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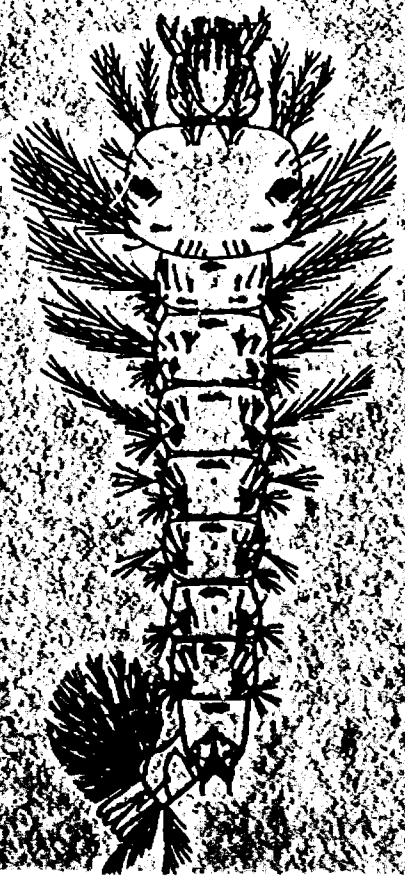
ABSTRACT

This self-instructional booklet is designed to enable malarial control workers to identify the larvae of "Anopheles" species that are important malaria vectors. The morphological features of the larvae are illustrated in a programed booklet, which also contains an illustrated taxonomic key to 25 species of anopheline larvae. A glossary and a short bibliography are included. (DI)

Preliminary Issue

WORKBOOK ON THE IDENTIFICATION OF ANOPHELES LARVAE



U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE

WORKBOOK ON THE IDENTIFICATION OF ANOPHELES LARVAE

Harry D. Pratt

and

Chester J. Stojanovich

1966

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
Communicable Disease Center
Atlanta, Georgia 30333

INTRODUCTION

One of the most important aspects of the worldwide malaria eradication program is the accurate determination of the species of Anopheles mosquitoes actually involved in transmitting the disease. The decision in a particular area to use residual spraying of buildings, larviciding, or drug administration to achieve malaria eradication should be determined by such factors as: man-biting or animal-feeding habits of the adult Anopheles, outdoor or indoor feeding habits of the vector mosquitoes, tendency for adult female Anopheles to rest on sprayed walls after a blood meal, and the occurrence of larval breeding places, which can be larvicided more efficiently than houses can be treated by residual spraying. The accurate determination of the species of Anopheles mosquitoes is obviously of utmost importance in making such an assessment.

HOW TO USE THIS BOOKLET

The purpose of this self-instructional Work Book is to teach, not to test. It has been specially written so that you can learn by doing. Parts I and II can be completed with a pencil, each student setting his own pace, taking whatever time is necessary. Read each page carefully. Write in the answers as you work through the Work Book and compare your answers with those in the Answer Book.

REMEMBER

--Read EVERYTHING carefully, more so than you ordinarily do

--Work through each paragraph and page ONE STEP AT A TIME

--Do your best to answer all the questions BEFORE you look back or use the answer book.

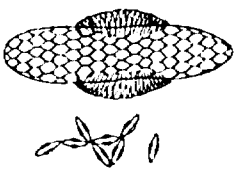
When you have completed Parts I and II, use a microscope and the illustrated key in Part III to identify specimen mosquitoes, which your instructor will provide.

PART I

What is an Anopheles Larva?

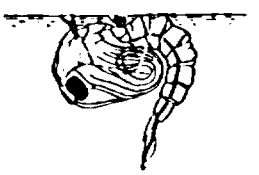
There are four stages in the life history of mosquitoes:

1. Egg

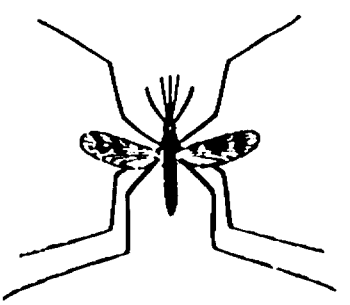


2. Larva

3. Pupa



4. Adult



The first three stages are aquatic; the fourth, or adult stage, is aerial. Among most species the adult females, but not the males, are bloodsucking.

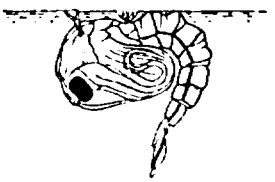
Test yourself: Draw a line from each name to the appropiate drawing.

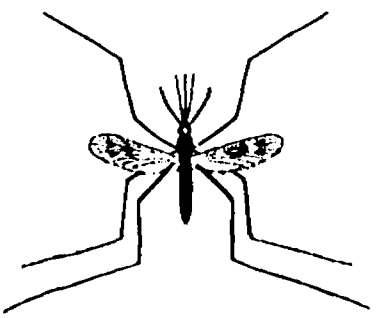
1. Egg

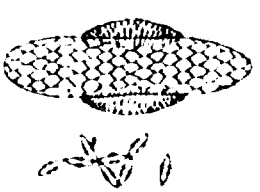
2. Larva

3. Pupa

4. Adult





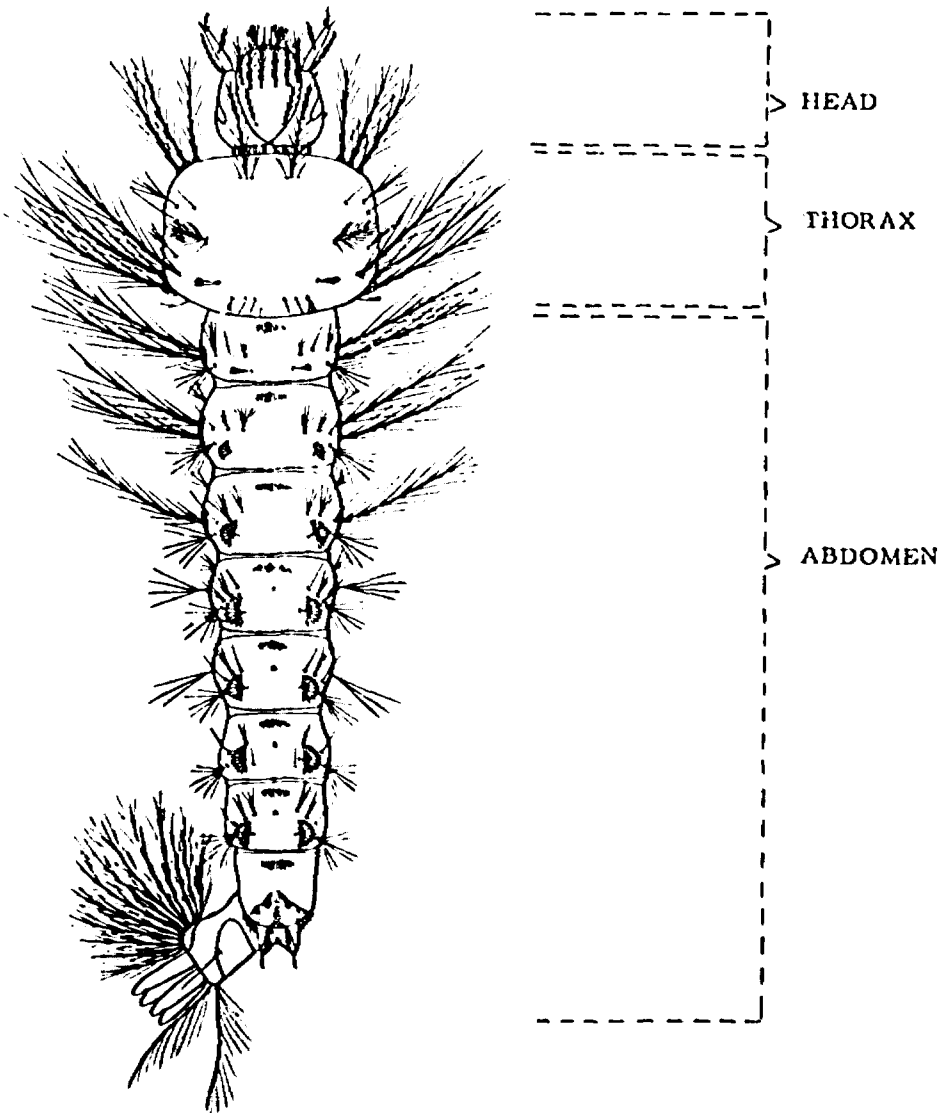


Mosquito larvae can be distinguished from all other aquatic insects by a combination of two characters:

1. They have no legs,

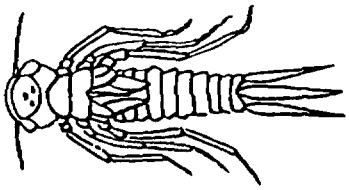
   and

2. The thorax is wider than the head or abdomen

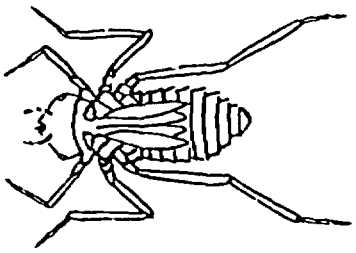


These are not mosquito larvae but are found commonly in collections of standing water.

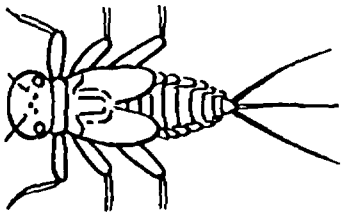
These aquatic insects have legs on the thorax.



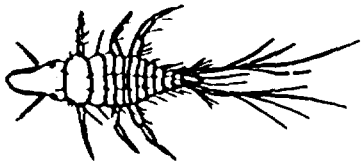
DAMSEL FLY



DRAGONFLY

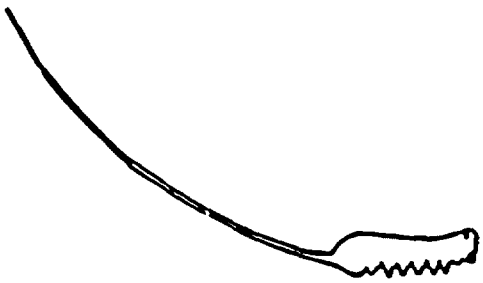


MAY FLY

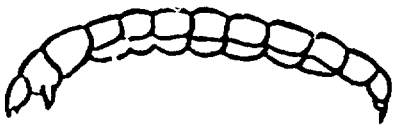


BEETLE

These aquatic insects have the thorax about as wide as the head and abdomen.

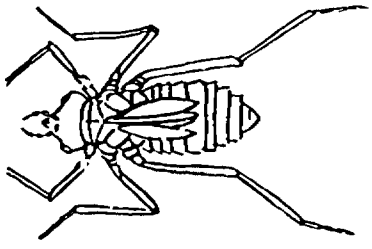


RAT-TAILED MAGGOT

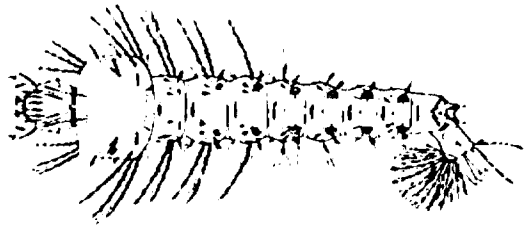


MIDGE LARVA

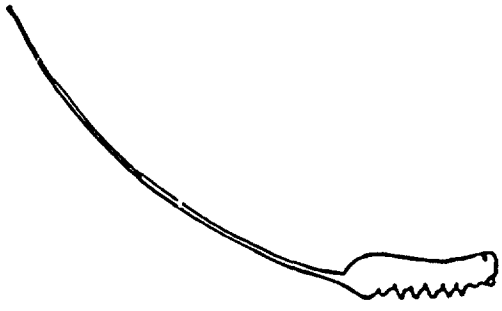
TEST YOURSELF: Circle the numbers of the specimens illustrated below that are mosquito larvae.



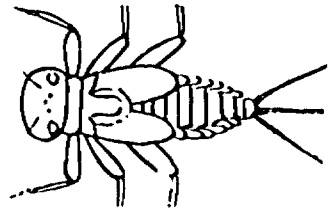
1.



2.



3.



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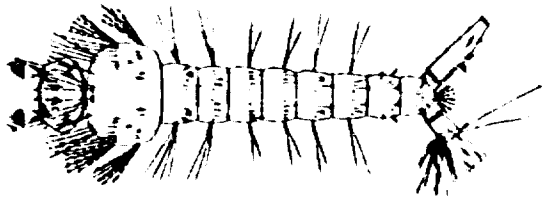

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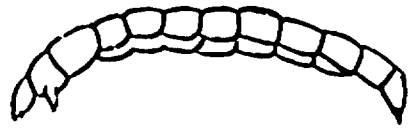
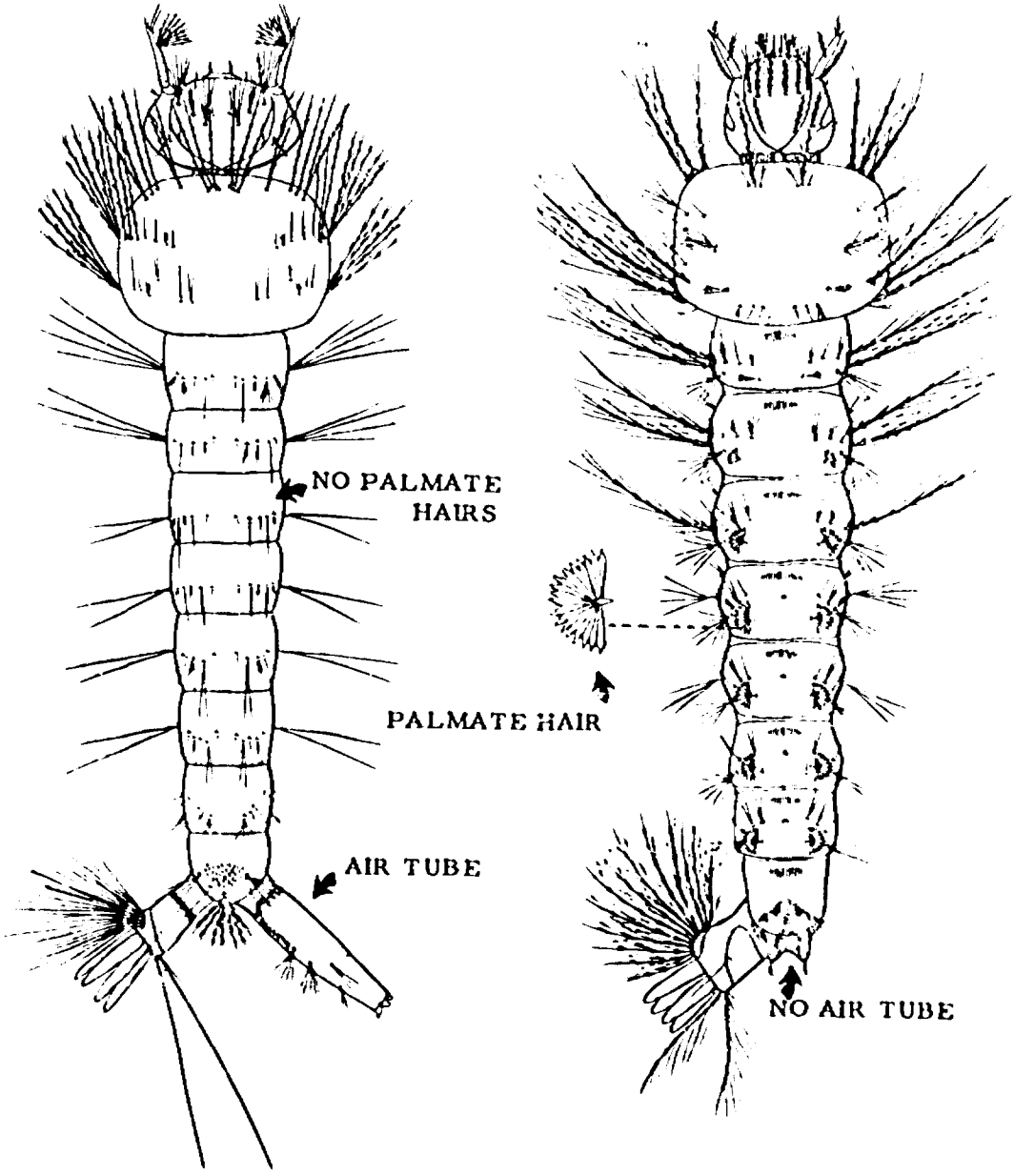


6.

Mosquitoes are divided into two main types known as "anopheline" or "culicine." An anopheline mosquito larva has palmate hairs and no air tube; a culicine mosquito larva has no palmate hairs but does have an air tube.

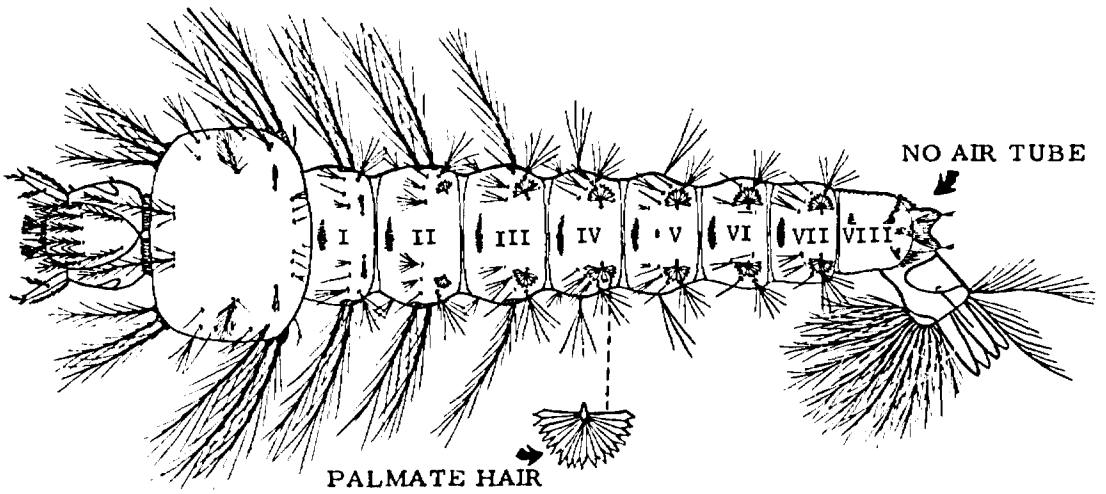


CULICINE

ANOPHELINE

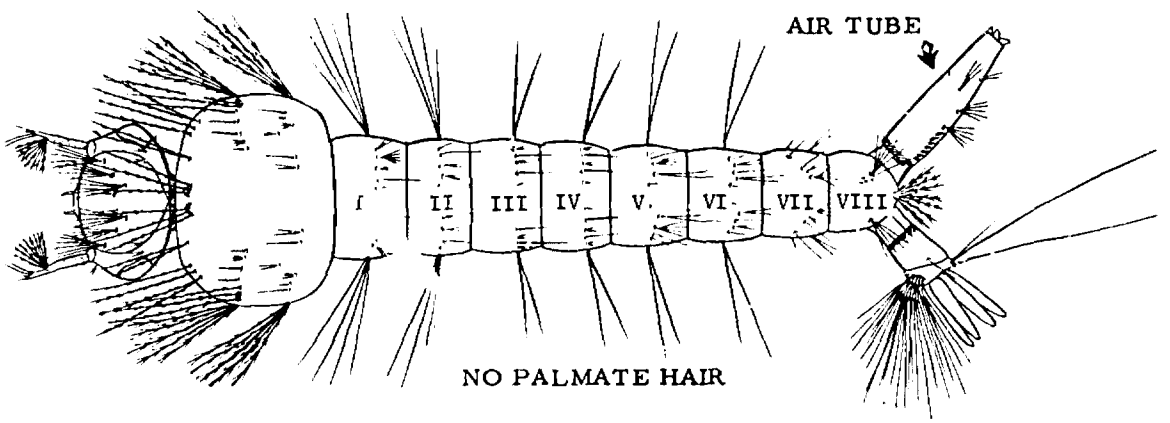
The palmate hairs (after the palm of the hand or a palm frond) are palm-shaped structures present on the abdomen of anopheline larvae and absent in culicine larvae.

