Aedes aegypti Handbook Series No. 2

Harry D. Pratt - Kent S. Littig - Milton E. Tinker

ENTOMOLOGICAL HANDBOOK FOR AEDES AEGYPTI ERADICATION

Preliminary Issue
September 1966

U. S. Department of Health, Education, and Welfare
Public Health Service
Communicable Disease Center
Aedes aegypti Eradication Branch
Atlanta, Georgia 30333

ENTOMOLOGICAL HANDBOOK FOR AEDES AEGYPTI ERADICATION

CONTENTS

ILLUSTRATIONS

3/8/91 James Stewart Gratis IC

INTRODUCTION

Eradication of an insect from a large geographical area is a most difficult entomological accomplishment. Moderately effective measures often suffice to reduce insect populations to an inoffensive level, but eradication requires a sharpening and enlarging of all abatement activities. Therefore the *Aedes aegypti* eradication program requires sincere devotion to duty and the best efforts of well trained, alert workers. This handbook provides the professional worker with information about this mosquito, its identification, significant habits, and the equipment and techniques used to seek out infestations, take and preserve samples, and identify the specimens.

As mosquito populations are reduced, the task of the field inspector becomes increasingly more difficult and the role of identifications becomes even more significant in verifying eradication. The able supervisory inspectors and taxonomists will not confine their studies solely to this handbook, but will seek out and study other references, and will strengthen their abilities with field observations that may disclose new knowledge significant to the Program.

DISTRIBUTION

Distribution of *Aedes aegypti* in the Americas is shown in Figure 1, which also indicates the countries where eradication has been completed. Distribution in the United States is limited to the Gulf States and adjacent states where it is disseminated during the summer (Figure 2). Overwintering occurs in the southern portions of the infested area, and possibly in mother foci somewhat farther northward.

In the United States the yellow fever mosquito is considered to be the type form *Aedes aegypti aegypti* and will be referred to simply as *Aedes aegypti* in this Handbook. *Aedes aegypti* is basically a tropical and subtropical mosquito. Freezing temperatures of short duration are harmless to the eggs, but eggs kept below 17°F. for 2 days usually fail to hatch. In the southern United States, where abundant larval sites exist, factors limiting abundance are: (1) frequency of rainfall, (2) duration of winter, (3) the presence of foci, and (4) the prevalence of containers.

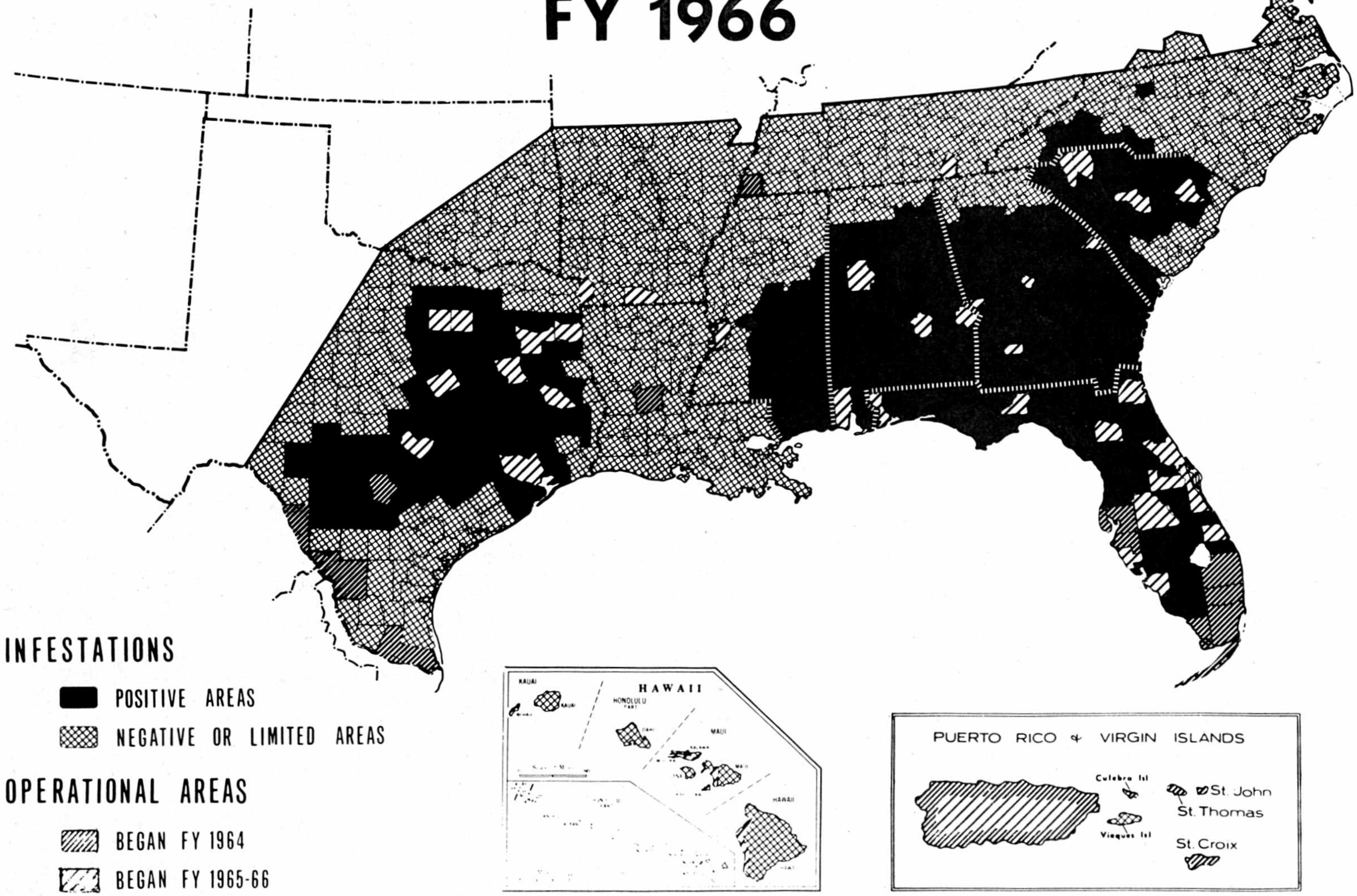
Figure 1.

STATUS OF THE AEDES AEGYPTI ERADICATION CAMPAIGN
DECEMBER 1965

* ERADICATION CARRIED OUT ACCORDING TO THE STANDARDS ESTABLISHED BY THE PAN AMERICAN HEALTH ORGANIZATION

Figure 2.

STATUS of Aedes aegypti Eradication Program FY 1966



U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE, Public Health Service, Communicable Disease Center

Larvae survive moderate winters where the temperature of the water is not often or long below 45°F. Adults are inactive at 50°F. In severe winters, the species survives in "mother foci" in cisterns and other protected water containers. Additional winter inspections and tests may confirm overwintering in Atlanta and other cities that experience much subfreezing weather.

BIOLOGY AND HABITS OF AEDES AEGYPTI

The *Aedes aegypti* eradication program is based primarily on three habits of the mosquito:

1. EGG-LAYING takes place only in water-holding containers, and development of the larvae, pupae, and adults may be prevented by focusing insecticidal applications on these breeding places, or by eliminating them.

2. FEEDING by the female adult is almost entirely on man, thus largely restricting this species to populated areas, especially to cities.

3. FLYING is normally for short distances, about 25 to 100 yards, which makes it practicable to use the city block as a unit in inspection and eradication operations.

Therefore, it is essential to have an understanding of the biology and significant habits of the yellow fever mosquito in order to plan and implement an effective eradication program.

LIFE CYCLE

The life cycle (Figure 3) is the circuit of development of the mosquito through the egg, larva, pupa, and adult stages. The life span refers to the length of its life in days, weeks, or months. Whereas a life cycle may occur in less than 2 weeks, the life span or longevity of the insect may be more than a month, beginning with the hatching of the egg and ending with the death of the adult.

THE EGG STAGE

The egg stage (Figure 3) enables the female to place large numbers of her progeny in a variety of locations favorable for their development. The egg is resistant to short periods of cold weather that would kill other stages. Within an hour or two after it is laid the *Aedes aegypti* egg shell darkens and becomes less permeable to water. There is a cuticle secreted within the egg shell 16-17 hours after deposition that greatly increases its permeability to water and its dissolved salts.

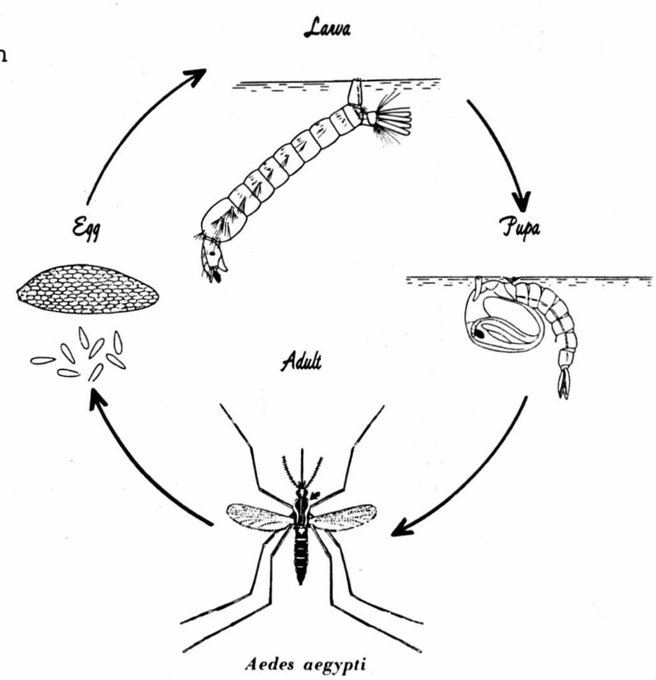


Figure 3. Life Cycle of *Aedes aegypti*

It is able to survive the drying out of breeding sites. Eggs may hatch many months later when moisture and temperature conditions are favorable for development. Insects and other animals that are oviparous (egg laying), such as most fish, are much more prolific than animals that are viviparous, or bring forth living young at a much more advanced state of development.

