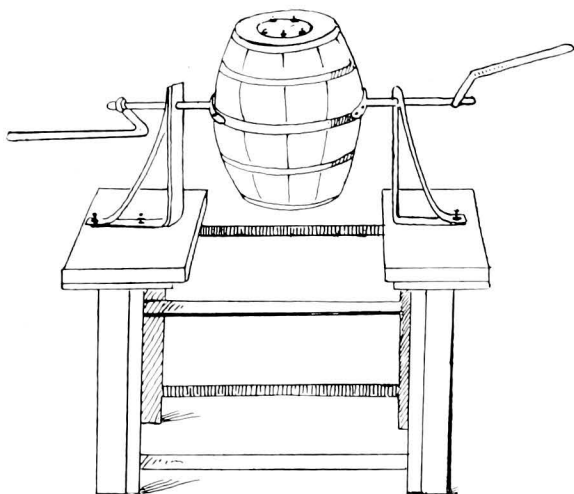
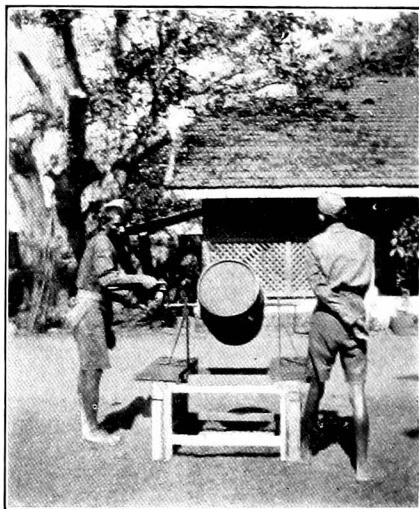
APPENDIX VIII

'PARIS GREEN': ITS ACTION AND USES

'PARIS GREEN' is a recent addition to our armamentarium for malaria control, and its cheapness, simplicity of application and effectiveness, even in the presence of thick vegetation, are assets which are not even nearly approached by other larvacides. It is as well, therefore, that all interested in Anopheline control should know the action and uses of this larvacide.

'Paris Green' is the American name for a chemical which is aceto-arsenite of copper. In its pure state it is said to contain about 58.62 per cent. of arsenious anhydride. As the commercial product is liable to be subject to adulteration by various extraneous substances, it will be a wise precaution, when ordering it for larvacidal purposes, to specify its arsenite content, and also put every new consignment to a practical field test before accepting it for use on a large scale. 'Paris Green' containing approximately 40 per cent. of arsenic estimated as As_2O_3 was found by us to be quite efficacious as an Anopheles larvacide. It is an exceedingly fine crystalline powder having a brilliant emerald green colour, and is practically insoluble in water.

'Paris Green' floats for several hours on the surface of water, and Anopheline larvæ, being surface feeders, swallow these floating particles, which act as a very powerful poison to them. Culicine larvæ, not being surface feeders, are not affected by this larvacide. It has no action on the pupal stage of Anopheline or Culicine mosquitoes, as pupæ do not feed. Eggs are unaffected by 'Paris Green', and hatch out into larvæ in the usual course. Fish and aquatic insects, like water-boatmen and water-bugs, are not affected by the use of 'Paris Green', and ducks feeding in some tanks where



PARIS-GREEN MIXER

this larvacide was used by us came to no harm. In both running and stagnant water, fresh or brackish, 'Paris Green' can be used with great benefit, even without removing any vegetation if present.

TECHNIQUE

Personnel.—Any ordinary Indian labourer will easily learn the method of dilution, mixing and distribution of 'Paris Green'. Highly trained labour is not required.

Dilution.—The best vehicle for dilution is fine road or clay dust. Cork dust, saw dust, fine sand or spoiled flour may also be used. The diluent used must be perfectly dry, since the least degree of moisture tends to cause the dust to sink. One part of 'Paris Green' mixed with one hundred parts of any of the above-mentioned diluents will be efficacious under nearly all conditions.

Mixing.—The figure opposite illustrates a very efficient method of mixing 'Paris Green' with a diluent. It consists of a barrel across which an iron pipe is passed in the middle for an axis, resting on a stand so that the barrel can be revolved with the greatest ease.

Quantity.—Fifteen grains of 'Paris Green' mixed with 100 parts of the diluent will suffice for every ten square yards of water surface. If the water surface is very densely covered with vegetation, it might be advisable to use a somewhat larger quantity, which can be easily judged after a few preliminary trials.

Intervals between Treatment.—Once in seven days is a safe interval for the application of 'Paris Green'; but since the development of mosquito larvæ depends a good deal on the existing temperature and other factors, the point to

remember is that the interval should be shorter than the period required for the appearance of *Anopheles* pupæ.

Distribution.—The mixture can be thrown in the air by hand, so that it is carried by the wind and spread over the water surface. If, however, there is dense vegetation present, it is very likely that a good deal of the mixture will be delivered on the foliage of the plants instead of on the water surface. In such cases hand-bellows with a container and nozzle can be used with advantage, so that the nozzle can be thrust through the vegetation and the larvicide spread directly on the water surface (*vide* page 65).

Apart from the simple precaution of keeping to the windward of 'Paris Green' dust and taking a good bath after using it, we have taken no other steps to protect our personnel employed in mixing and distributing 'Paris Green', and have observed no ill-effects on them resulting from daily contact with it.

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