AIR TUBE ABSENT: ABDOMEN WITH PALMATE HAIRS

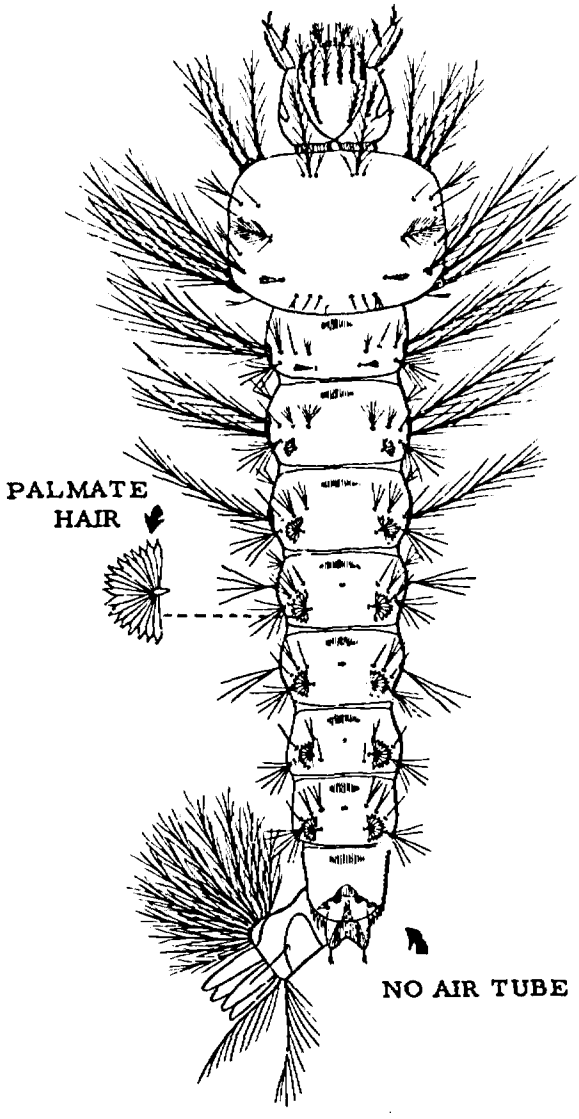


The air tube is a cylindrical structure arising from the eighth abdominal segment. It is present in the culicine larvae but absent in the anopheline larva.

AIR TUBE PRESENT: ABDOMEN WITHOUT PALMATE HAIRS



The malaria mosquito belongs to the group, or genus (plural–genera), named Anopheles. The term "anopheline" is derived from this name. Study the anopheline larva pictured here.



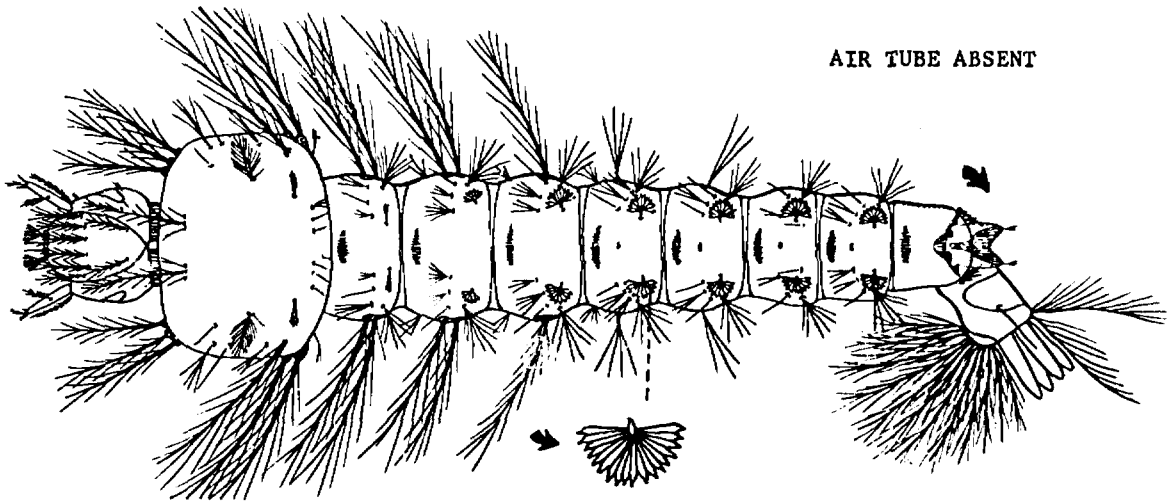
MALARIA MOSQUITO LARVA

(Anopheles)= "anopheline" mosquito larva

Remember these three facts to identify an anopheline, or malaria-mosquito larva:

1. It lies parallel to the water surface.
2. It has no air tube.
3. It has palmate hairs which help keep the abdomen at the water surface.

ABDOMEN WITH PALMATE HAIRS



PALMATE HAIR

TEST YOURSELF:

Mark out the wrong statement in (a) and (b).

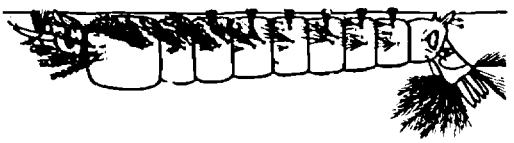
The malaria mosquito larva can be recognized in the field with the naked eye, for it

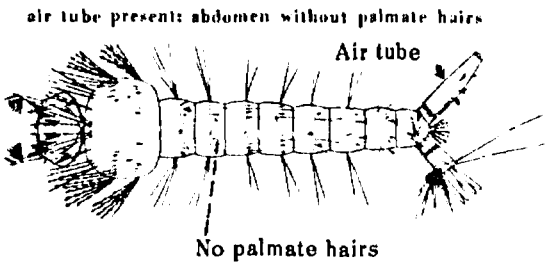
(a)
Hangs from the water surface.

Lies parallel with the water surface.

(b)
Has an air tube.

Does not have an air tube.

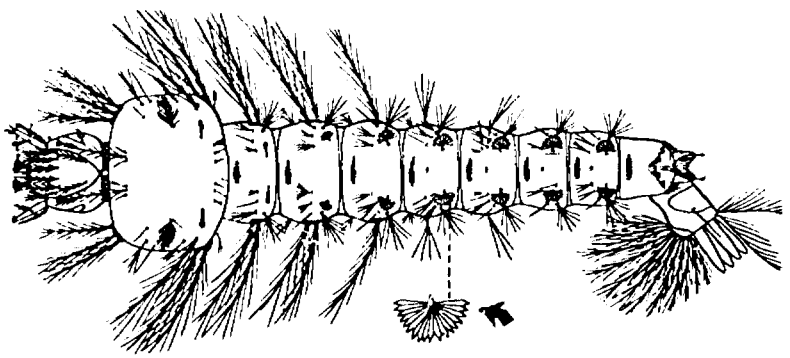




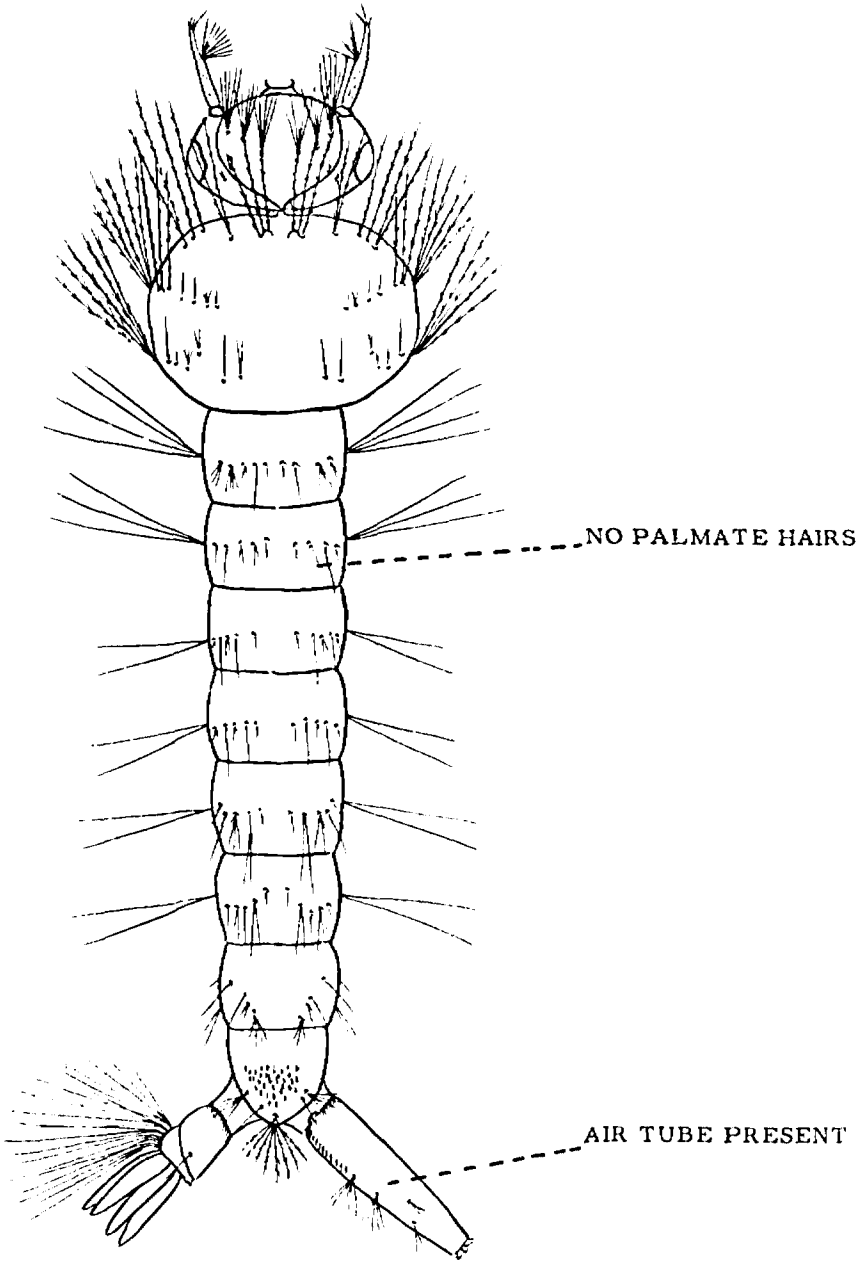
Fill in the blank in the statement below:

In the laboratory, with the aid of a microscope, you can see palm-shaped structures,

called _____, on some of the abdominal segments.



The term "culicine" mosquito comes from the genus named Culex, a well-known genus of pest mosquito. Study this drawing of a culicine larva.

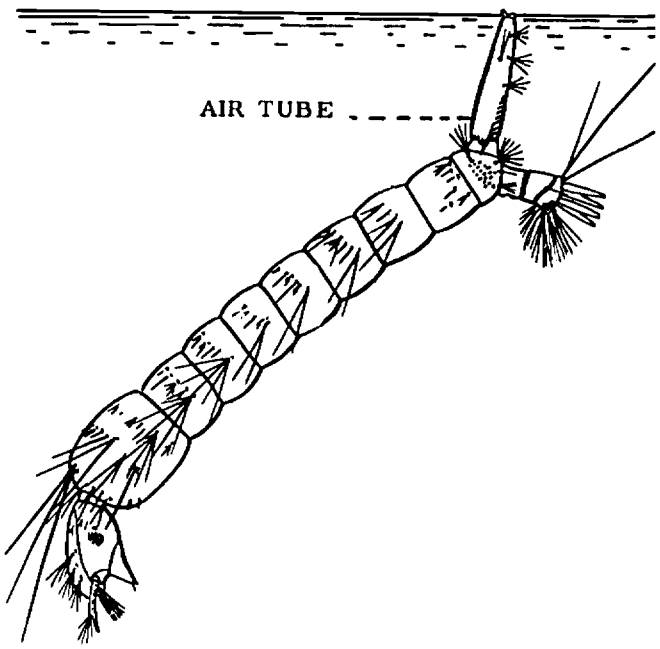


PEST MOSQUITO LARVA

(Culex) = "culicine mosquito larva"

These characteristics will enable you to identify the larva of a culicine, or pest mosquito.

1. It hangs at an angle to the water surface.
2. It has an air tube.
3. It does not have palmate hairs.

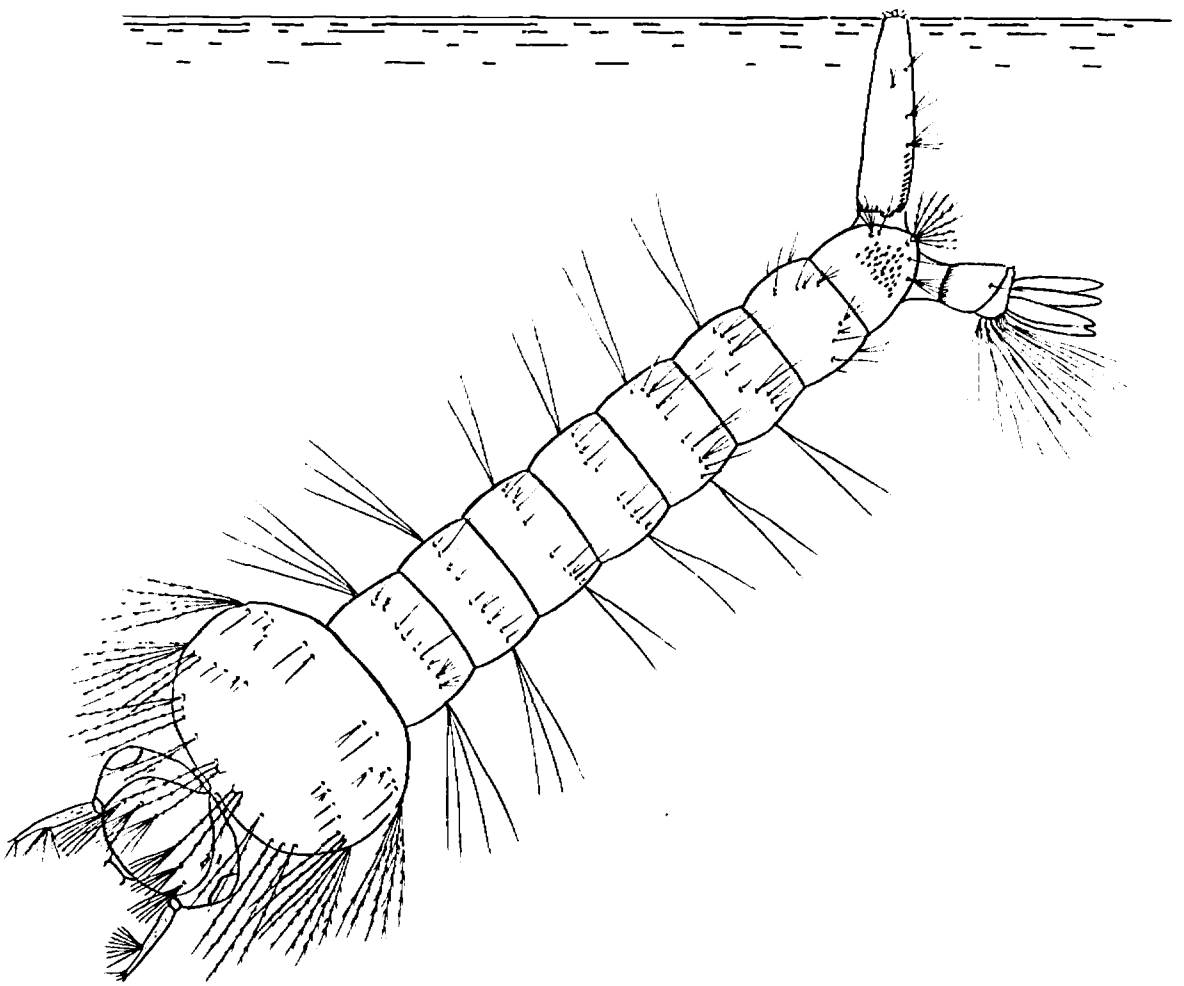


TEST YOURSELF: Culicine larvae can be identified by three characters:

1. _____

2. _____

3. _____



TEST YOURSELF:

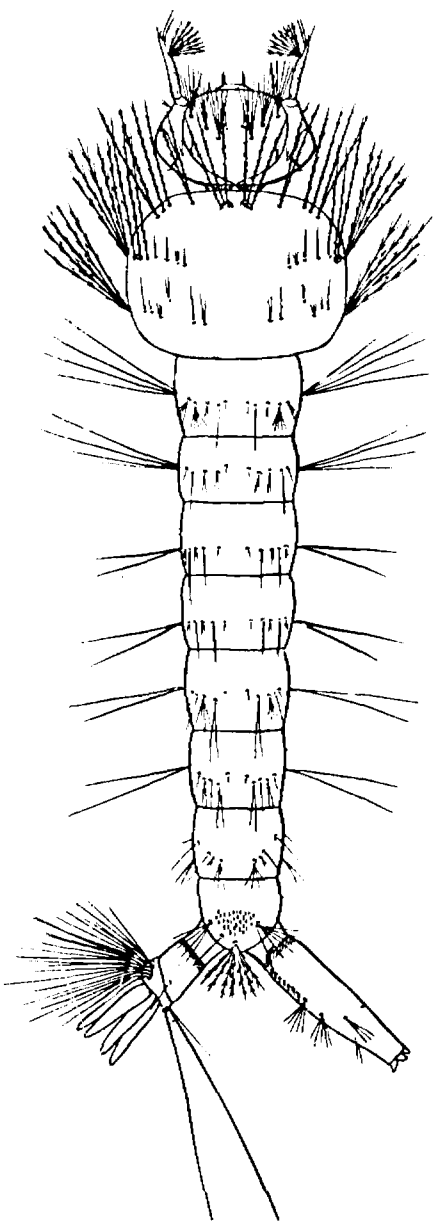
The two important types of mosquito larvae are called

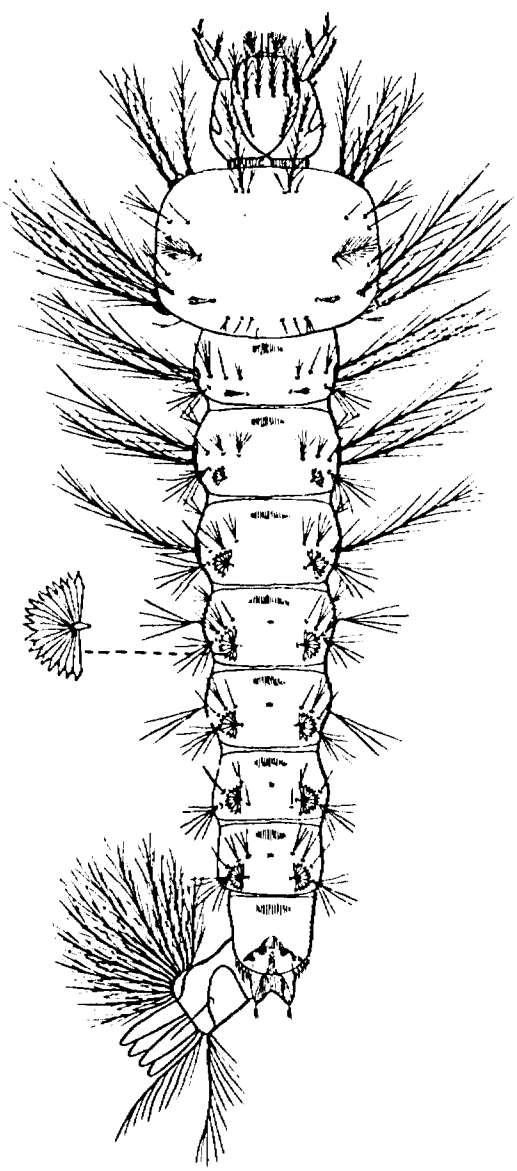
1. _____ or _____

2. _____ or _____

Write the appropriate names over the larvae pictured.