Egg-laying Sites

Figure 4. Oviposition Sites

The eggs of the yellow fever mosquito are never laid in a dry container, for the female must have contact with water to stimulate the ovipositing process. She deposits her eggs on the side of a water-holding container at or just above the water line, cementing them there with a secretion from her body. This need to cement the eggs to a hard surface may account for the fact that eggs are never found in pools and puddles with walls of earth, though wild *Aedes aegypti* may breed in depressions in rock. Man's environment supplies many suitable breeding containers (Figure 4 and Table 1) such as wooden receptacles, tires, jars and bottles, battery cases, cans, jugs, urns, and any other items that can catch and hold water. Occasionally eggs or larvae are taken from tree holes, the axils of leaves, crab holes, and storm-sewer basins. Less obvious breeding containers include roof gutters, junk automobiles and major appliances, neglected toys, and depressions in polyethylene sheeting or tarpaulin.

The fertile mosquito females, when abundant and under population pressure, will seek out even the most concealed oviposition sites. Some mosquito foci are extremely difficult to find and may remain untreated. Mother foci are breeding sites where eggs and/or larvae survive the onslaughts of winter and larviciding, thus serving to perpetuate the species unless discovered by a diligent inspector.

Water is a requirement for hatching, too. However, eggs that remain dry can survive for long periods - as long as a year or more - and then hatch promptly when reflooded.

Incubation

About 4 to 6 days at favorable summer temperatures, much longer at lower temperatures, are required for development of the larvae within the eggs. Once the eggs have passed through this incubation period, they hatch in a matter of minutes if reflooded.

Table I

Distribution of Aedes aegypti Breeding by Type of Container*

Type of Container	Aedes aegypti larvae taken: Dade County, Fla. 1951-5,1963 No.	%	San Antonio, Texas 1964 No.	%
Tires	15,077	38.3	562	23.8
Cans	6,908	17.6	310	13.2
Buckets and pails, refuse cans	5,088	13.0	275	11.7
Containers of cuttings	1,621	4.2	252	10.7
Major appliances and plumbing	921	2.3	256	10.7
Pots and pans	1,702	4.4	250	10.6
Jars and glasses, jugs, vases, bottles	2,584	6.6	124	5.2
Bird baths	357	0.9	64	3.5
Tubs and troughs	1,012	2.6	75	3.1
Barrels, kegs, drums	1,157	2.9	64	2.7
Ponds and pools, lined	138	0.3	42	1.8
Automobiles and parts	175	0.4	26	1.1
Boats	139	0.4	8	0.3
Other	2,409	6.1	40	1.6

* Dade County data received from Fred Stutz. San Antonio data from project reports. This is a tabulation of the containers found to be positive; not an indication of the relative abundance of containers.

THE LARVAL STAGE

Larval Habits

Painstaking collection of larval specimens is the most important operation in delimiting an infested area to furnish information for planning eradication activities. Larvae are found most abundantly in shaded water containers near human habitations when these containers have been undisturbed for more than a week. *Aedes aegypti* larvae are consistently more abundant in substandard areas of a city than in the better residential areas. This is due both to the greater number of water containers and to the greater rate of infestation of these containers. Tires are favored breeding sites, possibly because they provide both shaded water and a resting place for adults.

Development of the Larva

The *Aedes aegypti* larva (Figure 3) must molt its outside body covering or exoskeleton in order to grow. The four instars are the stages through which the larva develops prior to the pupal stage. The insect molts four times during the larval stage, the first three times to enter the 2nd, 3rd and 4th instars, each being larger and more developed than the preceding instar. The 4th larval molt produces the pupa. Although larvae can survive in water at 40°F., the stage is greatly prolonged and no pupation is possible at temperatures under 55°F. The larval stage is completed in 5-7 days at favorable temperatures in the 77-84°F. range. Under favorable conditions one day is spent in each of the first 3 instars, whereas the 4th instar requires 2 to 3 days.

Larval Molting

Molting is a rather hazardous process by which insects shed the old exoskeleton and make possible their growth and the development of more mature characteristics. No molting takes place in the mosquito after it reaches adult stage. At molting, a fluid is secreted that facilitates the separation of the exoskeleton (external skeleton) from the newly developed body covering and from body hairs and other structures. As the process begins, the larva swallows water until its body becomes taut; the head capsule and thoracic exoskeleton split, permitting the larva to emerge by peristaltic action, leaving behind an almost perfect cast skin, which incidentally can be mounted for study and identification. The soft parts of the body grow between molts, but the head capsule remains constant in size until replaced. Experienced inspectors differentiate between the four larval instars by the size of the head capsule rather than by the body size. Ordinarily only the third and fourth instars are sufficiently developed for routine identification.

Survival Conditions

Seasonal abundance of *Aedes aegypti* larvae depends upon temperature, rainfall, and relative humidity. Larvae cannot long survive continued exposure in water below 50°F., presumably because of drowning. In containers exposed to the sun in summer, larvae are soon killed by a temperature of 113°F. or higher. All stages except the egg may disappear during long periods of drouth or cool weather since both temperature and the availability of water serve as limiting factors.

Larvae reared in fresh water are killed by a 1.1 percent concentration of table salt. Heavy pollution of water prevents breeding of *Aedes aegypti*, but one or two generations of Culex quinquefasciatus may clear the water sufficiently to permit *aegypti* breeding. Some organic material in the water is required for hatching of the egg and as food for the larvae. Hatching of the egg is dependent upon the presence of carbon dioxide in the water.

Diet of the Larva

The larva uses its mouth brushes to create a current of water and food into its mouth cavity. It shows little selectivity in its choice of food, ingesting almost any particles small enough to be swallowed. Microorganisms are the principal foods, and nonliving organic matter may be important. Algae, rotifers, protozoa, bacteria, and fungus spores are fed upon indiscriminately and are swallowed without any noticeable amount of water. Certain amino acids or proteins are required in the diet. In the laboratory, larvae may be reared easily on powdered laboratory rabbit food.

THE PUPAL STAGE

Normally it will not be necessary to identify *Aedes aegypti* pupae (Figure 3) in the *Aedes aegypti* eradication program, although pupal keys are available. In the few cases where only pupae are found, specimens should be taken to the office or other suitable room, placed in a rearing container, and the adults permitted to emerge for identification. Newly emerged adults should not be killed for an hour or more as they will not make good specimens. After the body tissues have hardened, specimens can be killed by heat or in a killing tube, and identified.

The pupal stage in an insect's life comprises a most interesting developmental period when the adult characteristics such as compound eyes, wings, legs, and reproductive organs, present only as zones of body cells in the larva, develop to maturity and become evident when the adult emerges from the pupal covering.

Habits and Characteristics

The pupa (Figure 3) is comma-shaped and does not feed, for its developing head and mouthparts are secure beneath a protective sheath. The entire outside covering of the pupa hardens and darkens soon after the larval exoskeleton is molted. The pupa obtains atmospheric oxygen through two breathing trumpets that pierce the water surface and hold onto the surface film. The pupa or tumbler moves rapidly when disturbed, swimming downward by beating the water with its large paddles. Because it does not feed and is protected by a heavy exoskeleton, the pupa is difficult to kill with insecticides. The pupa and the larva are not truly aquatic, as they depend upon atmospheric air for an oxygen supply.

Duration

The pupal period requires 1 to 3 days at the temperatures of 82-90°F. prevalent during the summer months. In cool weather, 5 days or more may be required. Survival temperatures are similar to those of larvae.

THE ADULT STAGE

An understanding of the adult yellow fever mosquito, its habits, and its habitats is essential to the prosecution of a successful eradication program. The mosquito is more bound by its habits than are the higher animals, and the weaknesses in its straitjacket of habits create opportunities for combating it effectively.

Emergence of the Adult

During the process of emergence, the mature pupa slowly raises its abdomen to a horizontal position just beneath the water surface, and the exoskeleton splits down the center of the thorax or back. Within minutes, the thorax of the young adult protrudes through the split, and then the whole body rises into view. The emerging adult soon frees itself from the old body covering and rests on the old skin and the water surface. Emergence takes about 15 minutes, and after an hour of seasoning to permit expansion of wings and hardening of the new exoskeleton, the mosquito can fly normally.

Description

In general appearance, the adult female *Aedes aegypti* (Figure 5) is similar to other Culicine species, differing from them chiefly in ornamentation and scale structure. The yellow fever mosquito has a dark proboscis, whereas the salt marsh mosquitoes (Aedes sollicitans and Aedes taeniorhynchus) and the glades mosquito (Psorophora confinnis) have a pale band or area on the proboscis. The male is distinguished from the female by its plumose antennae and by its longer and more developed palps (feelers). *Aedes aegypti* is a small mosquito and the male is smaller than the female. It is dark-colored, almost black, and ornamented with white markings. These markings are due to areas of black and white scales, the silvery-white, lyre-shaped marking on the thorax behind the head being very distinctive. There are many important markings, but the ornate thorax and the white-banded legs are most distinctive. Specimens of *Aedes aegypti* in poor condition can be identified by the silvery-colored scales on the palps (feelers on each side of the beak or proboscis) and clypeus (base of proboscis). When on a wall or other vertical resting surface the insect rests with the head straight upward. The body is directed somewhat toward the resting surface.

Figure 5. The Adult Female *Aedes aegypti*

Survival and Longevity

Longevity of adult females under favorable conditions as to food, temperature, and humidity is probably about two weeks to a month, with rare individuals living as long as 6 months. Many females die after the first batch of eggs is laid. Females living for several weeks have an increased opportunity to become infected and to carry the disease agent to more than one victim. Males survive a shorter length of time than the female. This is not significant, for although a female may mate several times, one mating during the first day or two after emergence makes her fertile for life.