_____ _____

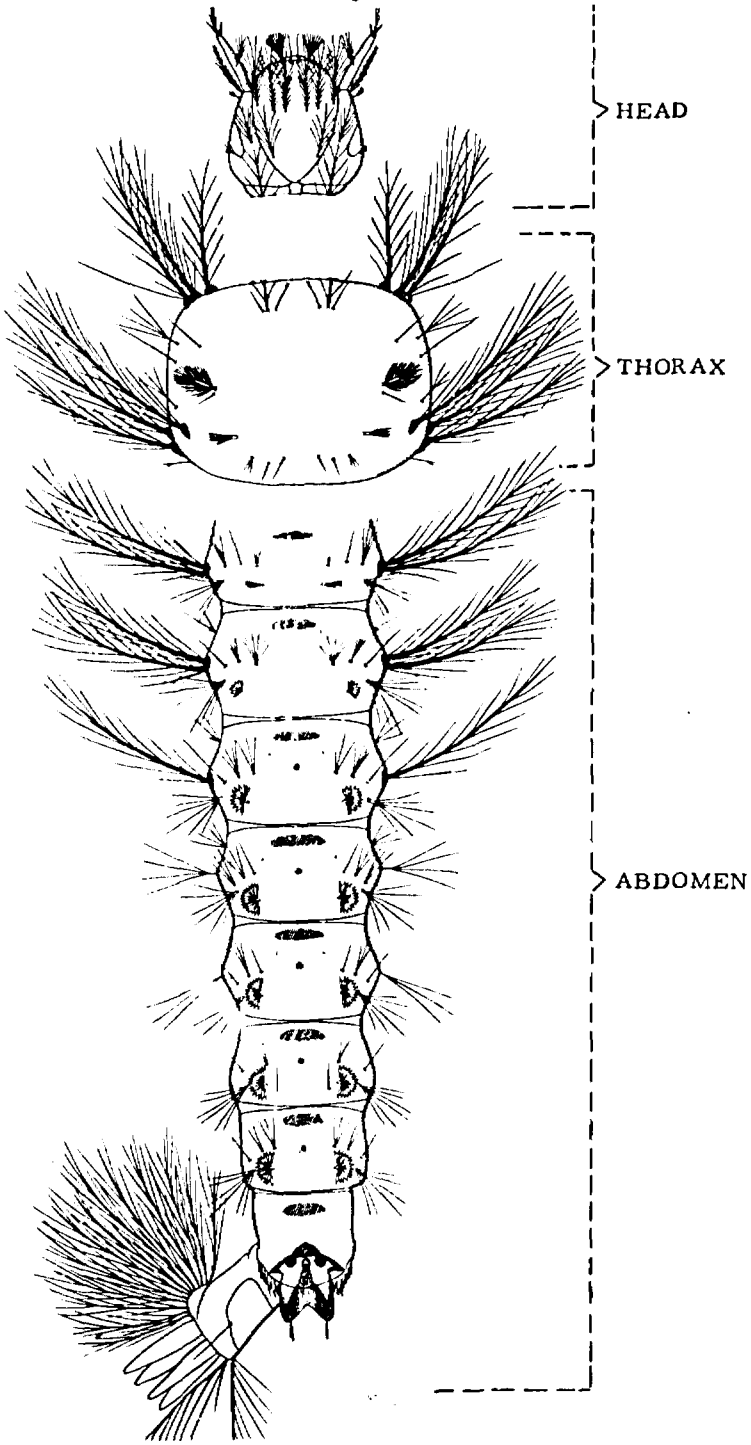




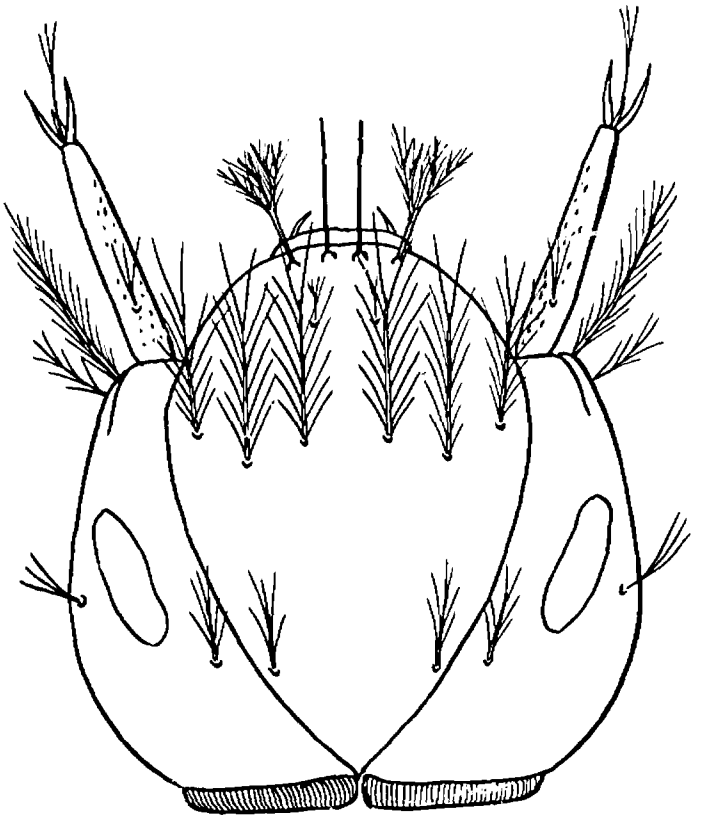
PART II

Morphology of Anopheles Larvae

The mosquito larva is divided into three body regions: head, thorax and abdomen. Structures on each of these three body regions are used in identifying mosquito larvae.

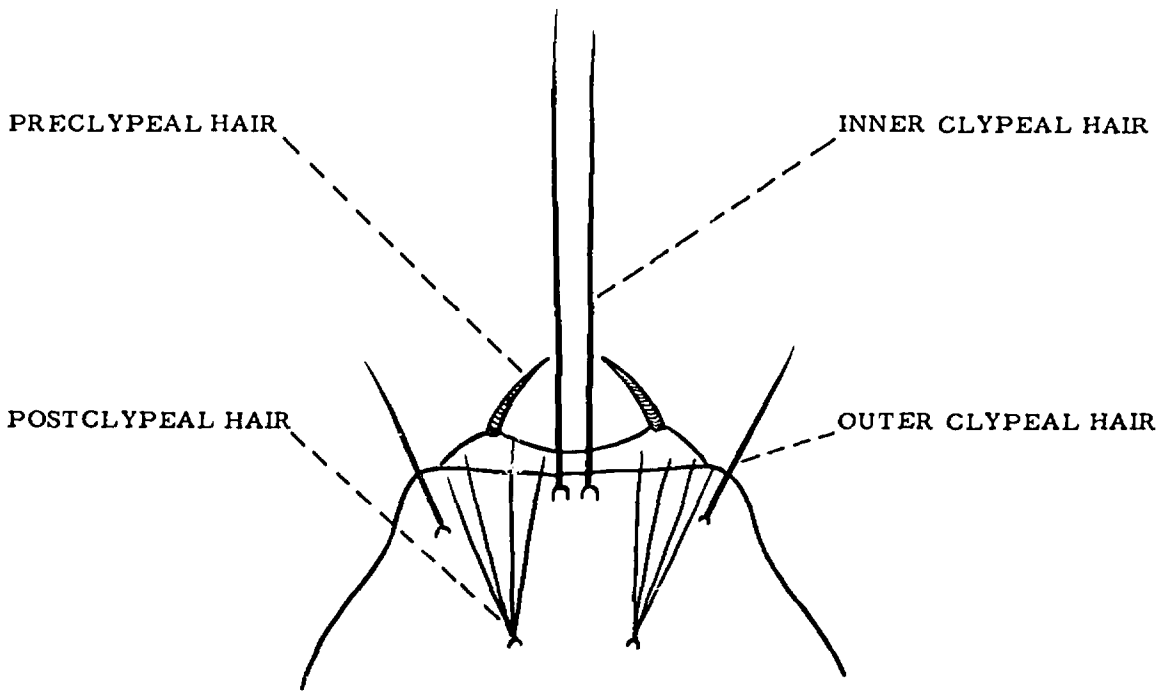


The first body region, the head, has many hairs that are used in identification.

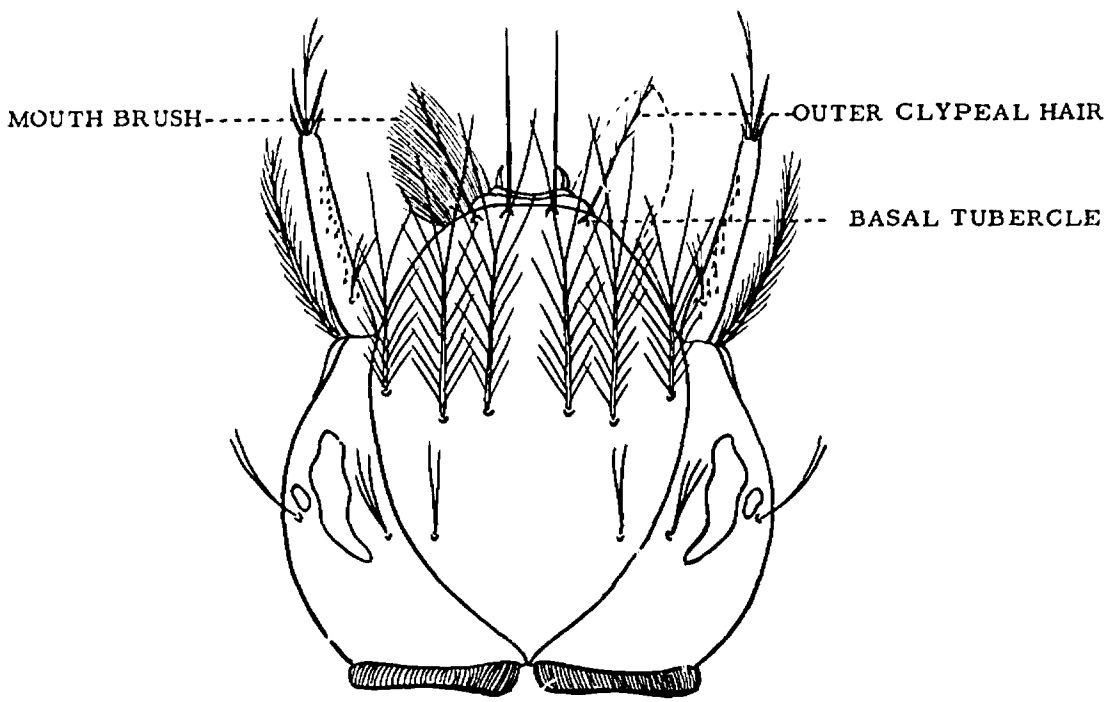


Many hairs on the head are used in identifying Anopheles larvae.

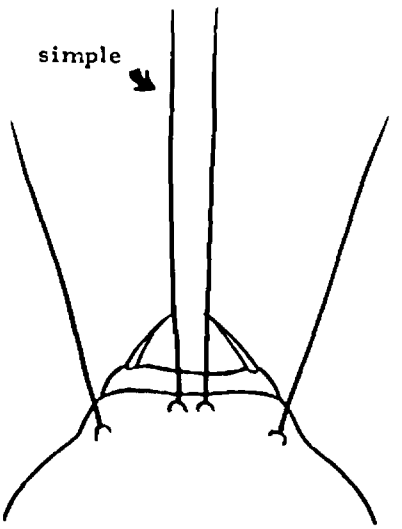
The preclypeal hairs or spines are a pair of straight or slightly curved hairs on the clypeus at the anterior end of the head. They are seldom used in identifying anophelines. However, the next three pairs of hairs behind them are of primary importance in identifying Anopheles. The inner clypeal hairs, the outer clypeal hairs, and the postclypeal hairs.



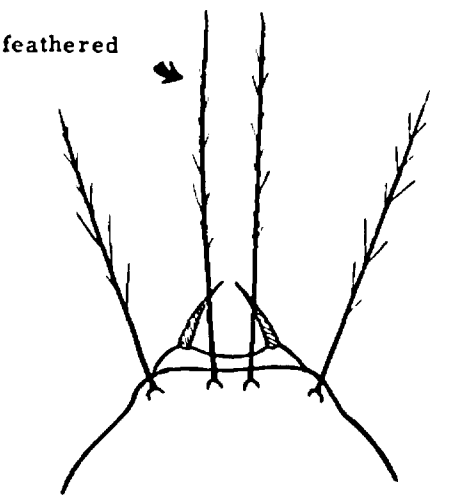
Careful observation is often necessary to distinguish the mouth brushes from outer clypeal hairs when the mouth brushes are expanded beneath them. The mouth brushes arise from a broad base, whereas the outer clypeal hairs arise from a single tubercle. In difficult cases, it is possible to focus on the basal tubercle of the inner clypeal hairs and then, keeping the same focus, observe the basal tubercle of the outer clypeal hairs and then the outer part of these hairs to determine whether or not they are branched.



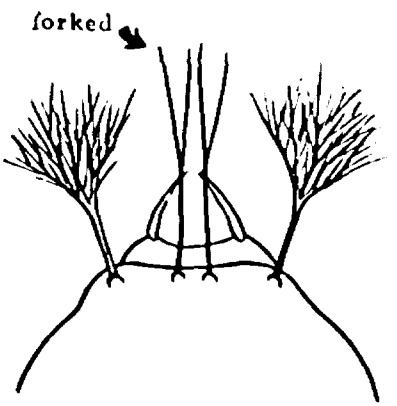
The inner clypeal hairs arise from a basal tubercle or socket. They are simple, feathered, forked, or many-branched.



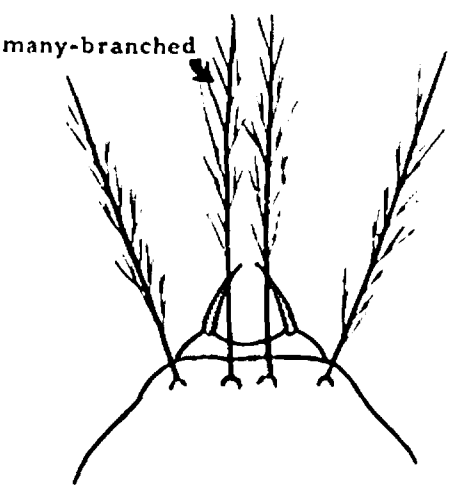
ANOPHELES PSEUDOPUNCTIPENNIS



ANOPHELES AQUASALIS

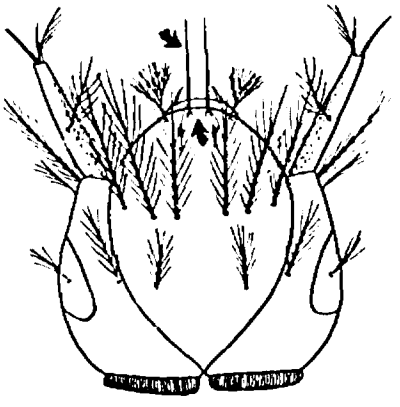


ANOPHELES EARLEI

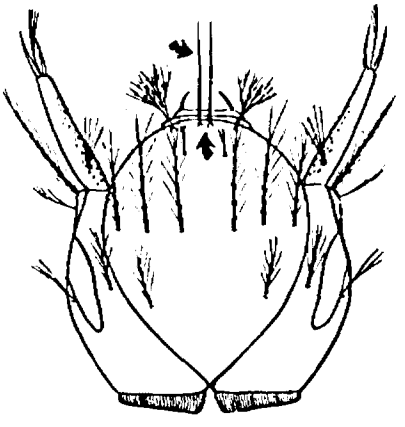


ANOPHELES OSWALDOI

In identifying Anopheles larvae, the width of the basal tubercle is used in separating species in which the "inner clypeal hairs are widely spaced, separated by more than the width of the basal tubercle," as in Anopheles quadrimaculatus, from other species in which the "inner clypeal hairs are set closely together, separated by less than the width of the basal tubercle," such as Anopheles punctipennis.

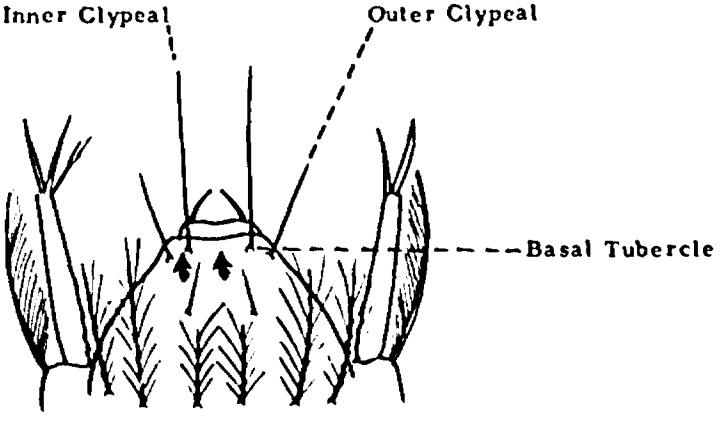


ANOPHELES QUADRIMACULATUS



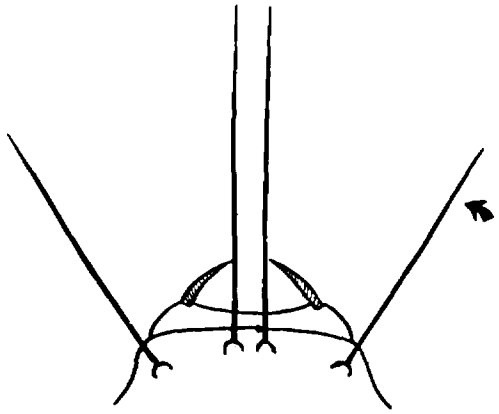
ANOPHELES PUNCTIPENNIS

Typical species of Old World Anopheles (subgenus Cellia) have the "inner clypeal hairs well separated." Depending on the identification key, "well-separated" is defined as "at least twice the basal diameter of the inner clypeal hairs", or "the distance between their bases twice or more than that between the base of the inner and outer clypeal hairs of one side".

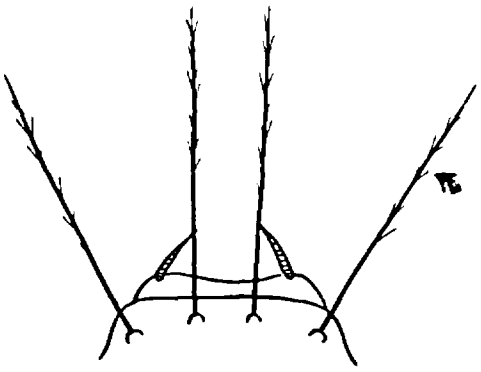


ANOPHELES GAMBIAE

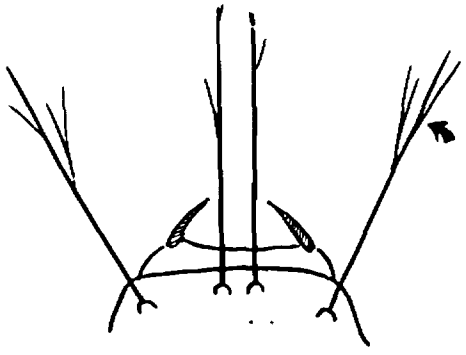
The outer clypeals are simple, feathered, forked or many-branched.



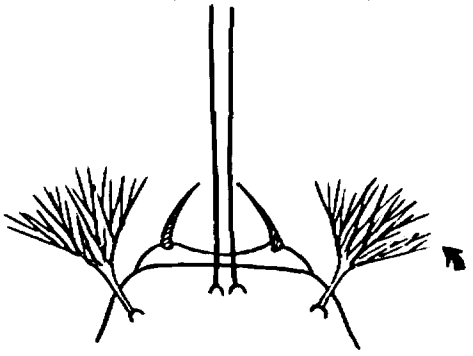
ANOPHELES PSEUDOPUNCTIPENNIS



ANOPHELES ALBIMANUS

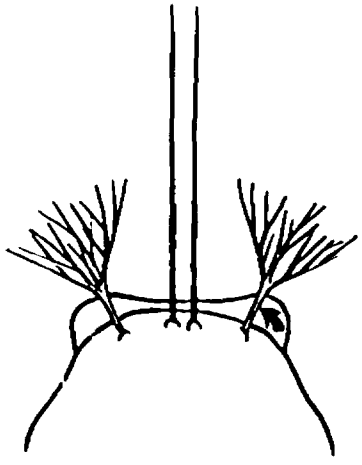


ANOPHELES ATROPOS

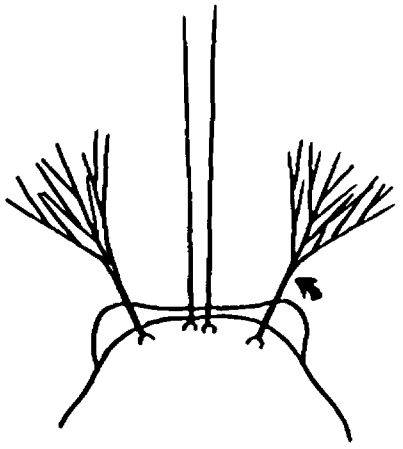


ANOPHELES SINENSIS

In some species the outer clypeals may have a short stem, as in Anopheles grabhami, or a long stem as in Anopheles vestitipennis.



ANOPHELES GRABHAMI



ANOPHELES VESTITIPENNIS

TEST YOURSELF: Match the following numbered statement with the lettered illustration.

1. Anopheles gambiae has the inner clypeals widely spaced; the inner and outer clypeals simple..... E

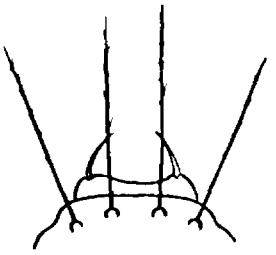
2. Anopheles philippinensis has the outer clypeals with many branches..... ____

3. Anopheles pseudopunctipennis has inner clypeals set close together and simple..... ____

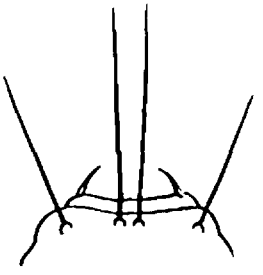
4. Anopheles albimanus has the four inner and outer clypeals almost evenly spaced and slightly feathered..... ____

5. Anopheles carlei has the inner clypeals forked..... ____

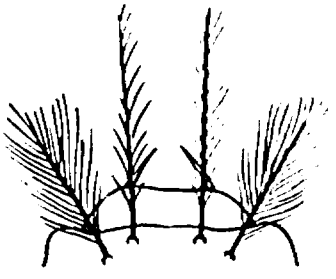
A



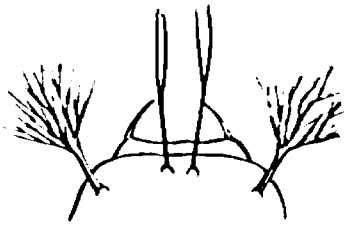
B



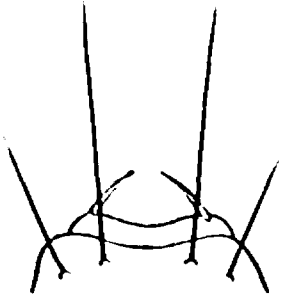
C



D



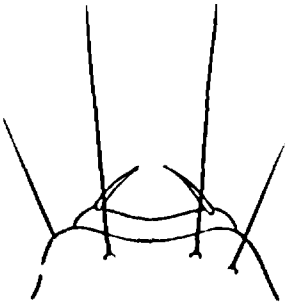
E



TEST YOURSELF: Match the following numbered statement with the lettered illustration.

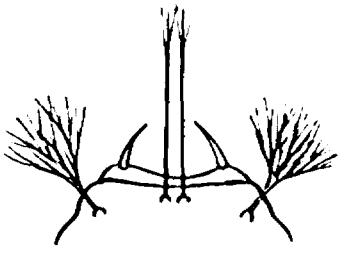
1. Anopheles quadrimaculatus has the outer clypeals densely branched; inner clypeals separated by at least the width of a basal tubercle..... ____

A



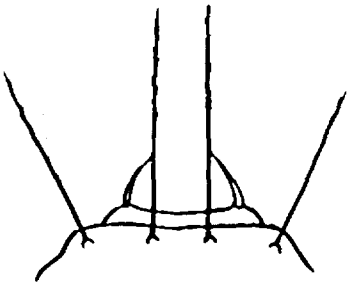
2. Anopheles aquasalis has all four clypeals about evenly spaced; outer and inner clypeals feathered..... ____

B



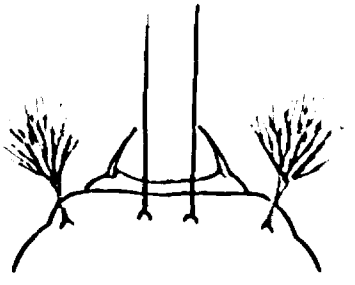
3. Anopheles minimus has inner clypeals widely spaced; all clypeals simple..... ____

C

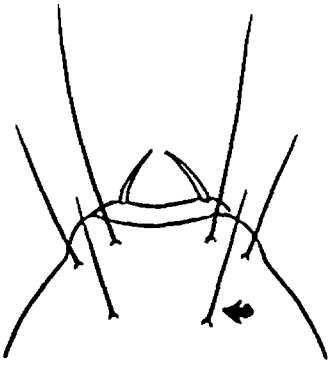


4. Anopheles sacharovi has inner clypeals branched at tip, their bases nearly touching..... ____

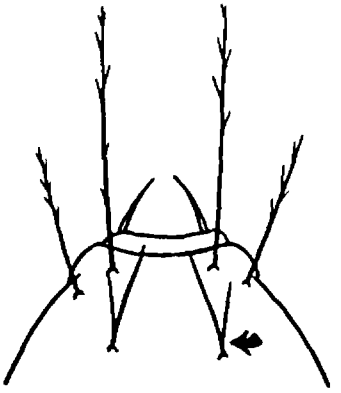
D



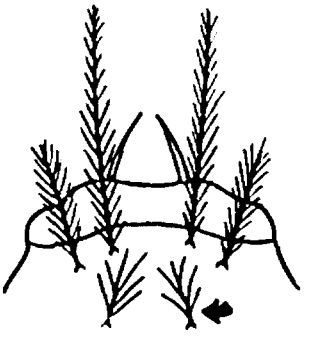
The postclypeal hairs are single, double or many-branched.



SINGLE

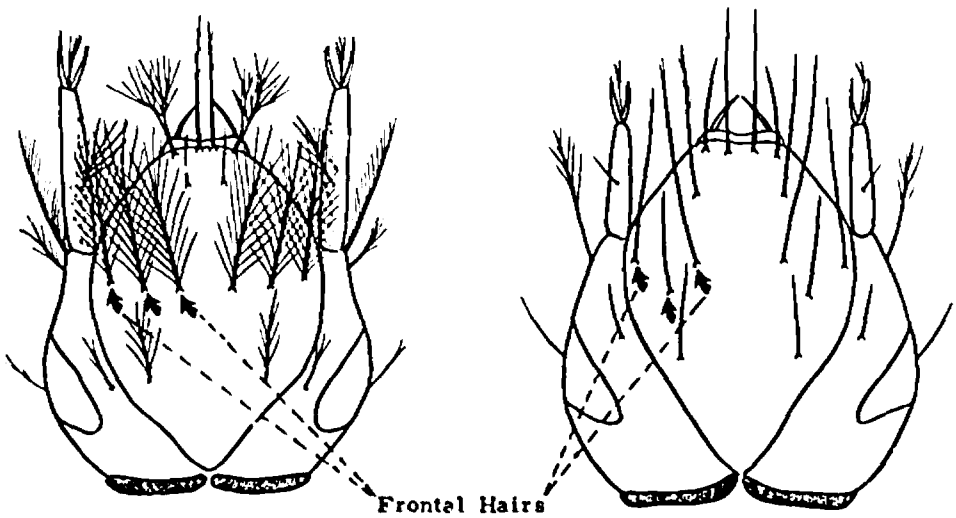


DOUBLE



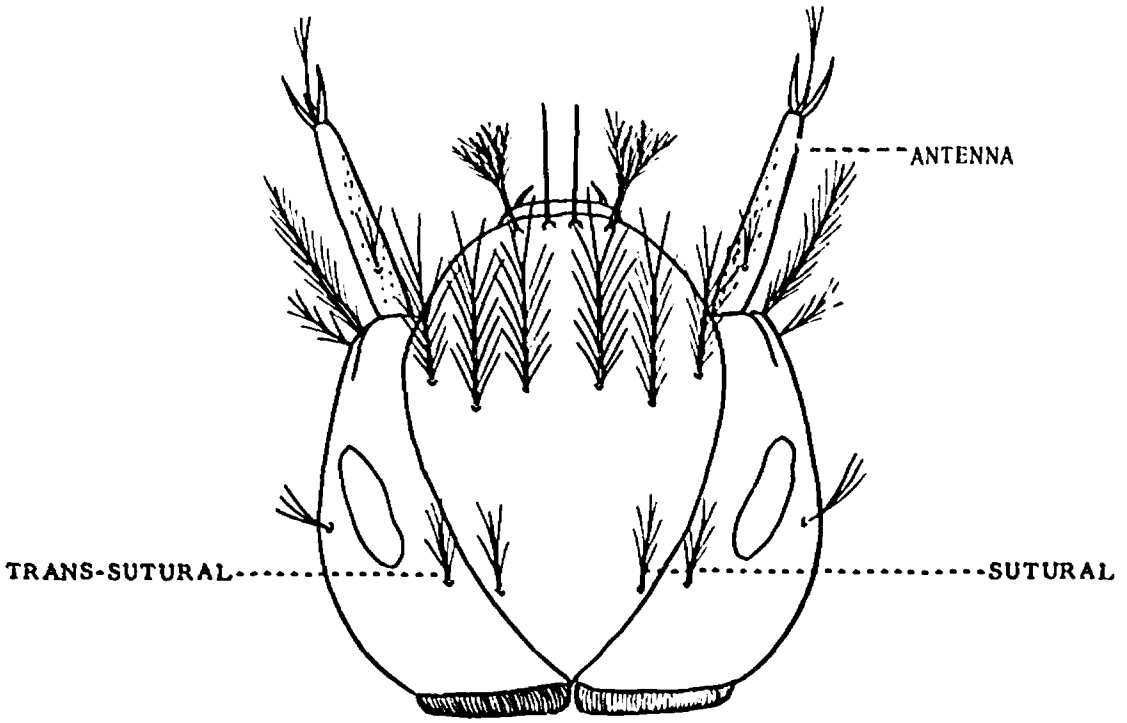
MANY-BRANCHED

Behind the inner and outer clypeal and postclypeal hairs are the 6 frontal hairs. These normally are many-branched or feathered, but in some tree hole and bromeliad-inhabiting species the frontal head hairs are simple or frayed at the tips.



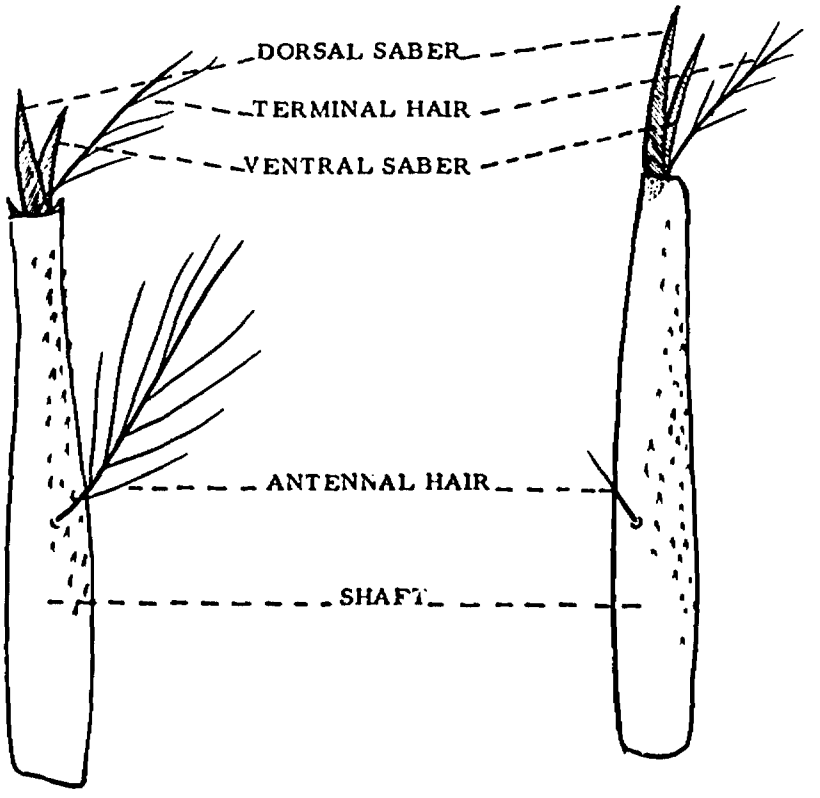
ANOPHELES QUADRIMACULATUS ANOPHELES BELLATOR

The head has a well-defined suture on the dorsal side. The hairs on either side of this suture are together called the suturals or sometimes they are given separate names, the inner one, the sutural, and the outer one, the trans-sutural. In some keys the suturals are called the occipitals because they are located on the occipital part of the head.



The antennae, or feelers, are a pair of tubular structures, one on each side of the head.

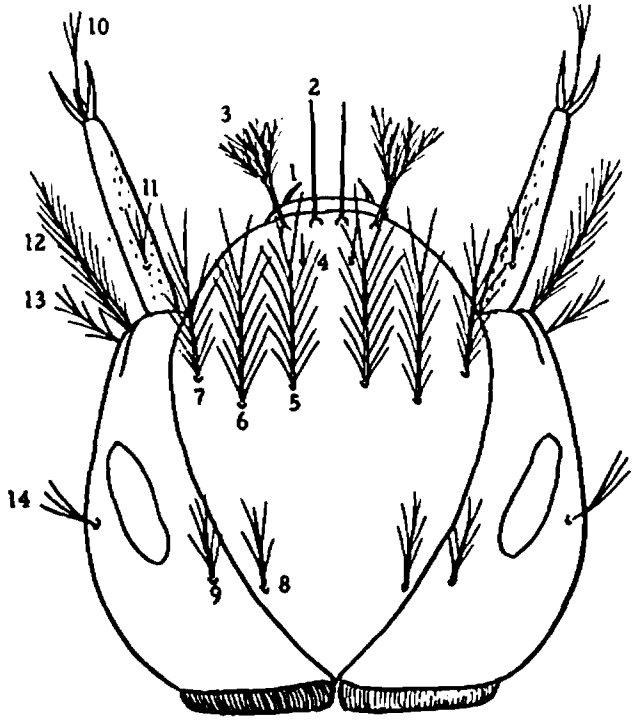
The antenna consists of a tubular shaft bearing an antennal hair, a terminal antennal hair and two sabers at the tip, a dorsal and ventral saber. The antennal hair is single, or branched. Its position on the shaft is of importance, for example, at the middle, at the basal third, or basal quarter. The antennal hair may be on the inner side of the shaft, that is, toward the clypeal hairs, or on the outer side or dorso-external surface. The shaft is smooth, spicular or spinose.



ANOPHELES QUADRIMACULATUS

ANOPHELES GAMBIAE

The hairs on the head have all been numbered. Some workers, and some identification keys, refer to the hairs by numbers rather than by names. The hairs are listed by number and name.



1 inner preclypeal

2 inner clypeal

3 outer clypeal

4 postclypeal

5-7 frontal

5 inner frontal

6 mid-frontal

7 outer frontal

8-9 sutural (occipital)

8 sutural (inner)

9 trans-sutural

10 terminal antennal

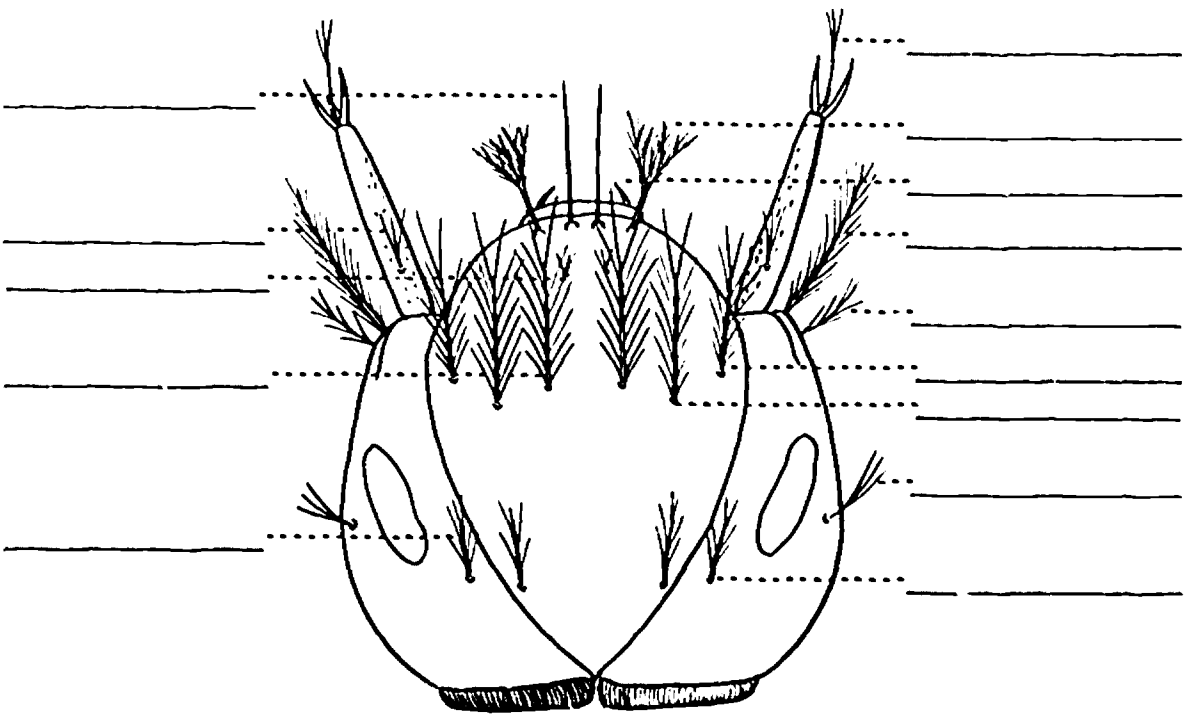
11 antennal

12 basal

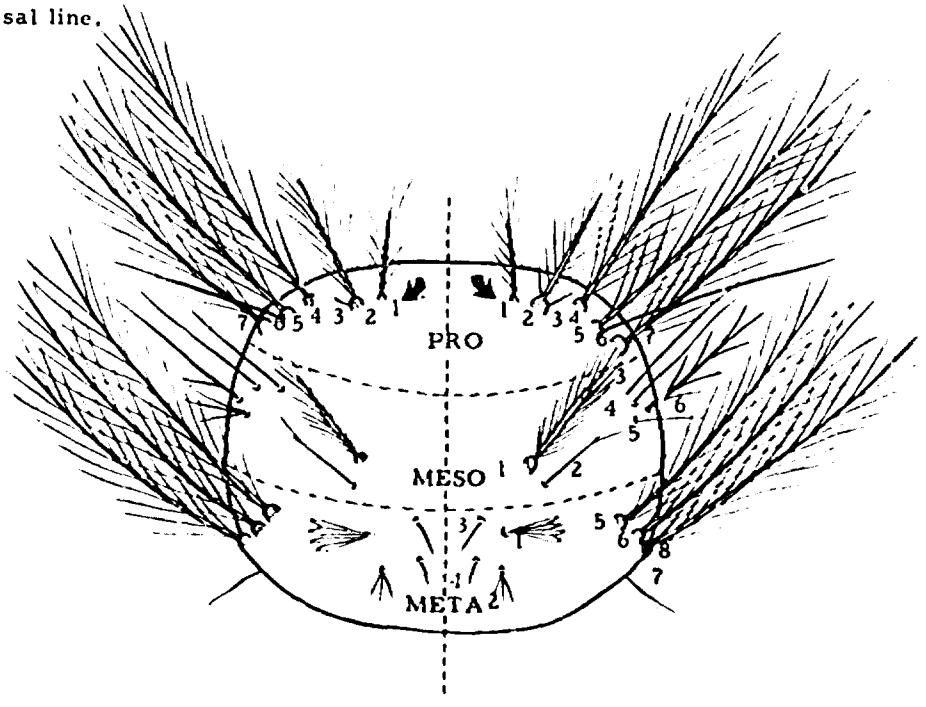
13 sub-basal

14 orbital

TEST YOURSELF: number and label the 14 hairs on the dorsal (or upper) surface of the head.