Adults are killed by temperatures below freezing in a short time and do not survive temperatures of 40°F. for more than 24 hours. They are incapable of movement at a temperature of 50°F.

The optimum temperature for adults is 82°F., and at temperatures of 112-115°F. death occurs in 3 minutes. A high relative humidity favors both general activity and longevity. These conditions prevail for several months in most areas having general infestations of the yellow fever mosquito.

A period of 4 days at 98°F., longer at lower temperatures, is necessary for effective yellow fever transmission. This permits migration of the virus to the salivary glands, and a subsequent opportunity for the mosquito to attack humans. At room temperature averaging 77°F., *Aedes aegypti* females become infective in 8 days (in tests using the African Asibi yellow fever virus strain). At 70°F. the mosquitoes were infective in 18 days, but at 64.5°F. they were not infective, even after 30 days. This fact limits yellow fever epidemics to warm weather and warm climates. Epidemics in the temperate zones have always been terminated by the onset of cool weather.

Feeding

The sense of smell (olfactory sense) aids the female *Aedes aegypti* in locating a human, the preferred host, for a blood meal. She flies upwind in the direction of odors emitted from humans or their volatile waste products. Once close to the host, she uses visual stimuli to locate the person and her heat receptors to select the site for the bite. This mosquito tends to attack humans below the waist and may crawl under the clothes before biting.

Feeding takes place primarily during the daylight hours, chiefly in the early morning and late afternoon. Reaction of the human victim to the mosquito saliva causes a soft whitish wheal, surrounded by a reddened area, and accompanied by itching. Young children who have not been bitten previously show no reaction to the bite, but they become sensitized after repeated bites and thereafter give the typical reaction. However, people in heavily infested and primitive areas may develop immunity to effects of the bite and display little or no reaction.

The female takes a blood meal about equal to her body weight (2-3 milligrams), which causes the abdomen to become greatly distended. Digestion takes place at temperatures above 40°F. and is rapid at 80°F. Females may live for long periods without blood meals, subsisting upon plant nectar, but they must have a blood meal in order to produce viable eggs.

The mouthparts of the *Aedes aegypti* female, as in most mosquitoes, are modified for piercing the tough skin of the host. There is no beak, as in some bugs that bite man. The mosquito mouthparts (Figure 6) are made up of a <u>labrum</u> (upper lip), a pair of <u>mandibles</u>, a <u>hypopharynx</u>, a pair of <u>maxillae</u> (cutting organs), and a <u>labium</u> (under lip) which ends in the labellum. The labrum encloses a food canal, through which blood is sucked, closed on the lower side by the hypopharynx. The hypopharynx has a median rib containing the salivary duct. The mandibles are very slender and appear to have little importance in *Aedes aegypti*. The maxillae have teeth on the tip for piercing the skin. The labium forms a sheath for the other mouthparts and does not penetrate the skin during feeding.

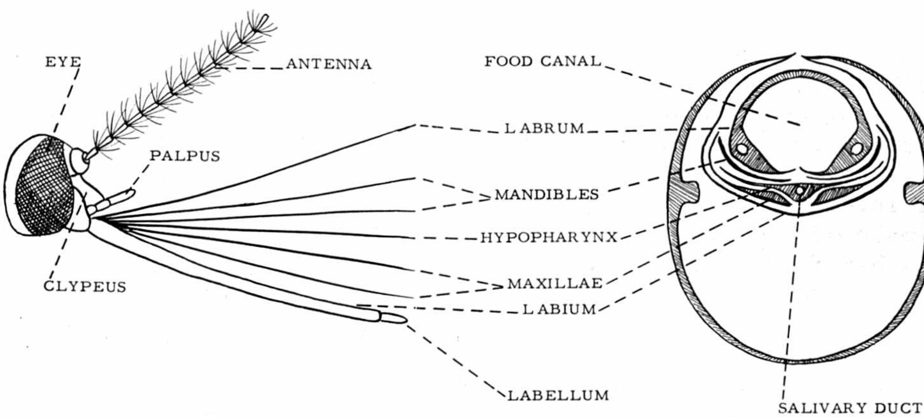


Figure 6. Mouthparts of *Aedes aegypti* Female

Behavior of the Adult in Response to Stimuli

<u>Response to Light</u> - *Aedes aegypti* may be active at any time during the day, with greatest animation during the early evening and morning hours when temperature and humidity may be more of a factor than light in determining the degree of activity. However, *Aedes aegypti* is repelled by light, and adults in a room will usually seek the darker places, such as on or behind dark garments hanging on a wall.

Response to Smell - Smell does not appear to be a strong attractive stimulus to *Aedes aegypti*, as experiments have given variable results. Carbon dioxide and human scents, such as those of perspiration and urine, appear to attract female adults.

Response to Sound - Hearing in mosquitoes resides in sensory organs of the antennae. A buzzing sound in the region of 300 to 500 cycles per second created by the wing beats of the female attracts the male and induces copulation. The sound will induce copulatory efforts by the male even when no female mosquitoes are present.

Response to Heat - The female is highly sensitive to temperature or to convection currents created by a heated object, and is readily attracted to objects heated to about 100°F. It will readily bite the warm skin of the hand but is not attracted to cold skin. There is little doubt that it is not heat alone, but the convection currents set up by the warm host, that causes *Aedes aegypti* to attack and feed.

Reaction to Moisture - Females are most active under conditions of high relative humidity, but a cold, damp object does not attract the insect to feed. Warm, humid weather therefore increases the incidence of mosquito bites in a community. Actual contact of the female *aegypti* with a water surface supplies the necessary stimulus for egg laying. The eggs are deposited near the point of contact between the surface of the water and the container. Females will die rather than lay eggs in a dry place.

Flight

Adults will fly into a breeze as long as they can make forward progress. When the wind velocity is more than 3 to 4 miles per hour (150 cm/sec), they cannot make forward progress and will seek shelter. The fact that this species will ordinarily fly into low velocity breezes probably limits its range of flight, which is usually not more than 25 to 100 yards, with rare individuals flying as much as one-half mile. They fly rather close to the ground and are therefore not carried great distances by the wind.

Mating

Swarming of males may take place in a room or out of doors, when females are present, usually over some object, such as a bush or a chair. Mating may take place at any site as long as both males and females are flying. Copulation has been observed in a container as small as a bottle. Copulation takes place in flight when the male, attracted by the sound beat of the female's wings, attaches to the female with the legs interlaced. Few matings take place after full engorgement of the female. The female *Aedes aegypti* will mate several times during her life span although one mating renders her fertile for life.

Oviposition

Oviposition (egg laying) ordinarily takes place in the immediate vicinity of human habitations. The female begins to lay eggs on the sixth or seventh day after emergence and the third or fourth day after her first complete blood meal. Subsequent batches of eggs are deposited every 3 to 4 days, with a blood meal usually taken between each effort. Individual females will each produce about 12 to 15 batches of eggs with 25 to 30 eggs per batch under favorable conditions, or a total of from 300 to 450 eggs from an unusually long-lived female. In some cases twice this number have been recorded in the laboratory. Many females do not survive long after their first oviposition period.

OTHER COMMON MOSQUITOES BREEDING IN CONTAINERS

Aedes atropalpus, a rock-hole and pool mosquito, breeds in artificial containers in Texas and possibly in other states. It occurs from Maine to Georgia and westward. There are several broods per year in warm climates, and larvae may be taken during the winter in the southern states. The females are persistent biters and may be important pests in localized areas.

Aedes triseriatus is known as a tree-hole mosquito throughout the United States and Canada, but large numbers of larvae may be found in other containers, such as tires, cans, and tanks. Larvae may be found at any time in the year in the extreme South. The bite of the adult is quite painful and the irritation it produces is long lasting.

Aedes zoosophus is a tree-hole mosquito. Its larva are very similar to those of Aedes triseriatus, but the adults have broad basal white bands on the first four segments of the hind tarsi. Larvae are found in tree holes, particularly in willows, and in artificial containers. The females bite man readily. It is found in southwestern United States, in Kansas, Oklahoma and Texas.

Culex nigripalpus, a vector of St. Louis encephalitis, breeds in the southern United States and southward to northern South America. This mosquito of pools, marshes, and other permanent waters is also taken in leaf axils of plants, and in artificial containers. Adults and larvae are found throughout the winter in the extreme southern United States.

Culex (pipiens) quinquefasciatus, the Southern house mosquito, is a vector of St. Louis encephalitis. It breeds in foul water in artificial containers, ditches, and pools throughout the southern United States. Breeding occurs throughout the year in subtropical areas of the country but is primarily in midsummer in the northern *Aedes aegypti* project areas. Only adult females hibernate.

Culex restuans occurs in nearly all of the United States, being most abundant in the spring and early summer. Later, it is replaced by Culex quinquefasciatus in the same habitats. Larvae and adults of C. restuans may be observed all winter in localities where climate is moderate.

Culex salinarius is widely distributed in the United States, breeding only occasionally in containers in either fresh or foul water. This common species bites readily and may enter homes. Females overwinter in the northern states, but breeding occurs at all times in the extreme southern areas.

Orthopodomyia signifera, another tree-hole mosquito, breeds in artificial containers throughout the South and as far north as Massachusetts. The winter is passed in the larval stage in the South. The reddish larvae are easily distinguished from other container breeders. The adults are not known to bite man.

Toxorhynchites rutilus is a very large, brilliant, metallic-colored mosquito that does not bite humans. Its extremely large larva has stout rods instead of mouth brushes, to permit it to seize and consume other mosquito larvae. It is found in the Southeast and in Arkansas, and breeds in tree holes, bromeliads, tires, and other artificial containers.