The second body region of the mosquito is called the thorax. The thorax is a compound structure resulting from the fusion of three segments known as the prothorax, mesothorax, and metathorax. Hairs on each of these three parts of the thorax are referred to as prothoracic, mesothoracic, and metathoracic hairs. The hairs on the thorax are numbered beginning at the median dorsal line.

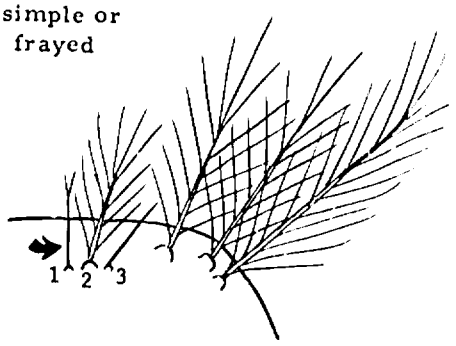


THORAX

Hair "1" of the prothorax is sometimes called the submedian prothoracic hair. Its size and shape is of great importance in identification.

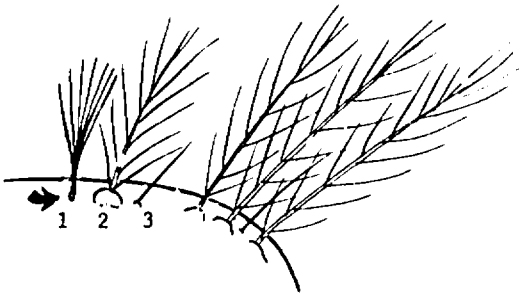
The shape of the prothoracic hair "1," sometimes called the submedian prothoracic hair, is of major importance in identifying anopheline larvae. This hair may be minute and simple, branched, feather-like or shaped like a palmate hair.

simple or frayed



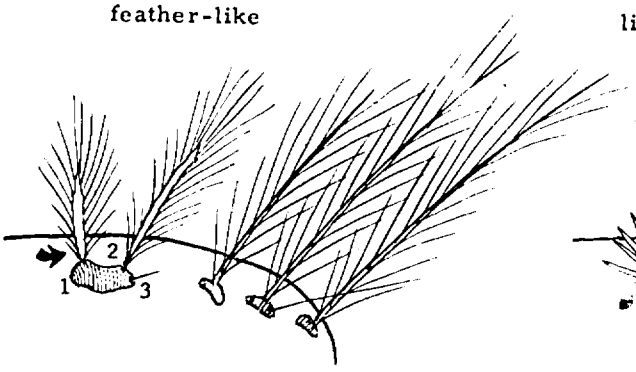
ANOPHELES QUADRIMACULATUS

branched



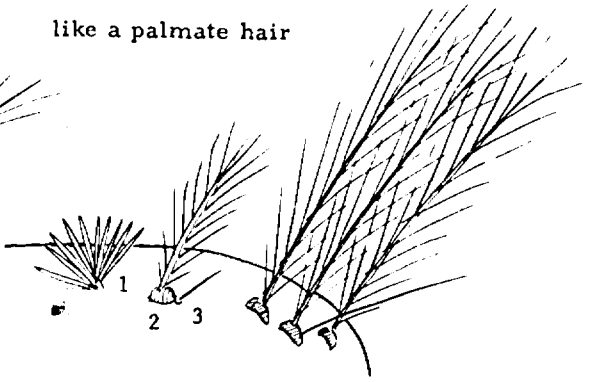
ANOPHELES BARBIROSTRIS

feather-like



ANOPHELES ALBIMANUS

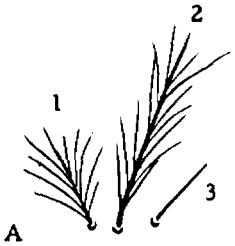
like a palmate hair



ANOPHELES AQUASALIS

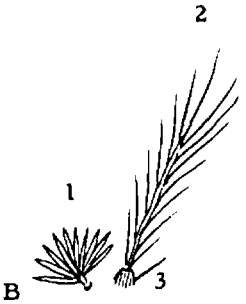
TEST YOURSELF: Match the following numbered statement with the lettered illustration.

1. Anopheles quadrimaculatus has the prothoracic hair 1 simple or frayed at tip..... ____



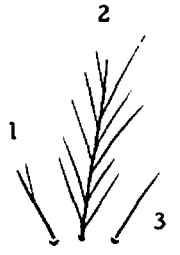
A

2. Anopheles albimanus has the prothoracic hair 1 feather-like and arising from a common tubercle with prothoracic hairs 2 and 3..... ____



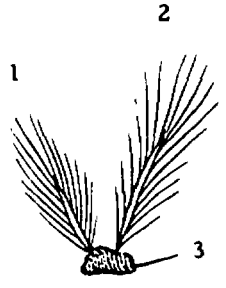
B

3. Anopheles aquasalis has the prothoracic hair 1 shaped as a palmate hair..... ____



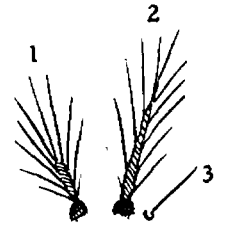
C

4. Anopheles gambiae has the prothoracic hair 1 branched and arising separately from prothoracic hairs 2 and 3..... ____



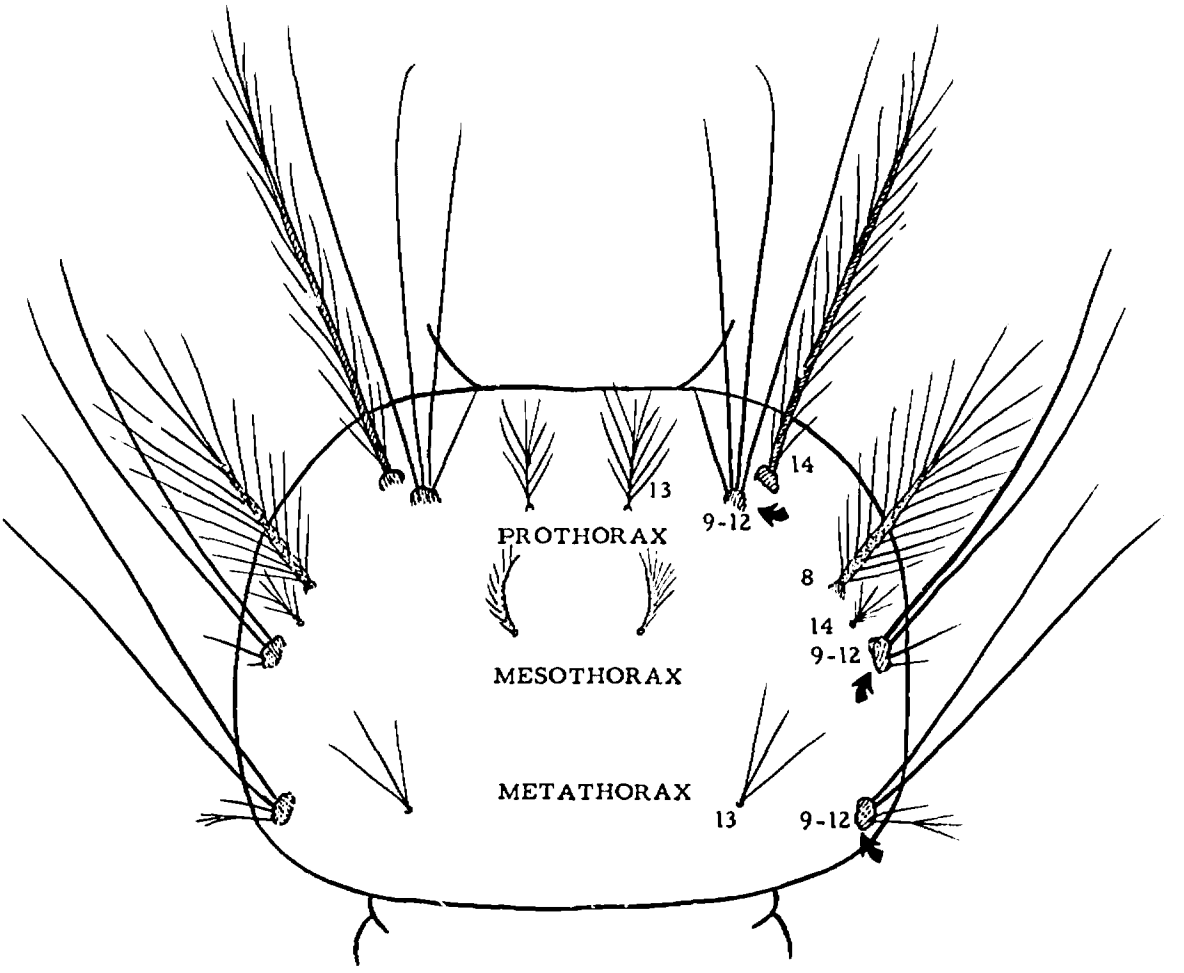
D

5. Anopheles minimus has the prothoracic hair 1 and 2 with heavy shafts and not arising from a common tubercle..... ____



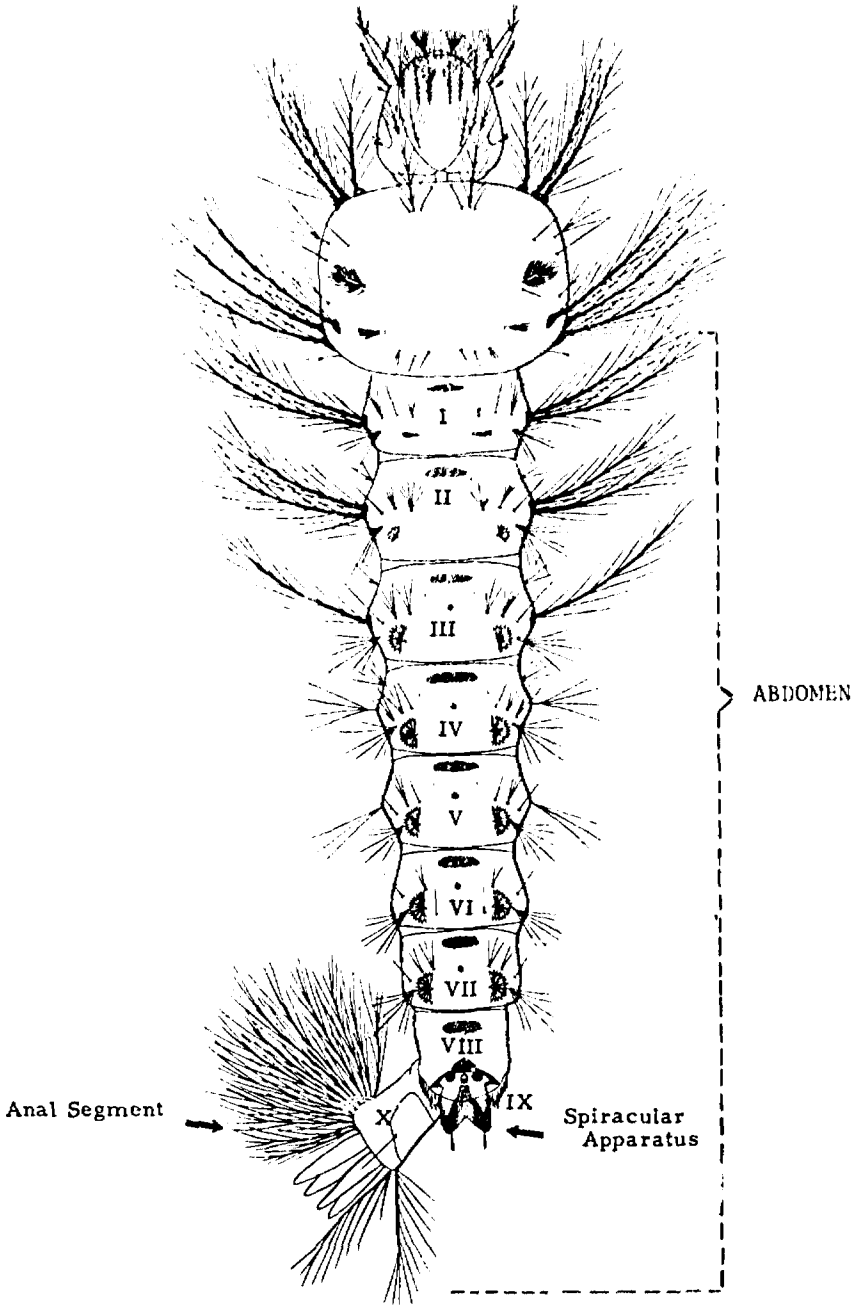
E

The pleural hai. are of great significance in separating the groups of Old World Anopheles. These consist of 3 groups of 4 hairs, Nos. 9-12, of varying sizes and branches arising from a common tubercle. The 3 pleural groups are called the prothoracic pleural group, mesothoracic pleural group, and metathoracic pleural group, after the 3 main parts of the thorax.

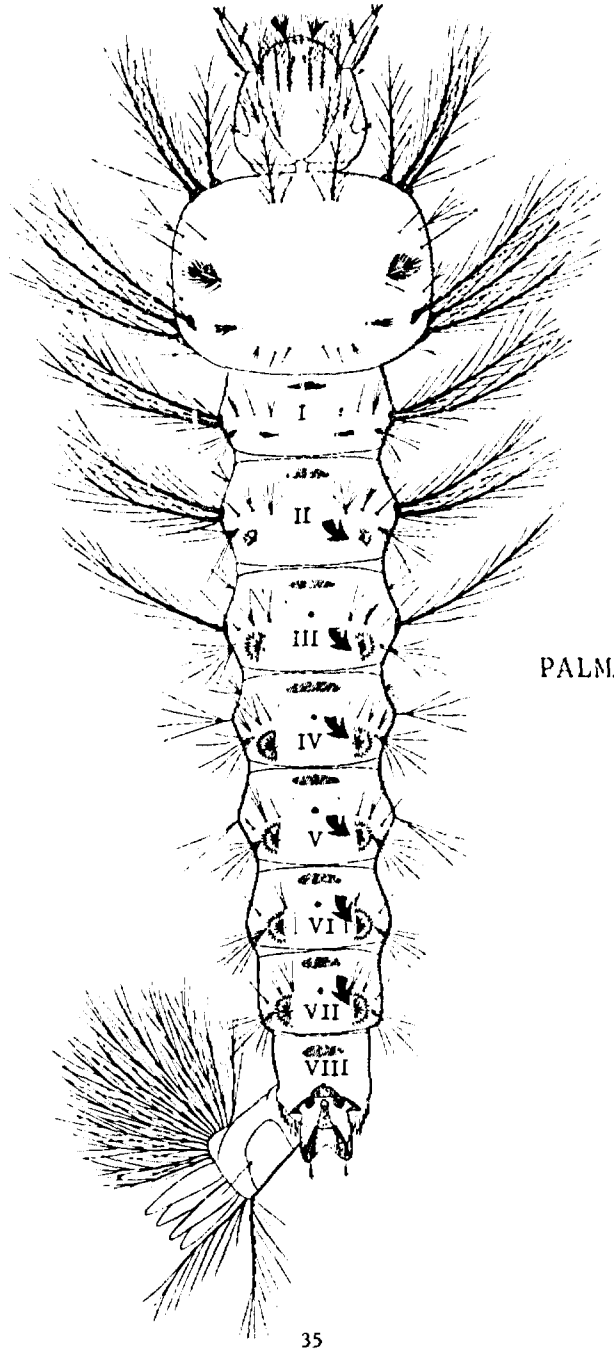


PLEURAL HAIRS OF THORAX

The third body region, the abdomen, is narrower than the thorax and is composed of 10 segments. The first 8 segments are separated from each other by well-defined constrictions. The ninth is much reduced and forms part of the spiracular apparatus. The tenth is cylindrical and forms the anal segment bearing a tergal plate, the caudal hairs and anal gills.



In dorsal view, the palmate hairs are among the most conspicuous structures on the anopheline abdomen. They appear like a pair of palm-like or fan-shaped structures, always well-developed on segments IV to VI and sometimes on segments I to VII. The number of well-developed palmate hairs is a good, easily-seen character to use in species identification.



PALMATE HAIRS

The palmate hairs are composed of leaflets that have a characteristic shape. Thus, the leaflets have the margins smooth, notched, or deeply notched. In the anopheline genus Chagasia, the individual leaflets are racquet-shaped. The individual leaflets have the margins smooth in most South American species of Anopheles (subgenus Nyssorhynchus), notched in many Anopheles (subgenus Anopheles), deeply notched in many Anopheles (subgenus Cellia), and hair-like on segments 1 or 2 of many Anopheles.

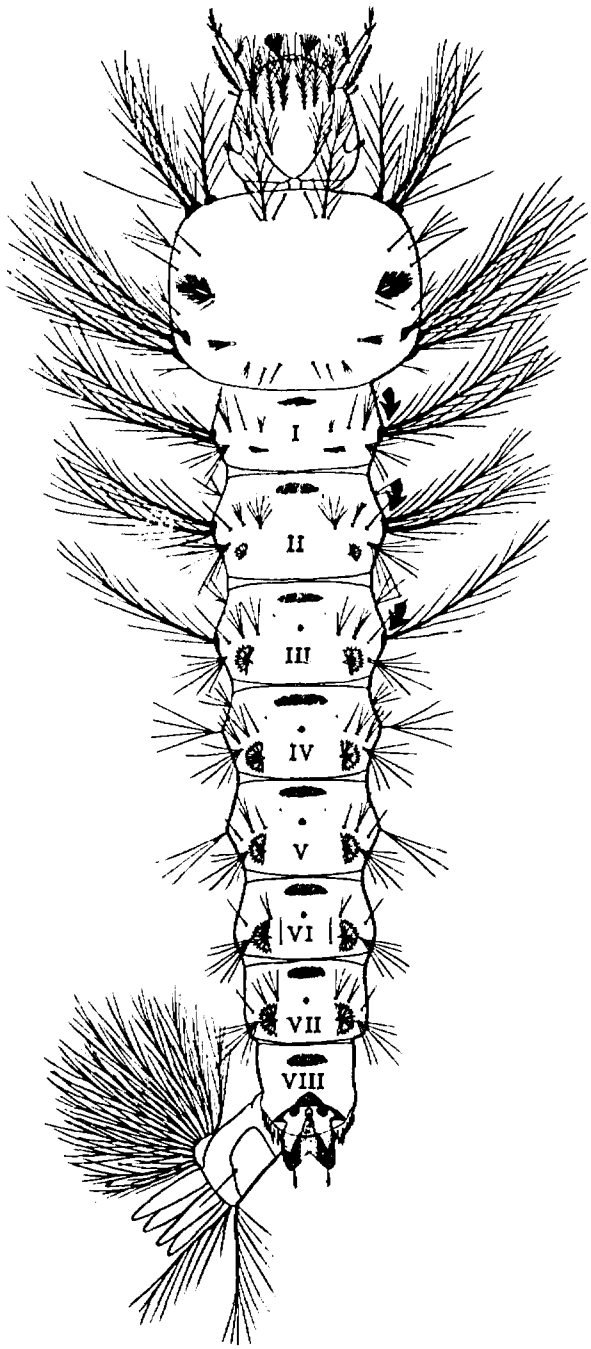
SMOOTH

NOTCHED

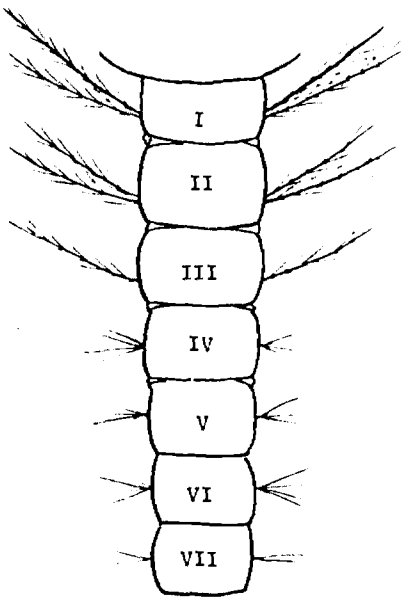
DEEPLY NOTCHED

HAIRLIKE

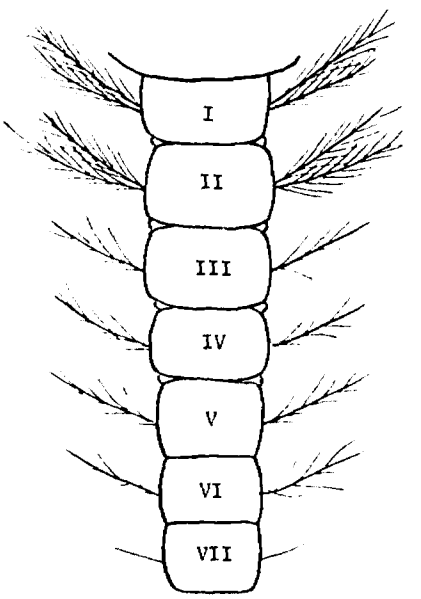
In most anophelines the first and second abdominal segments have two large fe .thery hairs, and the third has a single large feathery hair, on each side.



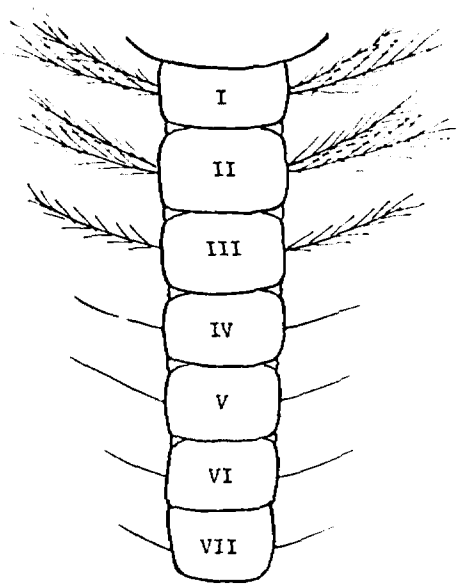
Usually the lateral hairs on the 4th to 7th segments are much more delicate than those on the first three, but some species have large feathery lateral hairs on the first 6 segments.



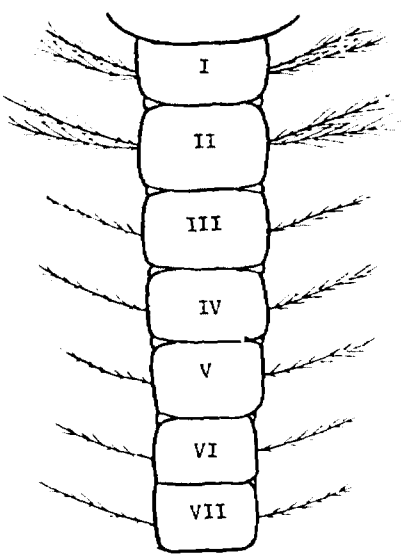
ANOPHELES QUADRIMACULATUS



ANOPHELES PSEUDOPUNCTIPENNIS

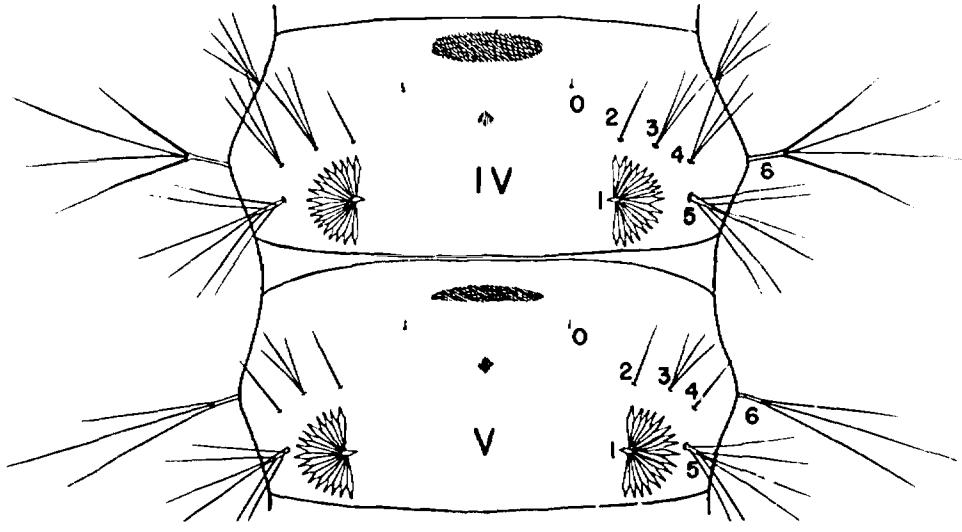


ANOPHELES ALBIMANUS

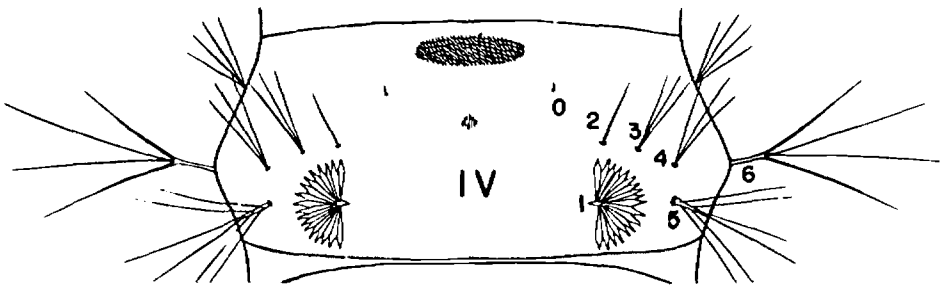


ANOPHELES BELLATOR

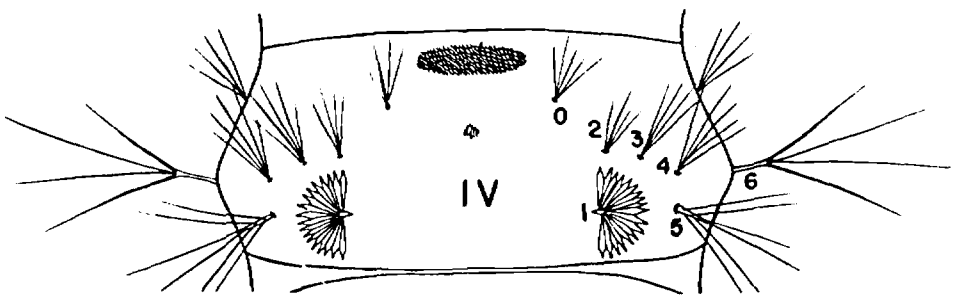
On the top, or dorsal, surface of typical anopheline larvae there are 6 hairs with such constant positions that they have been given definite numbers. In numbering these hairs, note that the left half of each segment is the mirror image of the right hand side. The palmate hair on each is the best landmark to use in numbering these hairs and is always considered the number "1" hair. Other hairs are given definite numbers from 0 to 6 starting near the anterior margin of each segment and working laterally and posteriorly.



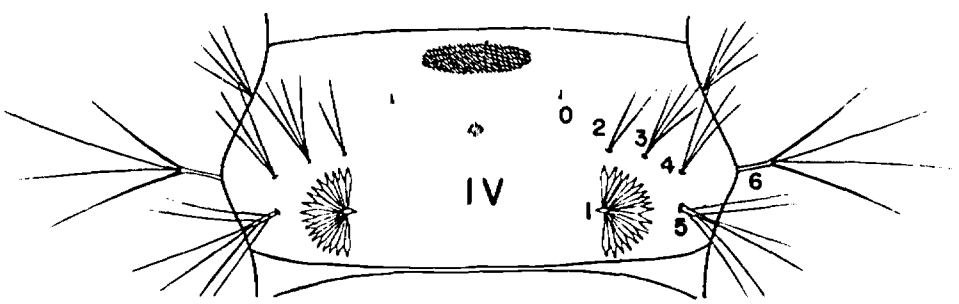
The number of branches in the number 0 and 2 hairs in front of the palmate hairs on the fourth and fifth abdominal segments are rather constant and of great importance in making species identification.



ANOPHELES QUADRIMACULATUS

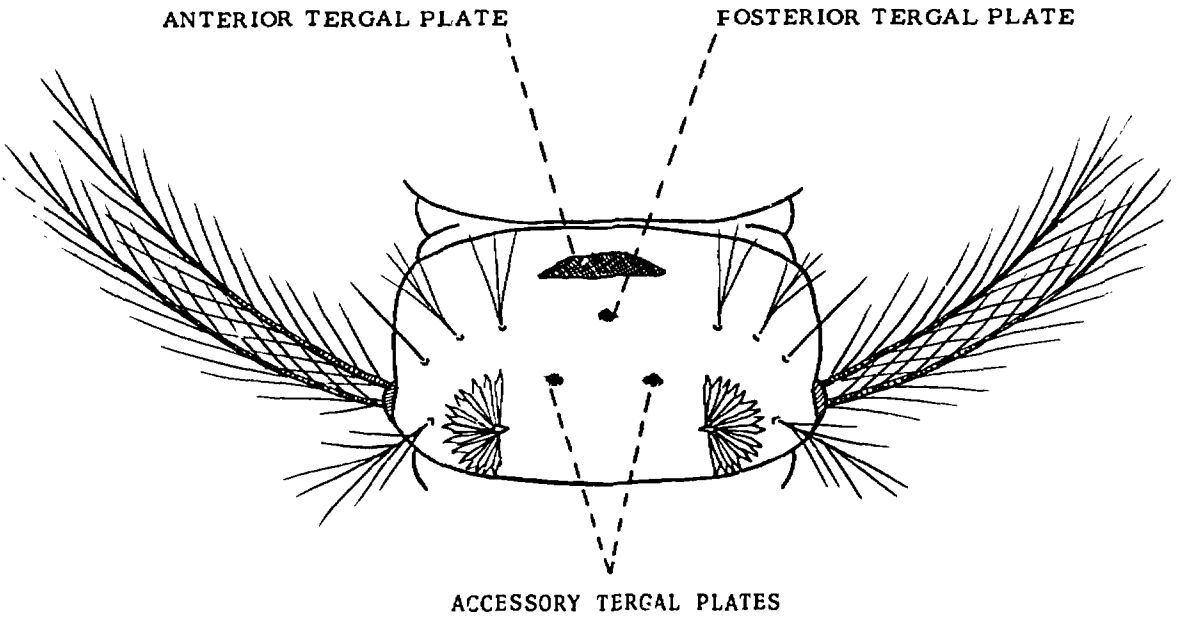


ANOPHELES CRUCIANS

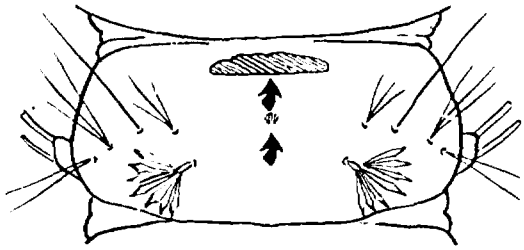


ANOPHELES PUNCTIPENNIS

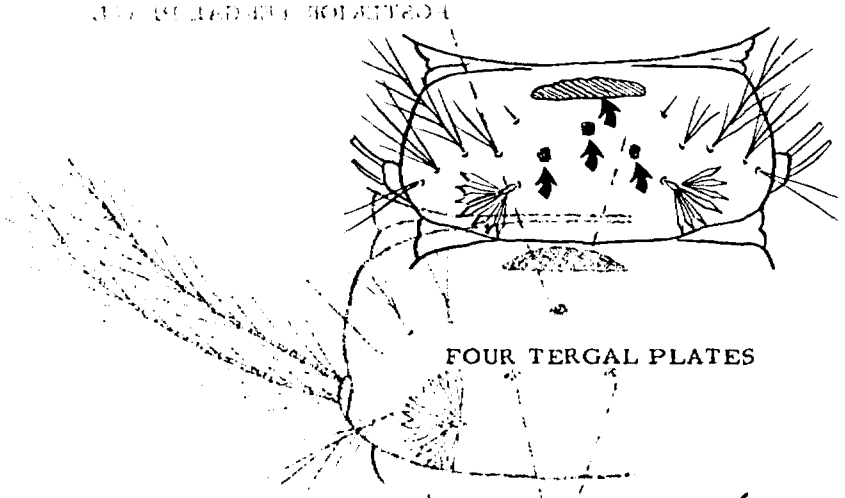
Each abdominal segment has hardened areas on the integument known as tergal plates. In typical forms there are four known as the anterior, posterior, and accessory tergal plates.



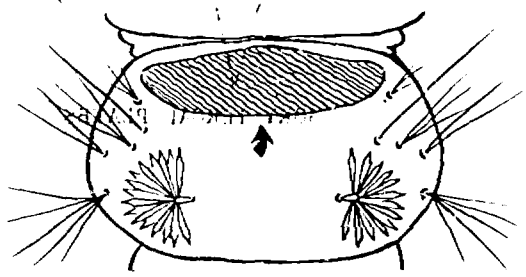
Many of the typical Anopheles have only two tergal plates, the anterior and the posterior, but other species have four. Some of the most important species, as Anopheles minimus, have one tergal plate greatly enlarged.



TWO TERGAL PLATES

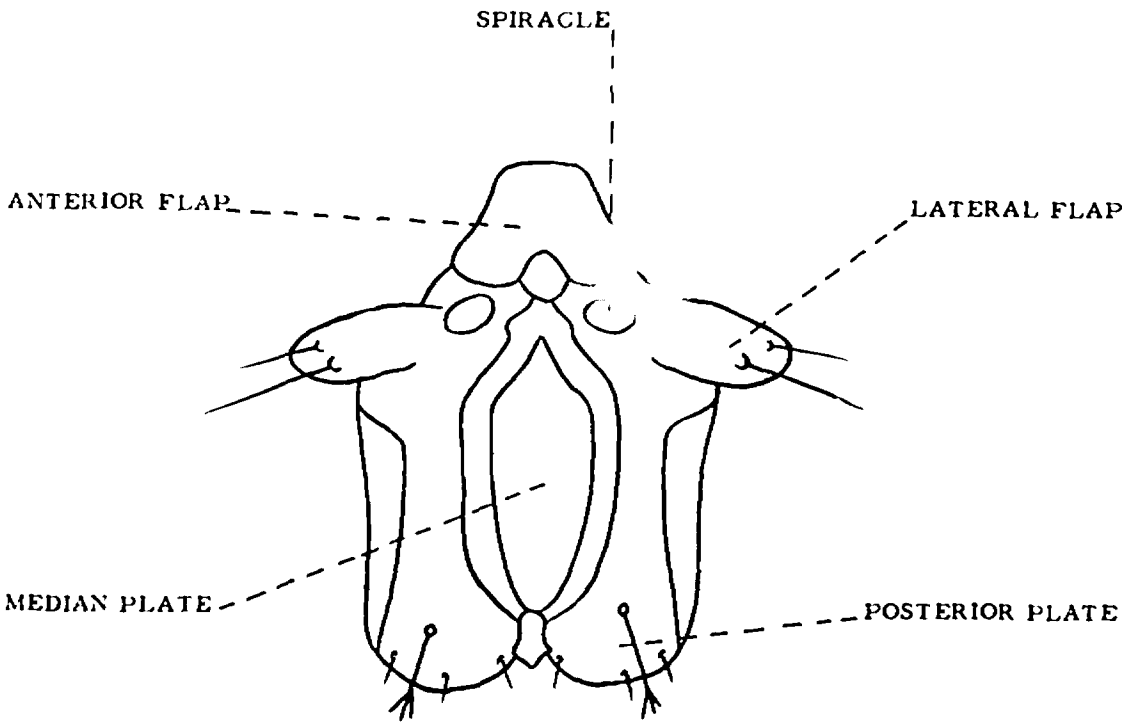


FOUR TERGAL PLATES



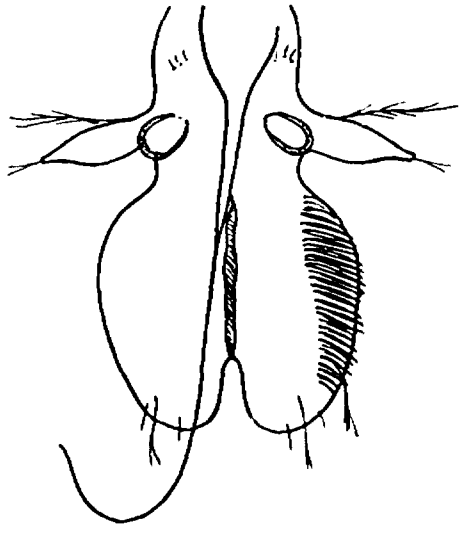
ONE TERGAL PLATE

The spiracular apparatus is composed of an anterior flap (the tergal plate of the 8th abdominal segment), a median plate, a posterior plate, and two lateral flaps. The two spiracles lie behind the anterior flap on either side of the anterior margin of the median plate.

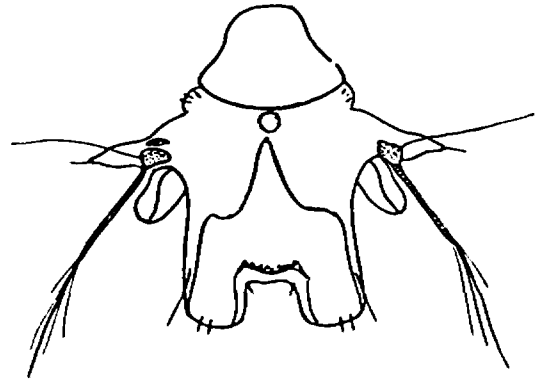


SPIRACULAR APPARATUS

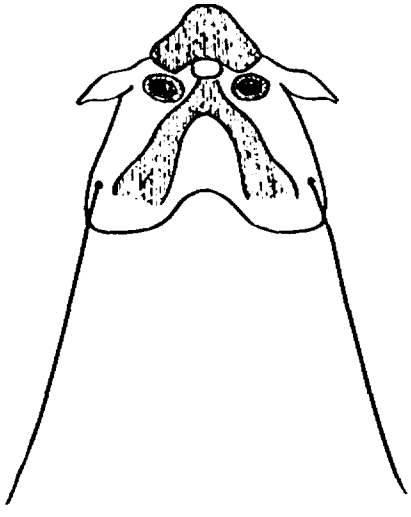
The spiracular apparatus is modified in a number of species. For example, the anterior flap is drawn out into a long tail in Chagasia bathanus. In Anopheles kompi the spiracles are widely separated and modified with a strong split bristle at each side. In Anopheles darlingi each lobe of the posterior plate bears a prominent pedicel and a long single hair. In Anopheles pseudopunctipennis each lobe of the posterior plate is drawn out into a "tail".