MOSQUITO COLLECTION AND IDENTIFICATION

FIELD COLLECTION AND RECOGNITION

Identification of mosquitoes collected during larval and adult surveys is one of the most important duties in the eradication of *Aedes aegypti*. Errors in determining the correct genus and species of samples may greatly increase the cost and duration of the program. Specimens are obtained only with great difficulty in areas of low population indices, and must be handled promptly and carefully to prevent loss.

Mosquito identification is the responsibility of area supervisors and their assistants, but it may be accomplished by trained technicians in large areas. In some cases, determinations (identification) will be made at state headquarters. Field identification is a means for recognizing the difference between *Aedes* larvae and other groups taken in samples. Recognition of *Aedes* larvae in the field does not confirm these specimens as *Aedes aegypti*, but is an operational measure used early in the eradication program when it is not practicable to identify all specimens in the office or laboratory.

Recognition of *Aedes* Larvae

Several groups of mosquitoes breed in the same type of receptacles as *Aedes aegypti*. The illustrations in Figure 7 help the inspector to differentiate between Aedes and Culex larvae, the predominant types. For purposes of survey records, all *Aedes* larvae will be considered as *Aedes aegypti* until checked by the area office for identification. The following information will help the inspector separate *Aedes* from others:

Position - the larvae hang 'head down'.
Movement - the *Aedes* larvae have a characteristic 'S' shaped, serpent-like, or 'figure 8' movement, which involves all parts of the body.
Air tube - the air tube is dark in color and about twice as long as wide.
Light - larvae react quickly to changes in intensity of light. They are disturbed by the beam of a flashlight or by a shadow and will retreat to, and remain in the darkest part of a container. The removal of the cover from the container will startle larvae, even if the container itself is not disturbed. Because *Aedes* larvae will dive to the bottom of a container when disturbed, they may be overlooked unless the inspector makes a careful search.

Recognition of Culex and Anopheles Larvae

Culex

Culex larvae are frequently found in association with *Aedes aegypti* and other *Aedes* larvae (Figure 7). The following information will help the inspector recognize Culex larvae:

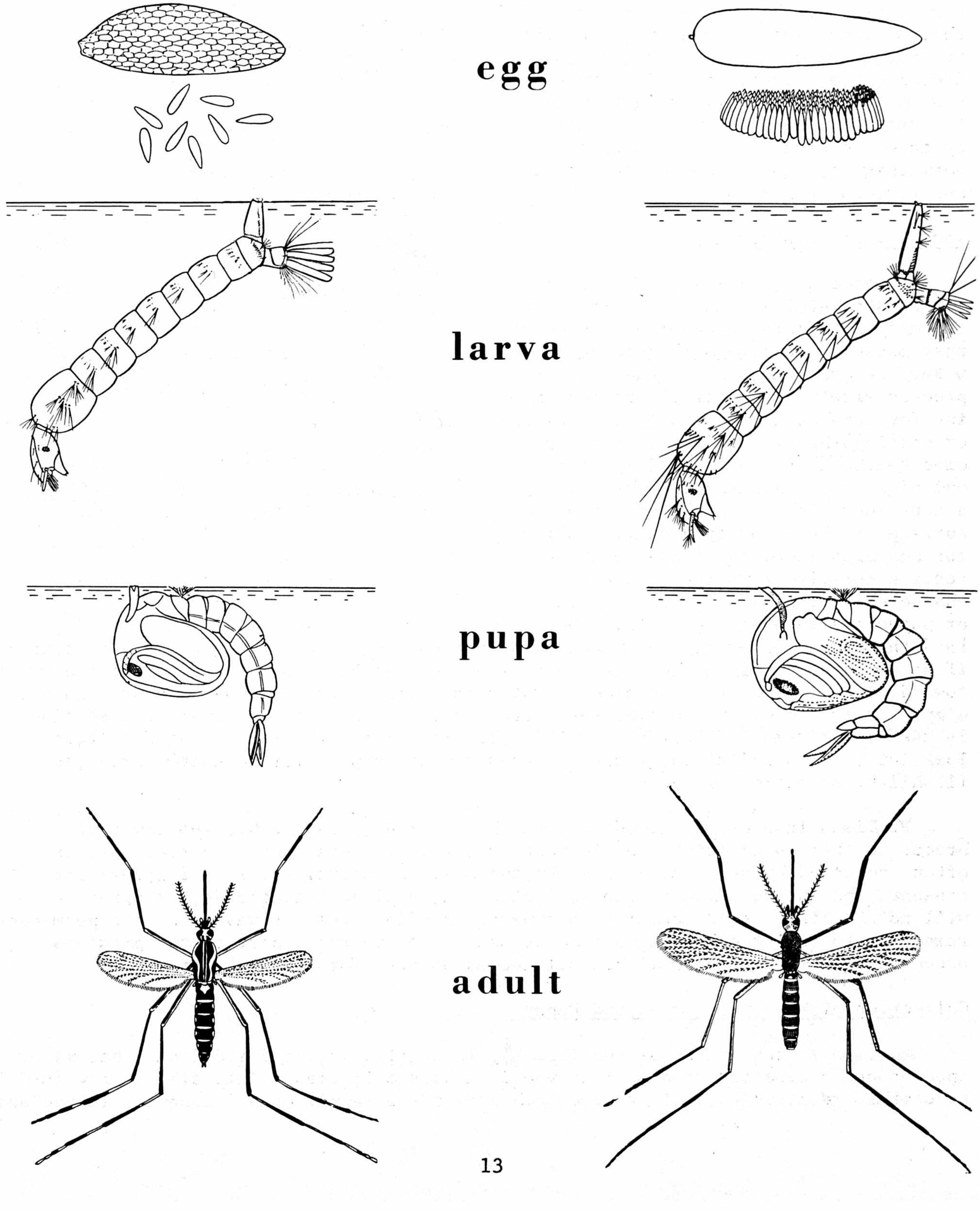
Position - the larvae hang 'head down'.
Movement - Culex larvae have a whip-like or 'figure C' movement which propels them rapidly to the bottom of a container.
Air tube - the air tube is long and tapered, being at least 3 times as long as wide.
Light - Culex larvae are not very sensitive to changes in light intensity - much less so than *Aedes aegypti*.
Timidity - a rather strong disturbance is required to startle Culex larvae and cause them to go to the bottom of a container. They return fairly soon to the surface.

Figure 7.

CHARACTERISTICS OF AEDES AEGYPTI AND CULEX QUINQUEFASCIATUS

Harry D. Pratt and Chester J. Stojanovich

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
Communicable Disease Center
Aedes aegypti Eradication Branch
Atlanta, Georgia 30333
1965



Anopheles

Anopheles larvae are occasionally found in containers, although they usually breed in pools, lakes, and marshes. They are recognized by the apparent absence of an air tube and by their habit of lying parallel to the surface of the water.

Inspector's Equipment and Supplies

Each inspector is responsible for all equipment and supplies assigned to him. Before each day's work the kit should be checked to make sure that the following are on hand: carrying case, 2-dram vials, dipper, medicine dropper, vial labels, mirror, flashlight, forms, tea strainer, pencils, chalk, battery syringe, note pad, aspirator, chloroform tube, pillboxes with cellucotton, and forceps (Figure 8).

Figure 8. Inspector's Equipment and Supplies

How to Inspect Containers

Inspection for *Aedes aegypti* larvae involves a careful search of premises for the many artificial containers in which they may be present. All containers of water are examined. It is necessary to proceed slowly and carefully in searching for larvae, as disturbing the water or casting shadows will cause them to dive to the bottom and possibly remain out of sight. When the inspector finds a container with water, he observes the surface of the water carefully, looking for mosquito larvae that may be either resting quietly or moving in their characteristic fashion. If no larvae or pupae are seen at the surface, he taps the container gently and watches for motion. When inspecting a large container, if he can see no larvae, he makes several quick dips beneath the surface of the water towards the sides of the container. Water in small containers may be poured into a dipper, where the larvae can be seen more easily. Quite often a small tea strainer is useful for removing larvae from the water in containers that are difficult to look into. When additional light is necessary to inspect for mosquito larvae, a flashlight or mirror may be used.

Premises inspection includes a search for tree holes, as *Aedes aegypti* sometimes breeds in them up to heights of 20 feet or more. The presence of a tree hole is often indicated by stain marks made by the overflow of rainwater. If larvae are present, the inspector makes the collection and applies insecticide, as spraymen will not be liable to discover this type of breeding site. However, a more permanent remedy is to fill the hole with sand or cement; so in the report to the premises occupant this suggestion will be included as an item for remedial action.

Collection of Mosquito Larvae and Pupae

Aedes aegypti larvae cannot be specifically identified in the field from other *Aedes* species and a generous sample of larvae is always collected. Initially, a new inspector is required to collect from each premises a sample of all mosquito larvae and

and pupae observed. When the inspector demonstrates his ability to distinguish *Aedes* from other mosquitoes, the foreman will authorize him to collect only *Aedes* larvae, but if the inspector has any doubt as to the type of larvae collected, he should submit all of them for identification.

Mosquito larvae may be removed from a small breeding container with a wide-mouth medicine dropper. If the container is reasonably large, most of the water should be poured out and the remainder poured into a dipper or pan and the larvae collected with a pipette. The battery syringe supplied to each inspector is useful in collecting larvae from water in tires and other containers into which the dipper cannot be inserted. In most cases larvae will be collected and put into vials containing only water, but in certain instances, such as Friday collections that cannot be examined before Monday, it may be necessary to preserve them in 70 or 95 percent alcohol. This may be done by removing the water and debris from the collection bottle with a medicine dropper and then adding 70 or 95 percent alcohol.

STATE SOUTH CAROLINA
TOWN WIGGINS
BLOCK 46 NO. 1129
TYPE RECEPTACLE PAINT BUCKET
INSPECTOR PEAKE
DATE 4-I-66
DHEW-ATLANTA, GA.