CHAGASIA BATHANUS



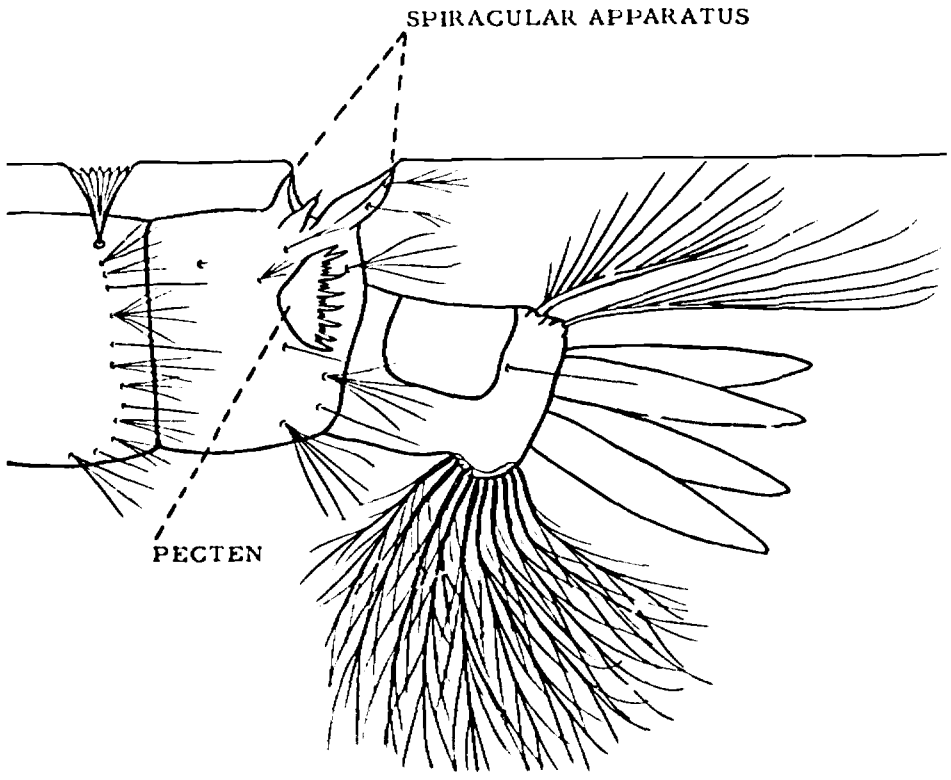
ANOPHELES KOMPI



ANOPHELES DARLINGI

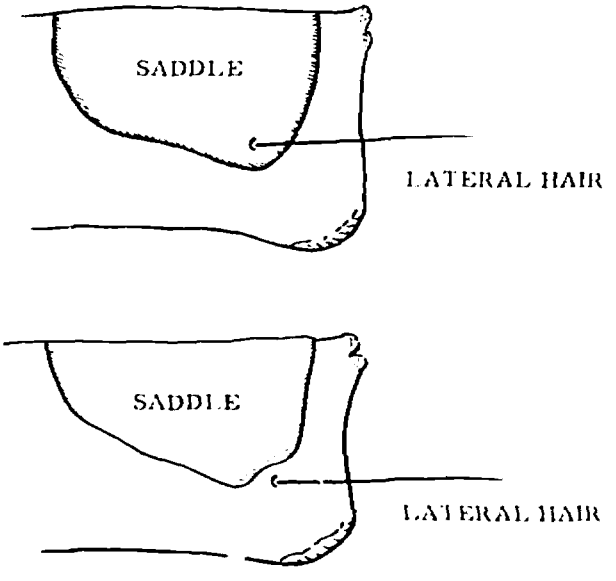
ANOPHELES PSEUDOPUNCTIPENNIS

Below the spiracular apparatus on each side lies the pecten, a somewhat triangular plate with teeth like a comb. In most species the teeth of the comb have an irregular arrangement, but in some there is a regular alternation of short and long teeth in the pecten and in some species all the teeth are equal.



IRREGULAR ALTERNATION REGULAR ALTERNATION ALL TEETH EQUAL

In many species the saddle hair arises from a socket or basal tubercle on the tergal plate, but in others the saddle hair arises from the membrane of the anal segment.

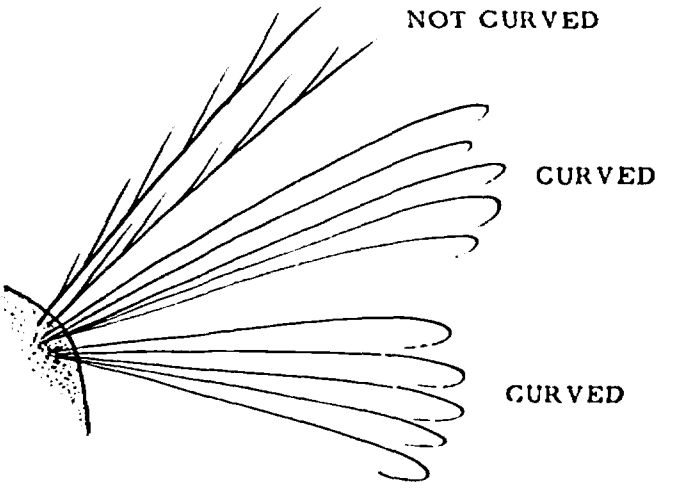


In a few species the lateral margins of the anal segment have setae which vary: in some with short, pointed tips; in others with furcate tips.

POINTED TIP

FURCATE TIP

The hairs on the anal segment are called the caudal hairs, from the Latin cauda for tail. These hairs normally do not vary greatly. However, in a few species, such as Anopheles culicifacies, the tips of the caudal hairs are curved.



CAUDAL HAIRS

PART III

Illustrated Key to Some Important Anopheles Larvae

Although there are some 300 described species of Anopheles, in most areas of the world only one or two species are primary vectors of malaria. An illustrated key to the larvae of some important Anopheles throughout the world is presented in the following pages. Use it to learn the characters necessary to identify the primary vectors in your area.

ILLUSTRATED KEY TO THE LARVAE OF SOME IMPORTANT ANOPHELES THROUGHOUT THE WORLD

Harry D. Pratt and C. J. Stojanovich

1. Palmate hairs of segment IV and V with smooth leaflets (Fig. 1A). . . . 2

   Palmate hairs of segments IV and V with leaflets which have notched or jagged margins (Fig. 1B) 5

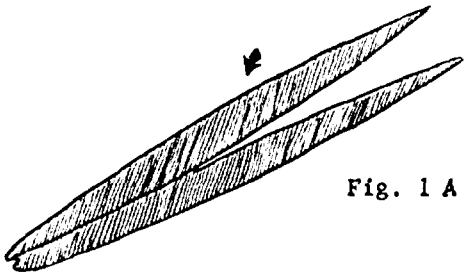


Fig. 1 A

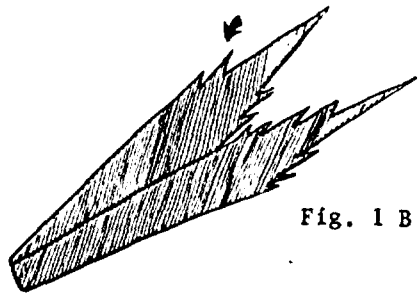


Fig. 1 B

2. No. 1 prothoracic hair with a thickened shaft, feather-like . . . . . (Fig. 2A) . . . . . Anopheles albimanus (Central and South America)

   No. 1 prothoracic hair like a palmate hair or many-branched hair . . . . (Fig. 2B) 3

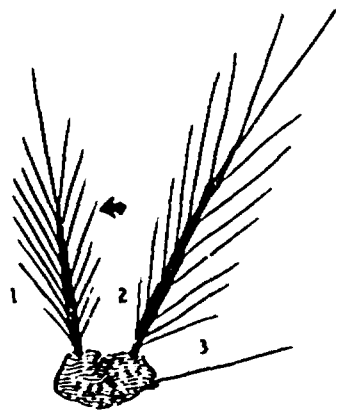


Fig. 2 A

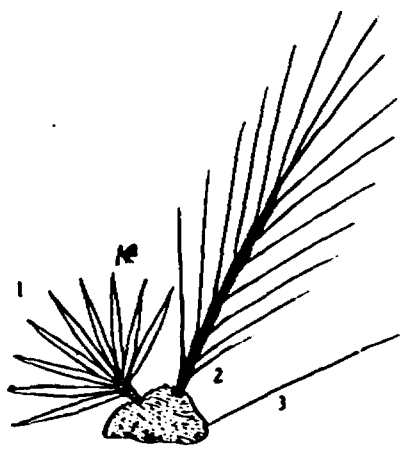


Fig. 2 B

3. Spiracular apparatus with 2 long hairs (Fig. 3A) . . . . . Anopheles darlingi (Central and South America)

Spiracular apparatus with 6 short hairs (Fig. 3B). 4

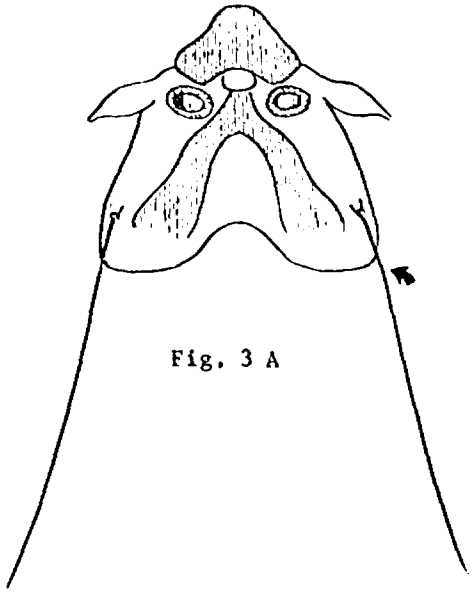


Fig. 3 A

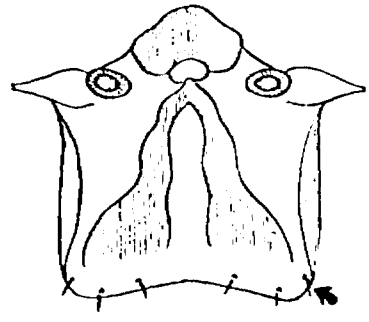


Fig. 3 B

4. Inner clypeal hairs bare; outer clypeal hairs with short branches . . . (Fig. 4A). . . . Anopheles albitarsis (Central and South America)

Inner clypeal hairs with short branches; outer clypeal hairs with long branches (Fig. 4B). .Anopheles aquasalis (Central and South America)

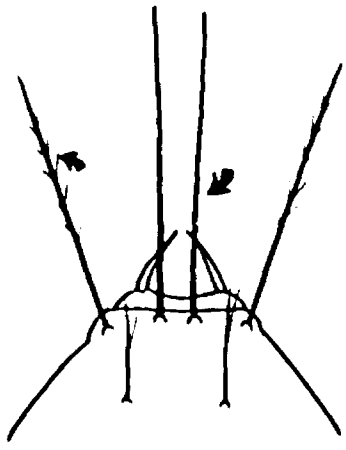


Fig. 4 A

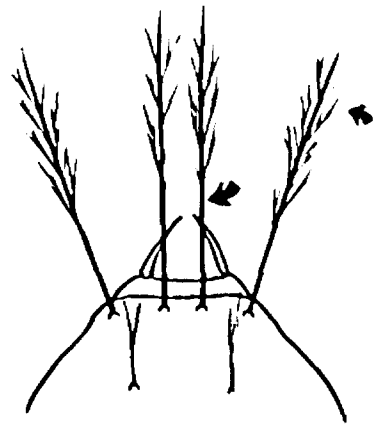


Fig. 4 B

5. Frontal hairs single, unbranched (Fig. 5A) . . . . . Anopheles bellator (Central and South America)

Frontal hairs branches, feather-like (Fig. 5B) 6

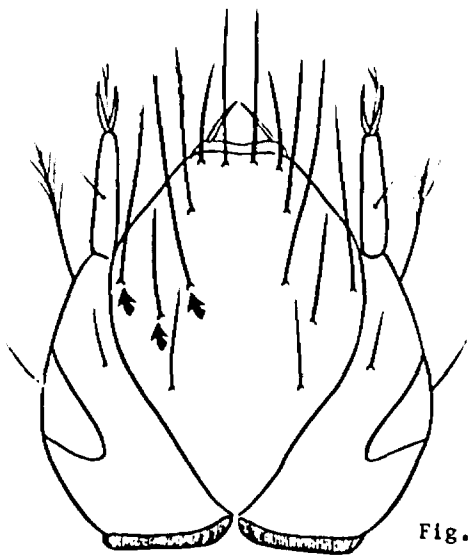


Fig. 5 A

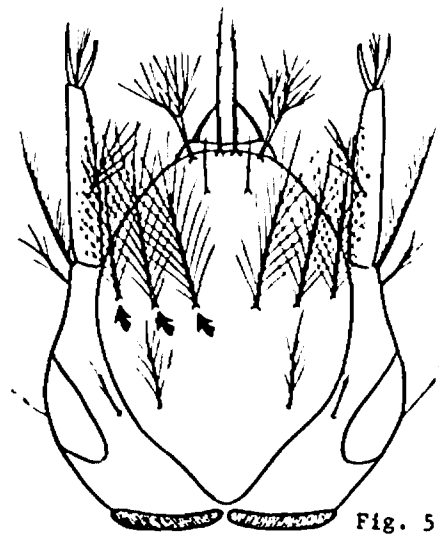


Fig. 5 B

6. Basal tubercles of inner clypeal hairs more widely separated than distance between basal tubercles of inner and outer clypeal hairs on one side; antennal hair single, arising on outer side of antennal shaft (Fig. 6A) 13

Basal tubercles of inner clypeal hairs closer together than basal tubercles of inner and outer clypeal hairs on one side; antennal hairs usually branched, sometimes single, arising on inner side of antennal shaft (Fig. 6B) 7

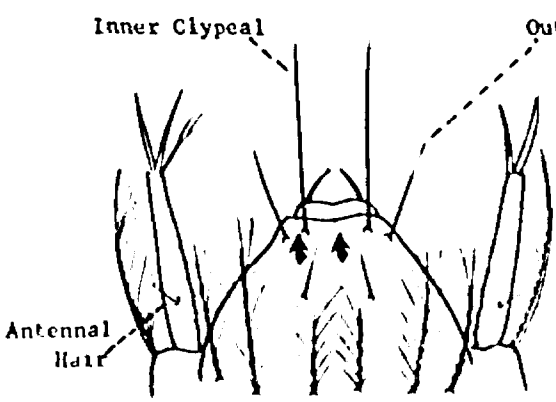


Fig. 6 A

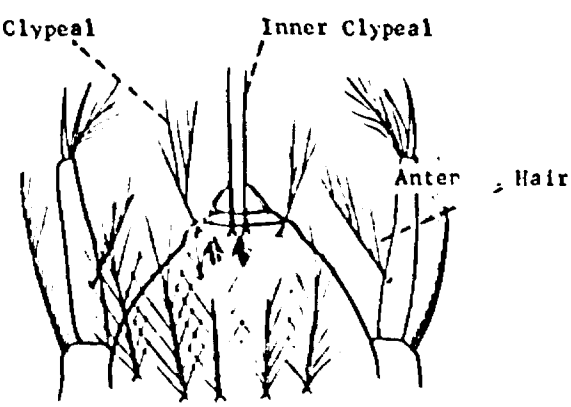


Fig. 6 B

7. Outer clypeal hairs single; spiracular apparatus with two long tails (Figs. 7A and 7B) . . . . *Anopheles pseudopunctipennis* (North, Central, South America)

Outer clypeal hairs branched; spiracular apparatus normal or without two long tails (Figs. 7C and 7D) 8

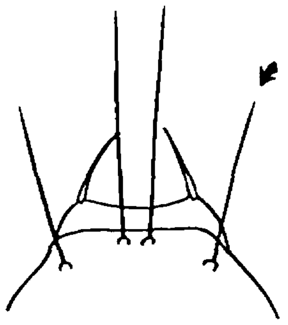


Fig. 7 A

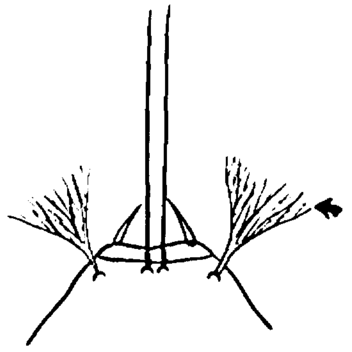


Fig. 7 C

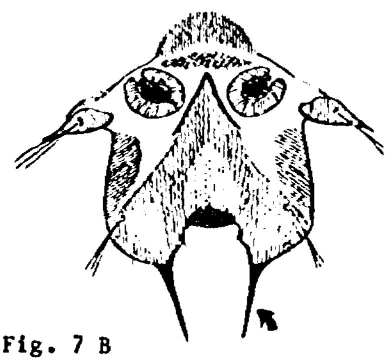


Fig. 7 B

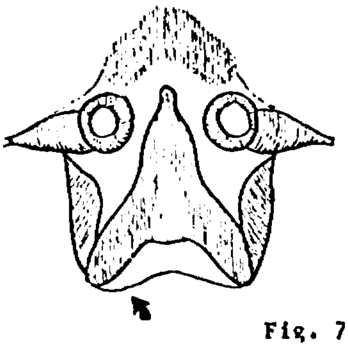


Fig. 7 D

8. Outer clypeal hairs with 5-10 branches (Fig. 8A) . . . . *Anopheles umbrosus* (Asia)

Outer clypeal hairs with 15 or more branches (Fig. 8B) 9

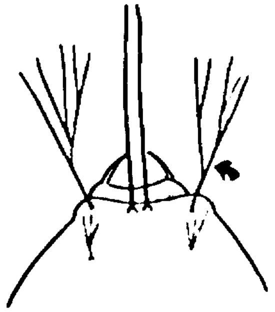


Fig. 8 A

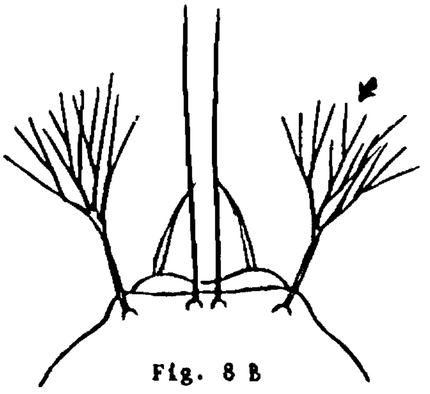


Fig. 8 B

9. No. 1 prothoracic hair with branches arising very near base . . . . (Fig. 9A) . . . . . Anopheles barbirostris (Asia)

No. 1 prothoracic hair single or with tip divided into several branches (Fig. 9B). 10

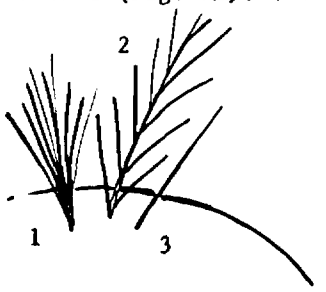


Fig. 9 A

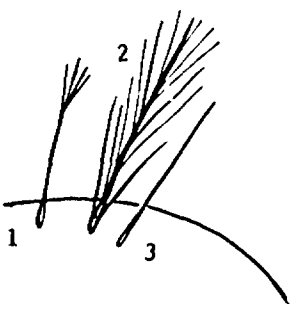


Fig. 9 B

10. Inner clypeal hairs forked or divided into several branches . . . . (Fig. 10A) . . . . . Anopheles maculipennis and allies (Eurasia)

Inner clypeal hairs single (Fig. 10B) 11

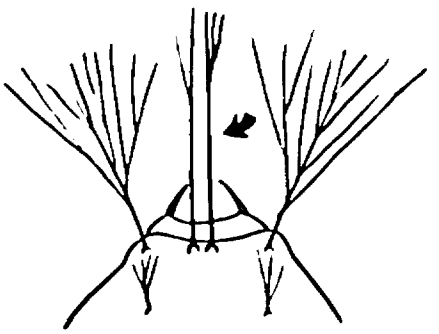


Fig. 10 A

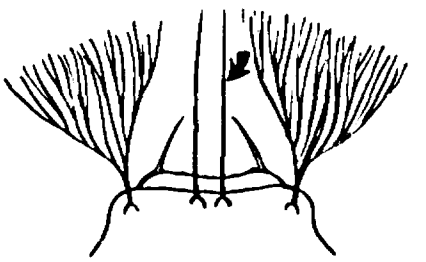


Fig. 10 B

11. Inner clypeal hairs separated by at least the width of basal tubercle of one hair(Fig. 11 A) . Anopheles quadrimaculatus (North America)

Inner clypeal hairs set closely together, separated by less than width of basal tubercle of one hair (Fig. 11B) 12

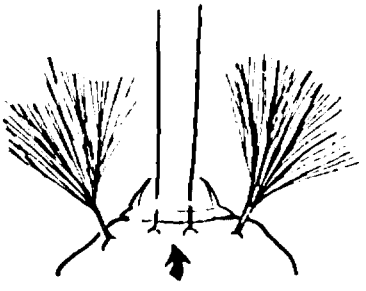


Fig. 11 A

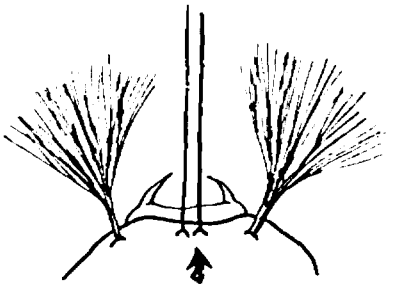


Fig. 11 B

12. Antennal hair arising near middle of antennal shaft (Fig. 12A) . . . . . Anopheles hyrcanus (Eurasia)

Antennal hair arising before middle of antennal shaft (Fig. 12B) . . Anopheles freeborni (North America).

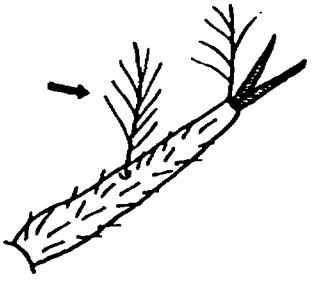


Fig. 12 A

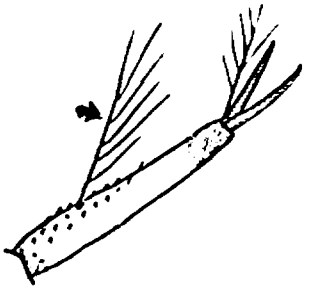
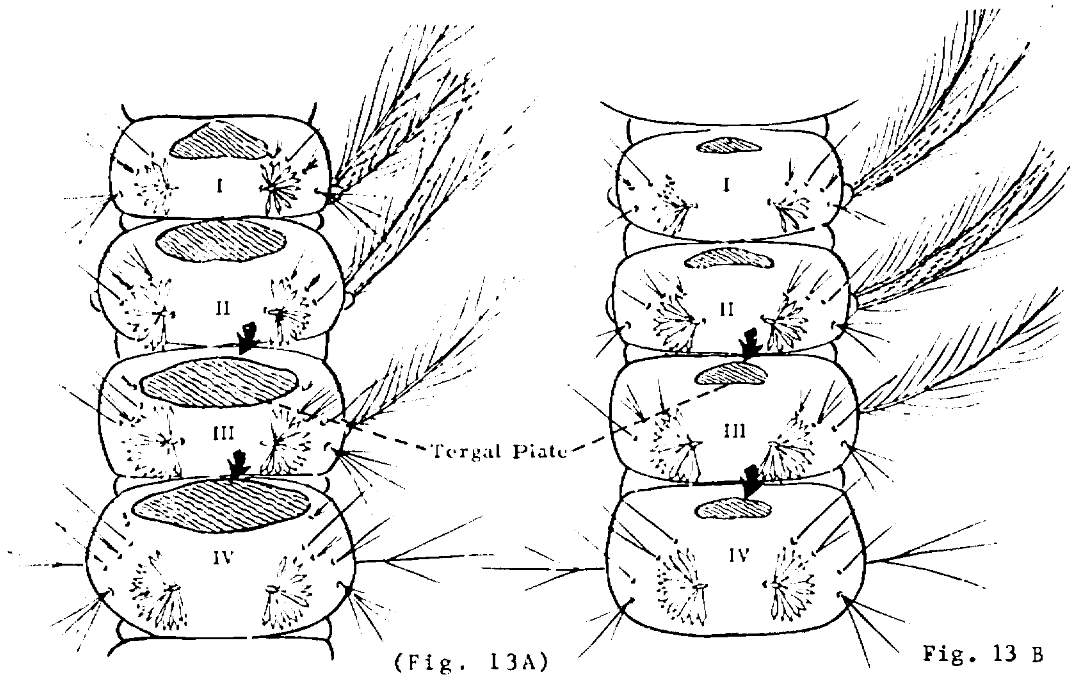


Fig. 12 B

13. Abdominal segments III-VII with very large anterior tergal plates, often more than half width of abdominal segment (Fig. 13A) 14

Abdominal segments III-VII with anterior tergal plates smaller, less than half width of abdominal segment (Fig. 13B) 17



(Fig. 13A) Fig. 13 B

14. Inner and outer clypeal hairs feathered (Fig. 14A). . . . . *Anopheles aconitus* (Asia)

Inner and outer clypeal hairs simple (Fig. 14B) 15

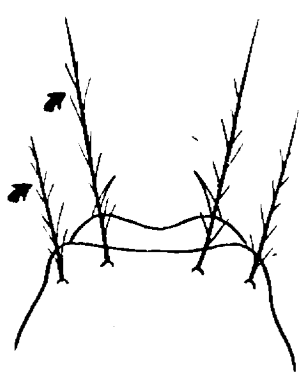


Fig. 14 A

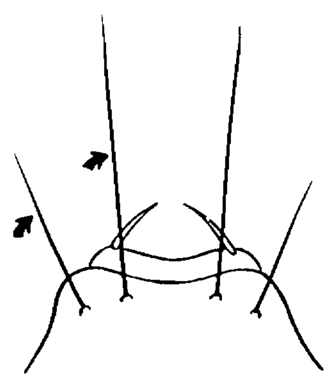


Fig. 14 B

15. Hair O arising on tergal plates II-VII (Fig. 15A) . . . . . Anopheles funestus (Africa)

Hair O not arising on tergal plates II-VII (Fig. 15B) 16

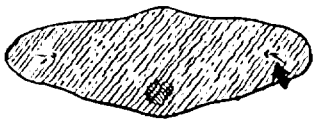


Fig. 15 A

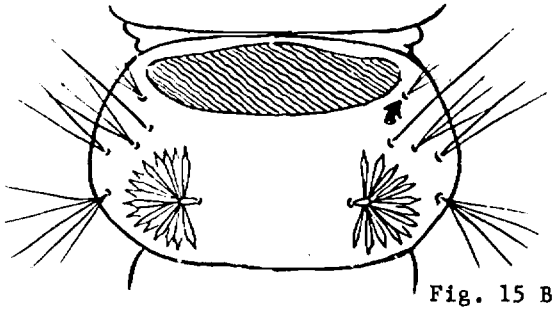


Fig. 15 B

16. Abdominal segments III-VII with large anterior tergal plate and 2 small posterior plates (Fig. 16A) . Anopheles fluviatilis (Asia)

Abdominal segments III-VII with large anterior tergal plate only (Fig. 16B) . . . . . .Anopheles minimus (Asia)

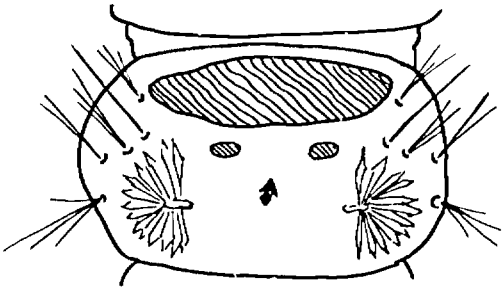


Fig. 16 A

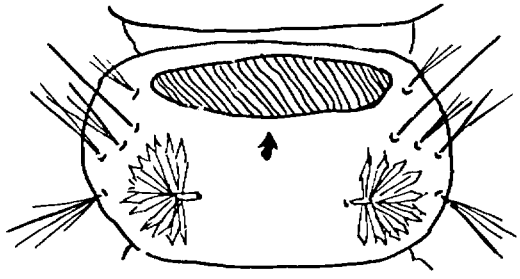


Fig. 16 B

17. Outer clypeal hairs densely branched (Fig. 17A) . . . . . Anopheles pharoensis (Africa)

Outer clypeal hairs simple, feathered, or frayed (Fig. 17B & 17C) . . . 18

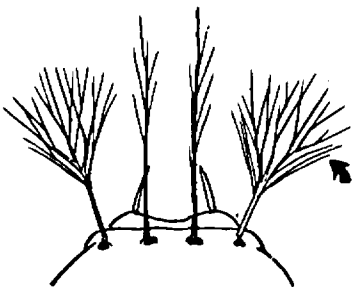


Fig. 17 A

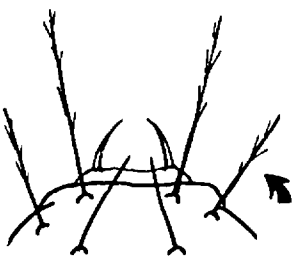


Fig. 17 B

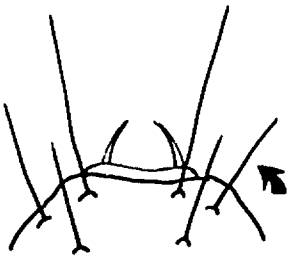


Fig. 17C

18. Palmate hairs on segment II weakly developed, about equal to palmate hairs on Segment I (Fig. 18A). . . . Anopheles balabacensis (Asia)

Palmate hairs on segment II fairly well developed, definitely larger than palmate hairs on Segment I (Fig. 18B). 19

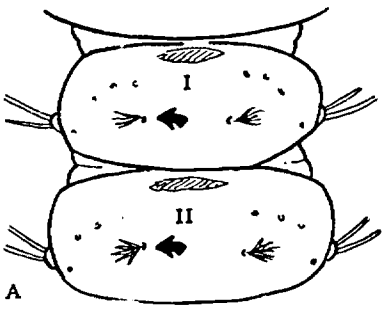


Fig. 6 A

Fig. 18 A

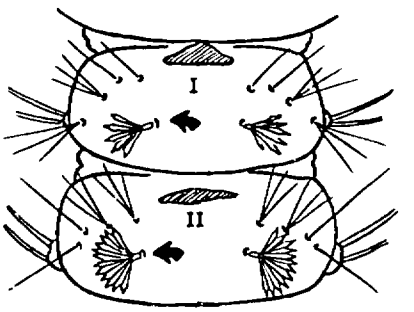


Fig. 6 B

Fig. 18 B

19. Palmate hair on abdominal segment I with broad leaflets (Fig. 19A). . . 20
Palmate hair on abdominal segment I with hair-like leaflets (Fig. 19B). 21

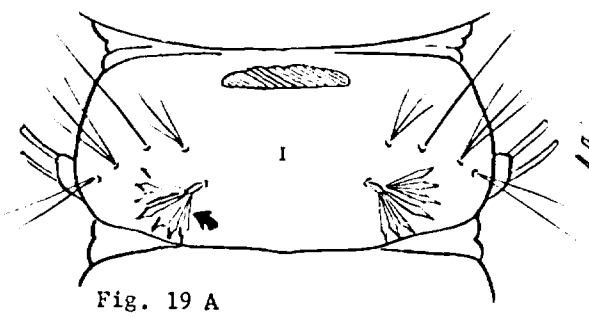


Fig. 19 A

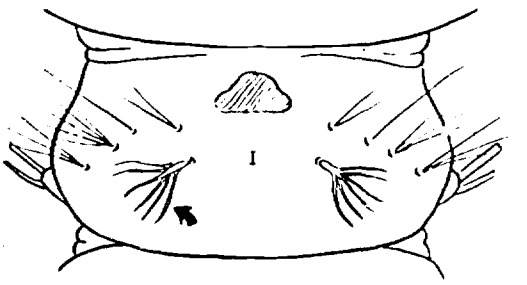


Fig. 19 B

20. Ends of branches of outer submedio-dorsal caudal hairs curved, hook-like (Fig. 20A). . . . . Anopheles culicifacies (Asia)
Ends of branches of outer submedio-dorsal caudal hairs straight (Fig. 20B) . . . . . Anopheles farauti (South Pacific)

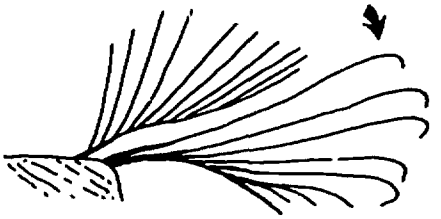


Fig. 20A

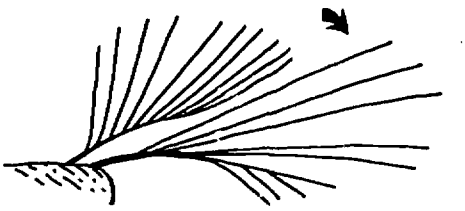


Fig. 20B

21. No. 1 prothoracic hair not arising from a tubercle (Fig. 21A) . . . . . Anopheles gambiae (Africa)

No. 1 prothoracic hair arising from a tubercle (Figs. 21B or 21C). . . .22

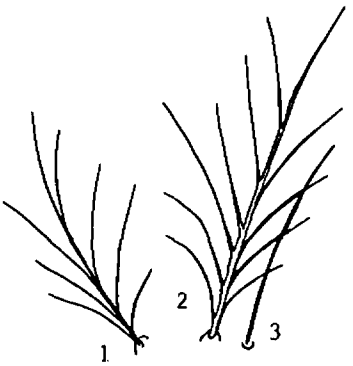


Fig. 21A

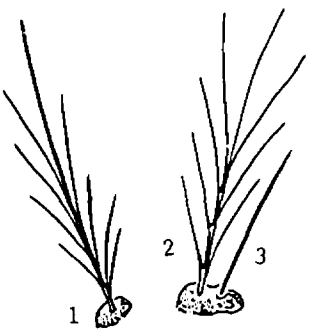


Fig. 21B

Fig. 21C

22. Filament of palmate hairs on abdominal segments IV and V more than half the length of blade (Fig. 22A) 23

Filament of palmate hairs on abdominal segments IV and V half or less than half as long as blade (Fig. 22B) 24

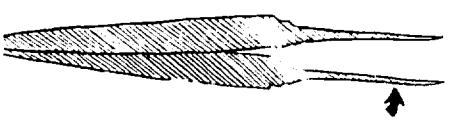


Fig. 22A

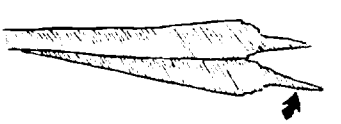


Fig. 22B

23. Usually associated with fresh-water upland streams . . . . . .
. . . . . Anopheles superpictus (Eurasia)

Usually associated with brackish water swamps, fishponds, or rice fields..
. . . . . Anopheles sundaicus (Asia)

Larvae not always separable. Well marked specimens separated as follows:

24. Outer and inner clypeal hairs finely feathered (Fig. 24A). . . . . .
. . . . . Anopheles maculatus (Asia)

Outer clypeal hairs always simple, inner clypeal hairs usually simple (Fig. 24B) . . . . . Anopheles stephensi (Asia)

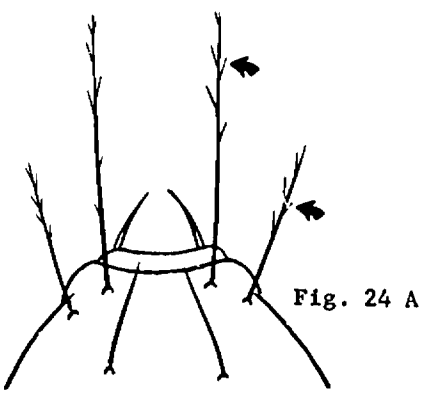


Fig. 24 A

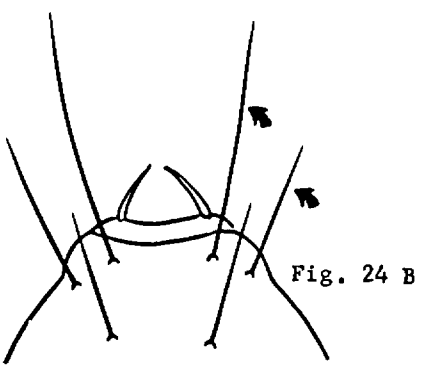


Fig. 24 B

GLOSSARY

abdomen - third body region, p. 15

accessory tergal plate - small, paired plates behind anterior or posterior tergal plates on abdominal segments, p. 41

adult - the fourth stage in mosquito development, p. 1

air tube - a tubular structure present in culicine mosquito larvae, p. 6

anal segment - the tenth abdominal segment, with the alimentary canal emptying through the anus; hence the term anal segment, p. 34

anopheline - malarial mosquito (from the genus name Anopheles), p. 6, 8

antenna - a tubular structure on each side of the head, the "feeler", p. 27

anterior flap - the anterior plate on the spiracular apparatus, p. 43

anterior tergal plate - the large anterior plate on each abdominal segment, p. 41

basal hair - hair 12 behind antenna, p. 28

caudal hair - hairs on the anal segment, p. 47

culicine - non-malarial mosquito related to Culex, p. 6, 11

dorsal saber - the top, or dorsal, pointed structure at tip of the antenna, p. 27

egg - the first stage in mosquito development, p. 1

frontal hair - one of a group of 6 hairs, Nos. 5, 6, 7, located on middle of dorsal surface of head, p. 25, 28

head - first body region, p. 15

inner clypeal hair - hair 2 near middle of anterior margin of clypeus, p. 17, 28

inner frontal hair - hair 5, the middle pair of frontal hairs, p. 28

inner preclypeal hair - hair 1, one of a pair of spine-like hairs on anterior margin of head, arising from labrum, p. 17, 28

larva - the second stage in mosquito development, p. 1

lateral hair - a hair on the side, as of abdomen or anal segment, p. 47

leaflet - one element of a palmate hair, p. 36

median plate - the middle plate of the spiracular apparatus, p. 43

mesothorax - the second part of the thorax, p. 30

metathorax - the third part of the thorax, p. 30

middle frontal hair - hair 6, p. 28

mouth brush - a brush of hairs arising on either side of the mouth under the outer clypeal hairs, p. 18

occipital hairs - Nos. 8 and 9, p. 28

orbital hair - hair 14, p. 28

outer clypeal hair - the lateral pair of hairs on anterior margin of clypeus at anterior end of head, No. 3, p. 17, 28

palmate hair - float hair, shaped like palm of hand or a palm frond, located on thorax or abdomen, p. 6

pecten - a comb-like structure on each side of spiracular apparatus, p. 45

pleural group - one of 3 groups of hairs, Nos. 9-12, arising from common tubercles on underside of thorax, p. 33

postclypeal hair - hair 4, behind the inner clypeal hair, near anterior end of head, p. 17, 28

posterior plate - one of a pair of plates on posterior end of spiracular apparatus, p. 43

posterior tergal plate - the small rounded plate on some abdominal segments, behind anterior tergal plate, p. 41

preclypeal hairs - one of a pair of hairs on the clypeus, hair 1, p. 17, 28

prothorax - the first part of the thorax, p. 30

pupa - the third stage in mosquito development, p. 1

shaft - the tubular part of the antenna, p. 27

spiracle - one of two circular openings of respiratory system on spiracular apparatus, p.43

spiracular apparatus - the group of plates surrounding the spiracles near tip of abdomen, p. 34, 43

sub-basal hair - hair 13 on the side of head behind antenna, p. 28

submedian prothoracic hair - No. 1 prothoracic hair, nearest mid-line along anterior margin of thorax, p. 30, 32

sutural hair - hair 8, mesal to suture on head, p. 26, 28

tail - a slender, hardened extension of posterior plate of spiracular apparatus, p. 44

tergal plate - a hardened plate on the dorsal surface of abdominal segment, p. 41, 42

terminal antennal hair - hair 10 at tip of antenna, p. 27, 28

thorax - the second main region of body, p. 15

trans-sutural hair - hair 9, lateral to suture on head, p. 26, 28

ventral saber - the ventral pointed structure at tip of antenna, p. 27

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