Figure 9. Label

The inspector must label every collection immediately. Using a lead pencil, (never a pen) he will fill in the required information on the labels provided (Figure 9). The day of the month and year are written in arabic numerals and the month in Roman numerals. Record the address, or if not available, a descriptive location of the premises on the label and on Form 2.1 'Mosquito Inspection-Block Record' (Figure 10). Insert the label in the vial and tighten the screw cap.

MOSOUITO INSPECTION-BLOCK RECORD

County EVANS　Cycle 3RD
Sector H　Zone 14A　Block No. 46
Date DECEMBER 6, 1965　Inspector PEAKE　Block Rating FAIR

No.	OAK STREET / 8TH ST. / 7TH ST. / PINE STREET Premises Address	Exterior							Interior					
		Closed	Refused	Inspected	With *Ae. aegypti*	Type container with *Ae. aegypti*	With other mosquitoes	Treated by Inspector	Closed	Refused	Inspected	With *Ae. aegypti*	Type container with *Ae. aegypti*	Treated by Inspector
1	328 7TH ST.			√	O									
2	VACANT LOT PINE ST.			√	X	BUCKET								
3	1121 PINE ST			√	O									
4	1123 PINE ST			√	O									
5	1125 PINE ST			√	X	TIRE								

Figure 10. Mosquito Inspection-Block Record

Collection and Preservation of Adults

In areas of light infestation, it may be necessary to collect adult mosquitoes. The presence of *Aedes aegypti* larvae in well hidden containers is difficult to bring to light. The finding of adults indicates breeding in the immediate vicinity and simplifies the location of larvae.

As the larval and pupal stages of *Aedes aegypti* are completed, some adults may be found resting near the container or on the water. When this situation prevails, the collection and identification of adult specimens will afford the only means of verifying the presence of the species.

The inspector must be familiar with the coloration and markings of adult *Aedes aegypti* to avoid confusing them with other mosquitoes (Figure 11). This is a rather small, black mosquito with white bands on the tarsi (feet) and a distinctive white lyre-shaped marking on the thorax (back). Specimens of *Aedes aegypti* in poor condition can be identified by the silvery-colored scales on the palps (feelers) and clypeus (portion of head at base of the proboscis). The abdomen is pointed rather than blunt as in Culex. Male mosquitoes can be easily differentiated from the females because the antennae of males are much bushier than those of the females and the palps are about as long as the proboscis.

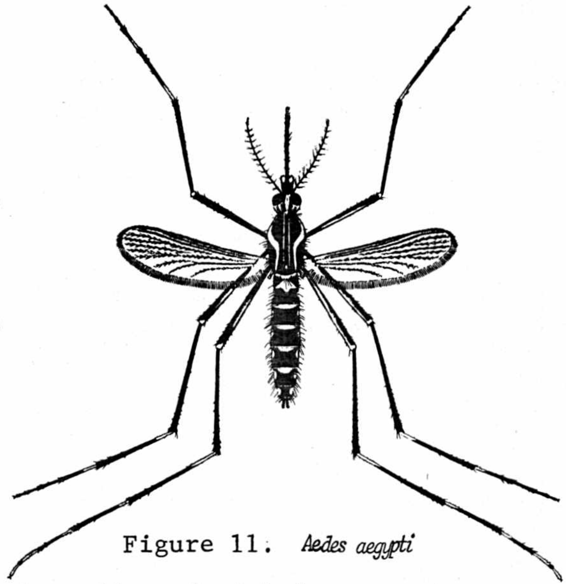


Figure 11. *Aedes aegypti*

Figure 12. Labelling of Pillbox

Adult mosquitoes can be collected with insect net, an aspirator, or a chloroform tube. If they are collected with the aspirator, they should be blown into a chloroform killing tube. The killed specimens are then placed in pillboxes between layers of cellucotton or tissue (facial or toilet tissue, or lens paper). Specimens should be handled with extreme care as they are easily damaged, and damaged specimens are difficult to identify. Each pillbox must be labeled in pencil to record the date, zone, block, street address, and inspector's initials (Figure 12). The city and state should be entered on the pillbox if identifications are not to be made locally. A little soft tissue paper (not absorbent cotton) is placed in each pillbox to prevent specimens from moving about the pillboxes and reduce breakage of specimens.

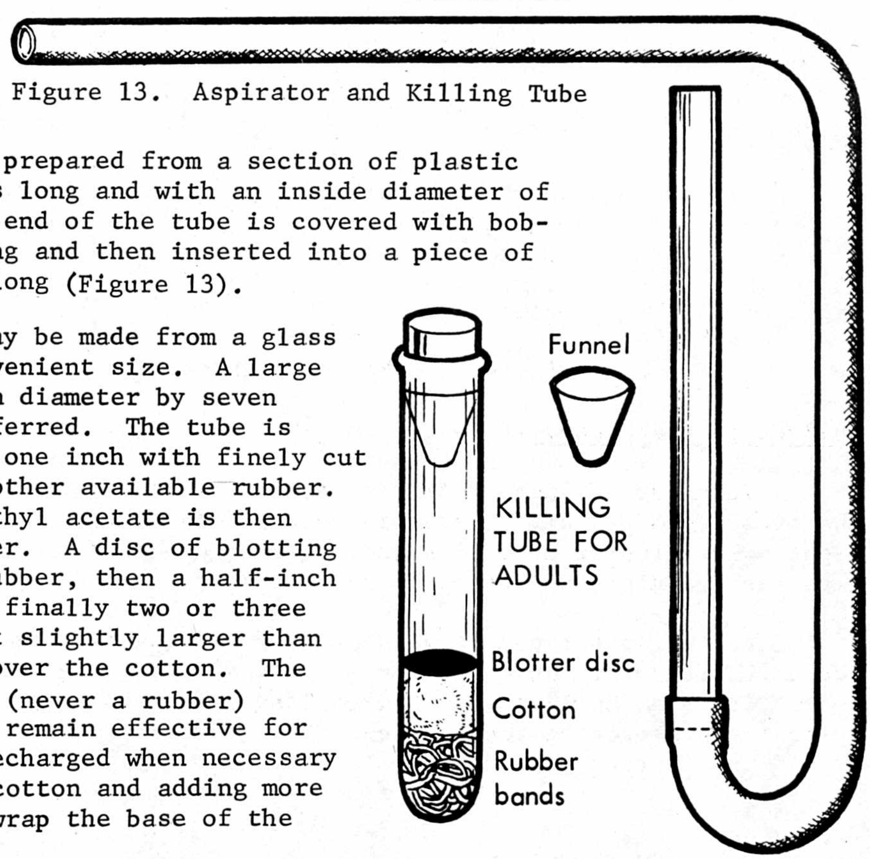


Figure 13. Aspirator and Killing Tube

A simple aspirator is prepared from a section of plastic (or glass) tubing 12 inches long and with an inside diameter of about 3/8 of an inch. One end of the tube is covered with bobbinet or fine wire screening and then inserted into a piece of rubber tubing 2 to 3 feet long (Figure 13).

The collecting tube may be made from a glass or plastic tube of any convenient size. A large test tube about one inch in diameter by seven inches long is usually preferred. The tube is filled to a depth of about one inch with finely cut rubber bands, art gum, or other available rubber. Sufficient chloroform or ethyl acetate is then added to saturate the rubber. A disc of blotting paper is placed over the rubber, then a half-inch of cotton is inserted, and finally two or three discs of blotting paper cut slightly larger than the tube are pressed down over the cotton. The tube is closed with a cork (never a rubber) stopper. Collecting tubes remain effective for several weeks and can be recharged when necessary by removing the discs and cotton and adding more chloroform. Some workers wrap the base of the collecting tube with adhesive tape to lessen breakage, and others add an inverted paper cone inside the mouth of the tube to trap specimens more easily. The addition of crinkled tissue paper to the tubes helps keep specimens dry and prevents damage to them, thus making identification easier. Insect nets and special flashlight battery-powered suction devices are also used to collect adult mosquitoes.

LABORATORY IDENTIFICATION OF MOSQUITOES

Positive identification of mosquito specimens taken in the field is an exacting but relatively uncomplicated procedure on this Program, as only a few domestic species are concerned. Nevertheless, this important task must be performed by a well trained and motivated worker who practices approved techniques. As eradication becomes imminent, each identification of *Aedes aegypti* becomes increasingly significant; and identified larvae should be preserved on slides or in alcohol, and should be labeled with all significant data such as date, address of premises, block number, collector, and type of site from which it was collected.

Larval and adult identification are simplified if care has been taken in collection and preservation of specimens. Larvae should always be preserved in 70 or 95 percent alcohol when they are to be kept more than 3 or 4 hours, as they decompose rapidly and identification becomes difficult or impossible. Sometimes it is desirable to decant the collecting fluid and debris and add fresh alcohol. Adults killed in chloroform tubes deteriorate unless placed in dry pillboxes for transportation to the laboratory. Each collection of adults should be placed in labeled pillboxes to prevent mixing of collections and to reduce breakage of specimens.

Identification of specimens requires a knowledge of mosquito anatomy, as the distinguishing characters are the presence or absence of certain structures, the location, shape, and number of hairs, spines, and scales, and some slight variations in shape or color (Figure 14).

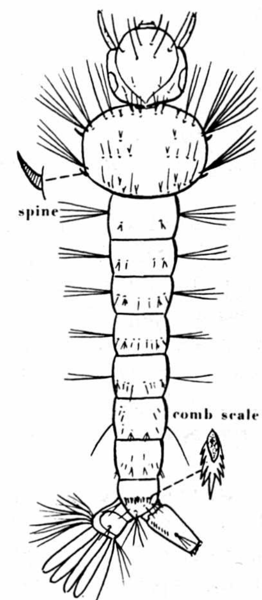


Figure 14.
Aedes aegypti Larva

Equipment and Materials

A binocular dissecting microscope is used for the identification of adult mosquitoes and third and fourth instar larvae. It should be provided with objectives and oculars giving magnification up to 75X or more. A microscope light or gooseneck lamp can be used to provide illumination. Other necessary supplies and equipment are:

For Adults

1. Specimen boxes for mounting pinned adults.
2. Insect pins and cardboard triangles for mounting adults.
3. Labels for pinned specimens.
4. Clear fingernail polish for mounting adults on triangles.
5. Paradichlorobenzene for protecting specimens from other insects.
6. Forceps and dissecting needles for use in mounting specimens.
7. Insect pins.
8. Balsa strips or styrafoam sheets for holding pinned specimens for identification.
9. Other supplies such as mounting blocks and pinning pliers are desirable but not essential.
10. Pillboxes

For Larvae

1. Slide boxes for storing and filing larvae slides.
2. Bottles with rubber-tipped pipettes for holding solutions.
3. 1" x 3" microscope slides.
4. Cover slips for slides - either round or square.
5. Dissecting pins - needles mounted on wooden handles for manipulating specimens.
6. Forceps for handling larvae (same as for adults).
7. Gummed slide labels for recording data on slides.
8. Seventy or 95 percent alcohol for preserving specimens.
9. Cellosolve (ethylene glycol monoethyl ether).
10. Clove oil or cedar oil for clearing larvae.
11. Canada balsam and bottle with glass rod, mounting medium.
12. Xylene (xylol) for diluting balsam to working consistency.
13. Glassware such as emergence jars, beakers, and petri dishes.

Larval Mounting Techniques

Take larvae to be mounted on slides from the alcohol and place them for at least 30 minutes in cellosolve in a small glass dish; then in clove oil or cedar oil in another dish until visual inspection shows them to be sufficiently cleared for examination of characters such as the comb, pecten, and body and head hairs.

Next take the larvae from the clearing medium with a dissecting pin and place them dorsal side up on a large drop of balsam in the center of the slide. Experience will determine the amount of balsam needed. Nick both sides of the larva with a dissecting pin at the 7th segment in order that the terminal segments will rotate 90 degrees and rest flat on the side. Clean the cover glass with tissue and carefully drop on the slide, covering the specimen and balsam. One side of this slip must touch the slide first and the cover slip will compress the balsam and spread it to the edges of the cover glass.

Write a temporary number on the slide with a grease pencil and lay the slide flat in a cigar box or other container for several days until the balsam hardens. Then write the labels with India ink or pencil as shown in Figure 15. Only after the balsam is hardened can the slide be mounted vertically in a slide box. The identified, labeled larva becomes a permanent record of infestation for a premises or a block.

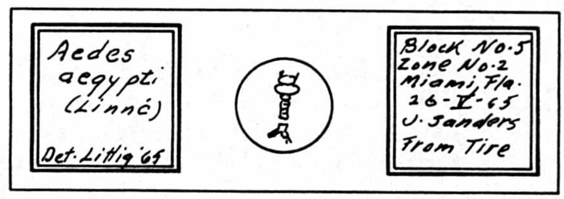


Figure 15. Labelling of Mosquito Slide

Mounting and Storing Adult Specimens

Adult female mosquitoes should be mounted as soon as possible after collection to preserve them from damage. If specimens are dry and brittle, they may be relaxed by placing the open pillbox with specimens in a humid container such as a covered mayonaise jar with a moist sponge or blotting paper. Leave for only a few hours in order not to permit formation of mold. A simple technique for mounting and identifying adults that are to be preserved is to:

1. Push insect pin through wide end of small cardboard triangle. These triangles are punched from 5" x 8" file card stock. By pushing pin between jaws of forceps, force the slide triangle nearly to head of pin.

2. Place drop of clear nail polish on outer portion of triangle. Grasp pin by the pointed end and apply cemented end of triangle to the left side of the mosquito's thorax. The legs should face toward the pin (Figure 16).

3. Stick pin in balsa strip and examine under dissecting microscope using low power. With dissecting needle carefully tease adult into correct position lying on left side with legs toward pin. This must be done quickly, before the cement hardens.

4. With forceps slide the triangle about 3/8 inch below the pin head. Be careful not to damage the specimen.

5. Identify the specimen and write species, date, and name of identifier on a small piece of note paper, or on a printed label and mount on pin below the specimen about 1/4 inch.

6. Fill out locality label and mount near pointed end of pin.

7. Carefully mount specimen in insect box used for zone or district from which specimen was collected.

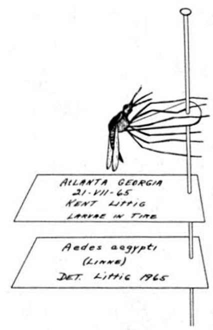


Figure 16.
Pinned Mosquito Adult

8. Place paradichlorobenzene crystals in a perforated pillbox and pin in corner of insect box to protect specimens from other insects.

<u>Use of the Larval Keys</u>

Figure 17 illustrates the characters used in identification of *Aedes aegypti* larvae. Study them before progressing to the pictorial larval key. The initial purpose is to learn the characters of a larva and compare the actual larva with the illustration.

Use the pictorial key (page 24) in learning more about the identifying characters and the use of identification keys. In this key, start at the top, making a choice among two or three important characters to see which description agrees with the specimen. Next proceed downward in the same manner until the specimen is identified. Any key is valid only for the species included and, if a species not represented on the key is identified, an incorrect determination will be made. Therefore, after the initial orientation period is finished, it is more satisfactory to use the couplet (<u>dichotomous</u>) key (pages 25-34) which includes additional mosquito species that may occur in artificial containers.

<u>Use of the Adult Keys</u>

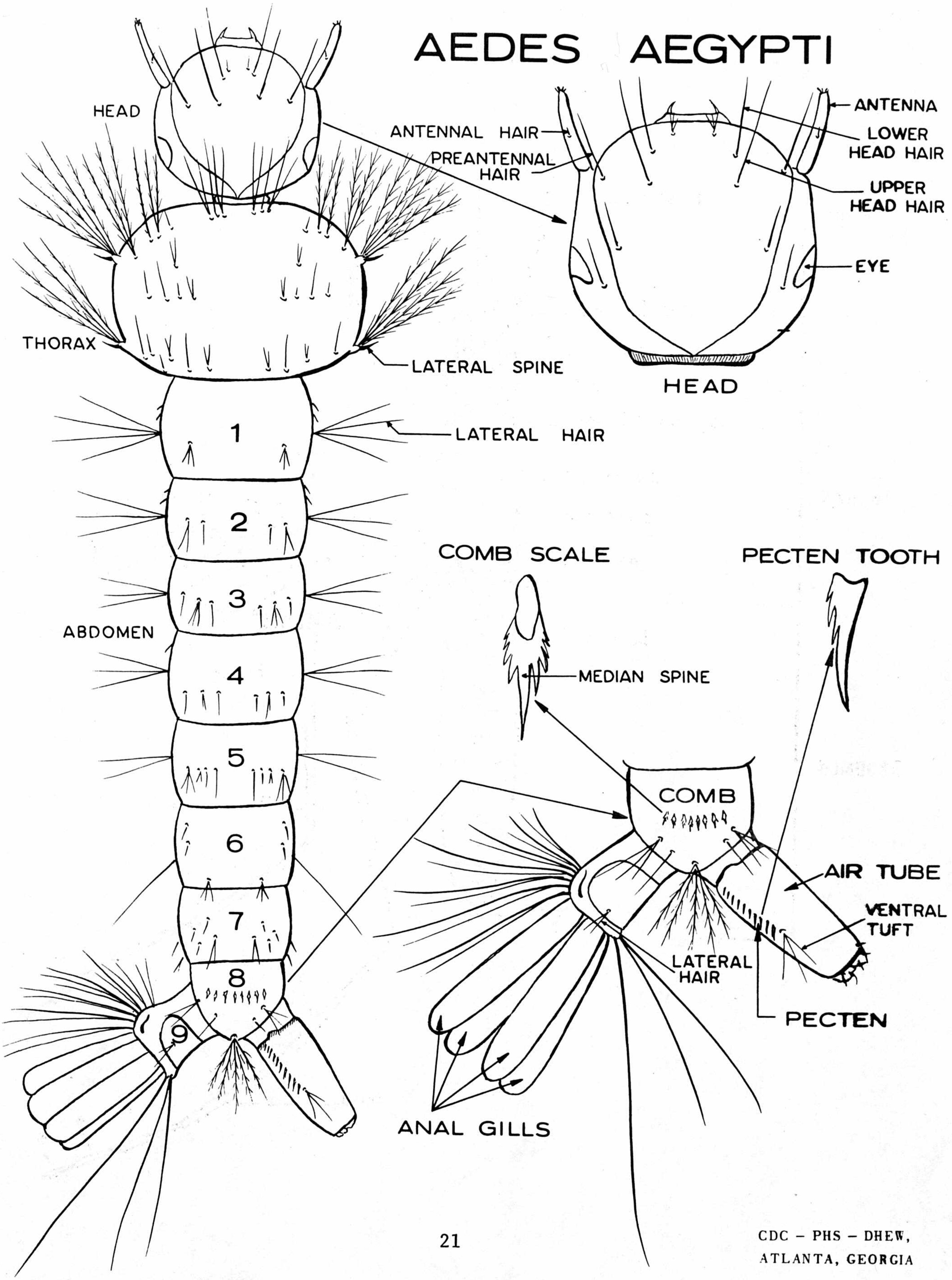
Figure 18 illustrates the anatomy of the adult mosquito, naming body parts used in adult identification. Figures 19-22 illustrate the differences between the appendages of the head by which adult <u>Culex</u> males and females can be distinguished from <u>Anopheles</u>.

As experience is gained in mosquito identification, the presence of spiracular and postspiracular bristles, and occasionally the lower mesepimeral bristles, will be found very useful (Figure 23). On rubbed specimens, these characters are more easily found than body scales.

The pictorial key (page 35) is used in the same manner as the larval key in learning the use of keys. The dichotomous key (pages 36-42), which follows, should be used after the identifier becomes familiar with the characters learned in the pictorial key. The illustrations may also be used in checking the determinations made. Should more advanced keys be desired, it may be well to obtain, "Mosquitoes of North America," Carpenter and La Casse, or other volumes listed under the heading, "Selected References." The use of different keys and different characters adds interest to the task of identifying mosquitoes and increases the competence of the public health worker.

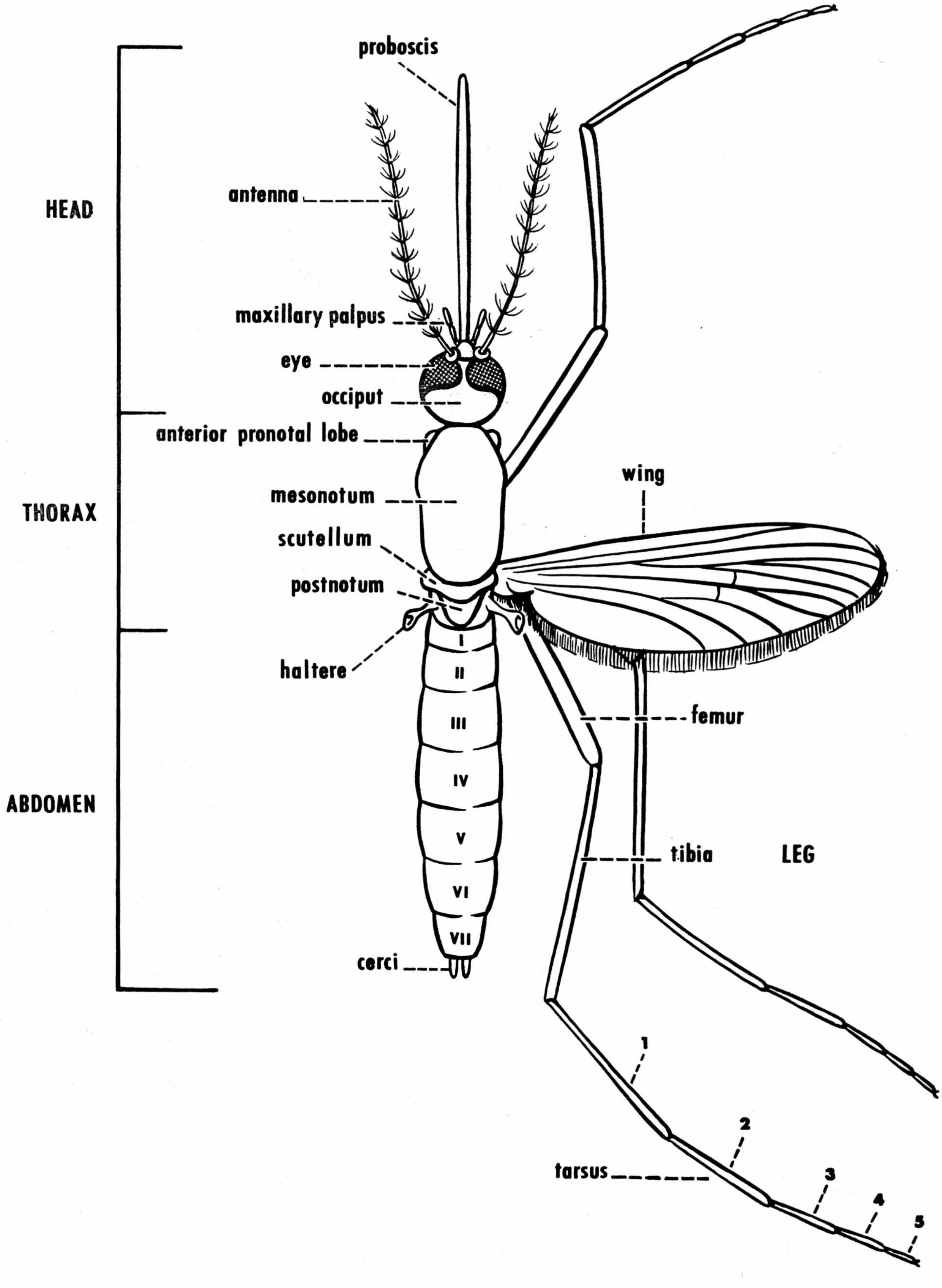
Figure 17.

AEDES AEGYPTI



CDC – PHS – DHEW,
ATLANTA, GEORGIA

Figure 18. Diagram of Adult Mosquito



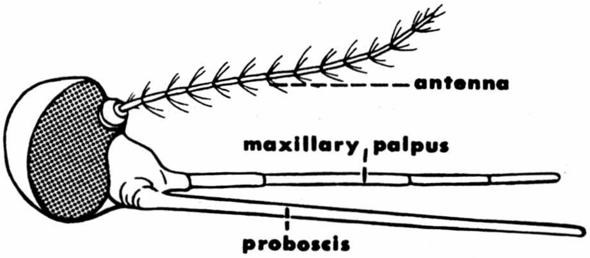


Figure 19. **Head of *Anopheles* female**

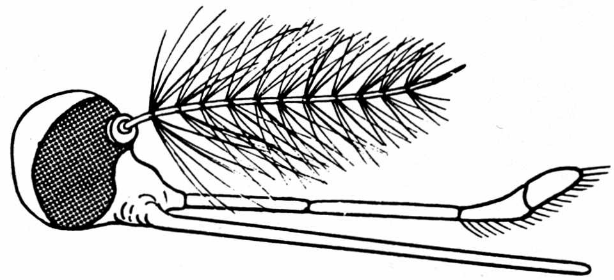


Figure 20. **Head of *Anopheles* male**

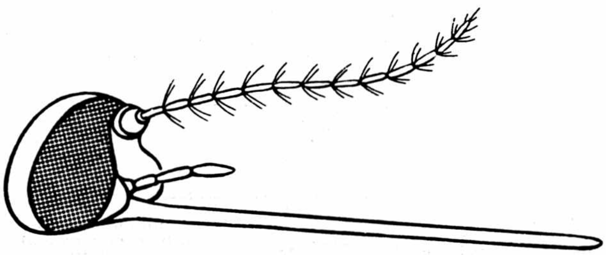


Figure 21. **Head of *Culex* female**

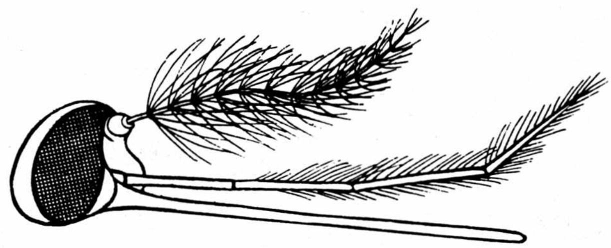


Figure 22. **Head of *Culex* male**

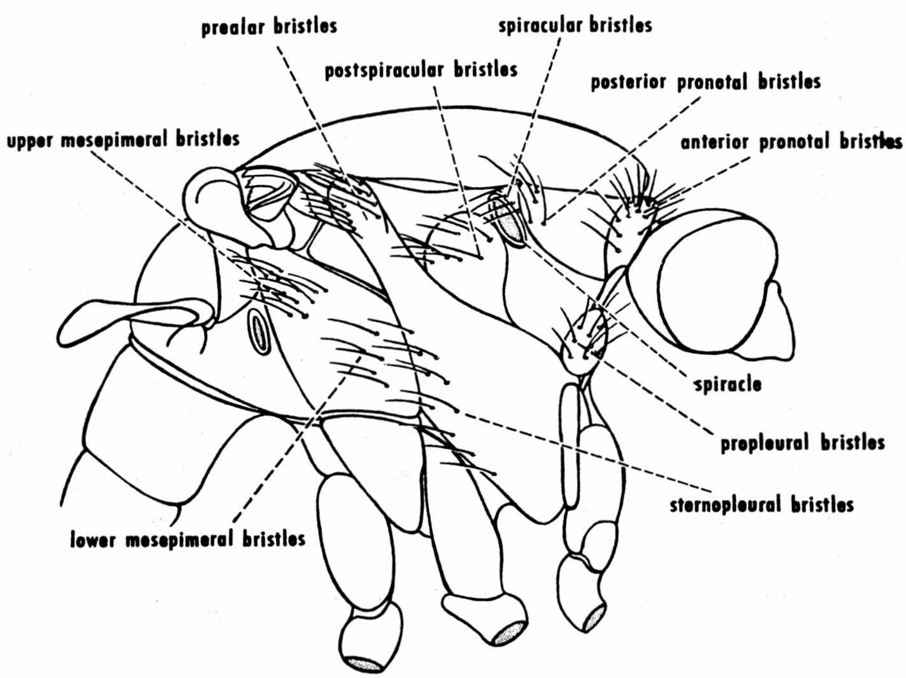
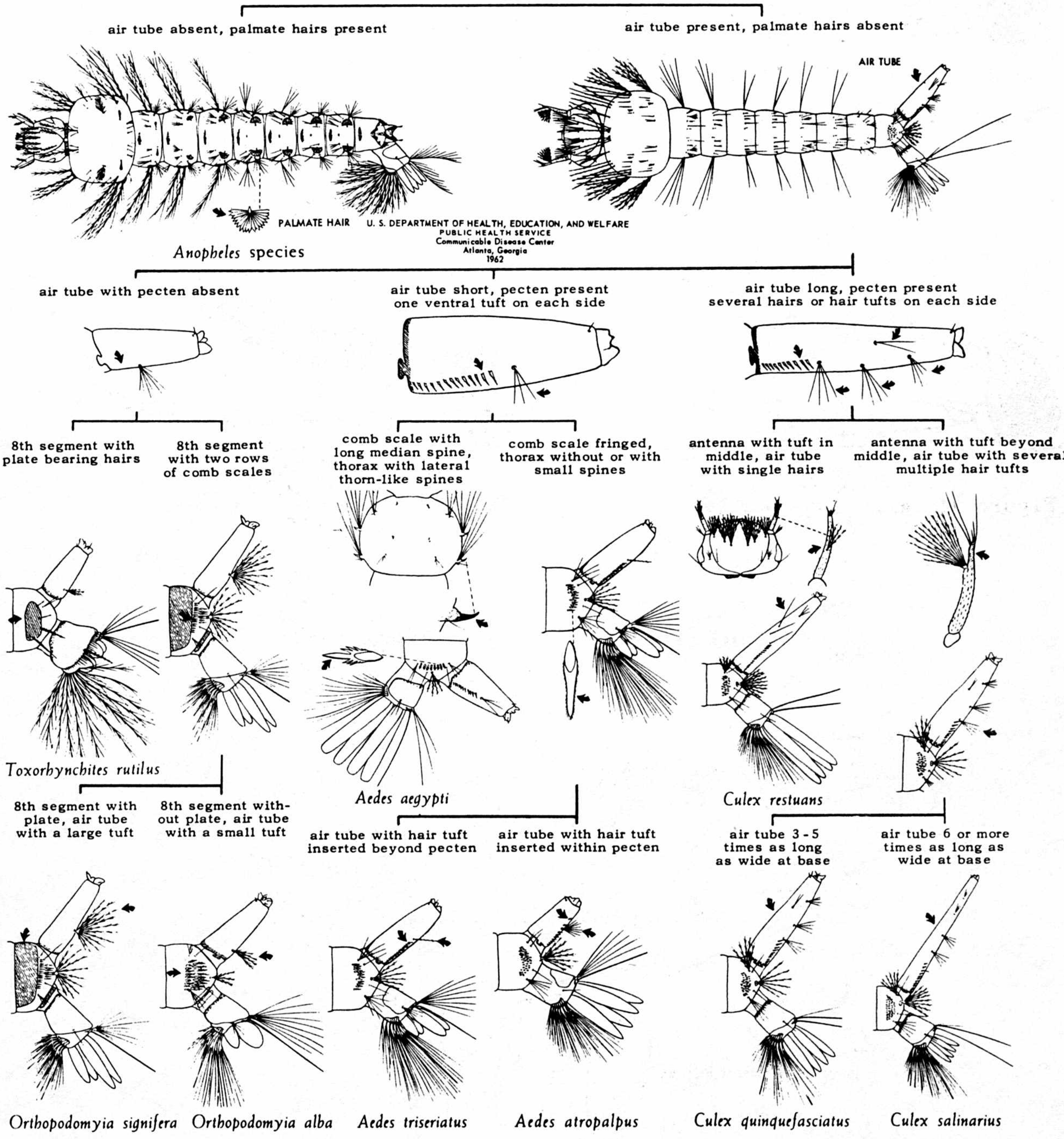


Figure 23. **Lateral view of mosquito thorax**

PICTORIAL KEY TO SOME COMMON MOSQUITO LARVAE FOUND IN ARTIFICIAL CONTAINERS

Harry D. Pratt and Chester J. Stojanovich



KEY TO LARVAL MOSQUITOES FOUND IN RECEPTACLES

Milton E. Tinker and Chester J. Stojanovich

1. Air tube present; palmate hairs absent on abdominal segments (Fig. 1 A)................2

   Air tube absent; palmate hairs present on some abdominal segments (Fig. 1 B)............ (Genus Anopheles)..22

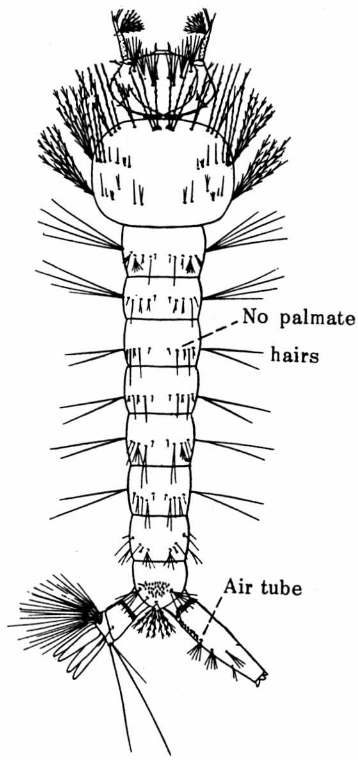


Fig. 1 A

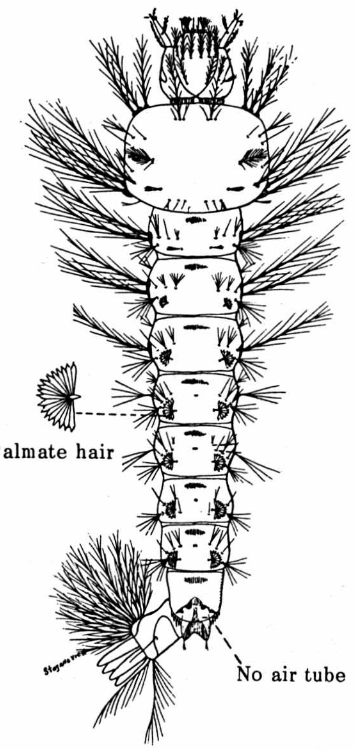


Fig. 1 B

2. Pecten present at base of air tube (Fig. 2 A)......................................3

   Pecten absent at base of air tube (Fig. 2 B).......................................20

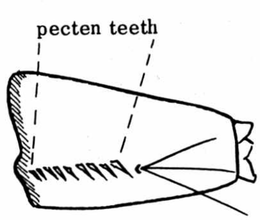


Fig. 2 A

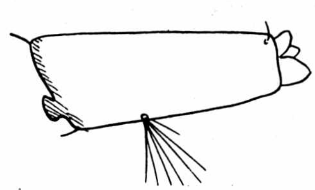


Fig. 2 B

3. Air tube with a single hair or tuft on each side; eighth abdominal segment with one to three rows of 6 to 21 comb scales (Fig. 3 A); (21 to 58 in Aedes atropalpus)....................4

Air tube with several hairs or tufts on each side; eighth abdominal segment with a triangular patch of many (30 to 60 or more) comb scales (Fig. 3 B)..............................12

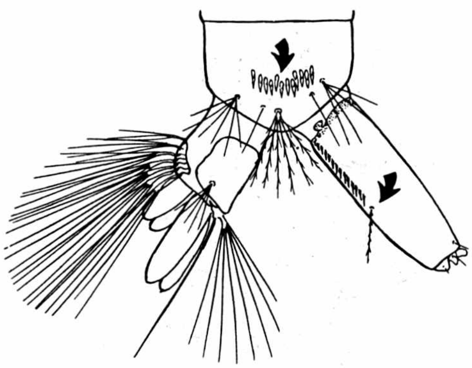


Fig. 3 A

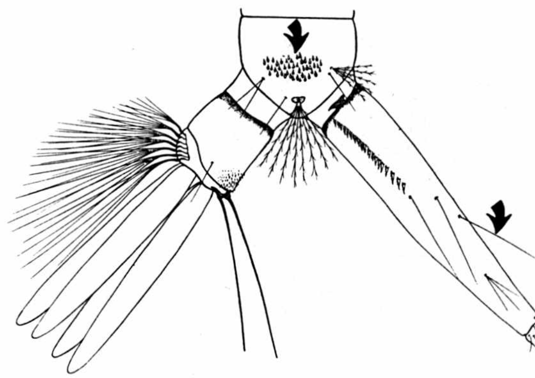


Fig. 3 B

4. Individual comb scales thorn-shaped with a strong median spine and stout lateral spines (Fig. 4 A)...5

Individual comb scales slipper shaped, evenly tapered with a fringe but no stout lateral spines (Fig. 4 B)..6

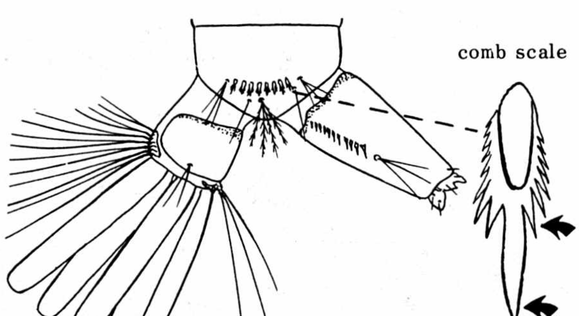


Fig. 4 A

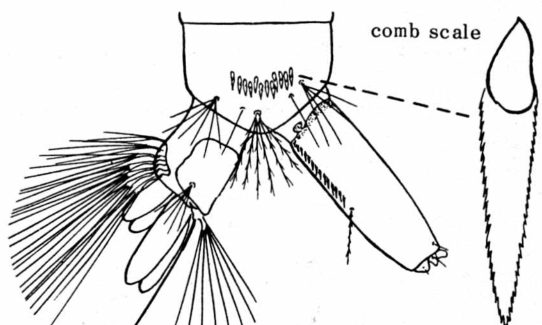


Fig. 4 B

5. Many pecten teeth on air tube (10 to 19); anal segment not completely ringed by sclerotized plate; air tube not inflated; lateral spines on thorax long and curved; head hairs single (Fig. 5 A, B & C)............................ YELLOW FEVER MOSQUITO *Aedes aegypti*

Few pecten teeth on air tube (3 to6); anal segment completely ringed by sclerotized plate; air tube inflated; lateral spines on thorax short and blunt; head hairs multiple (Fig. 5 D, E & F)..*Psorophora confinnis**

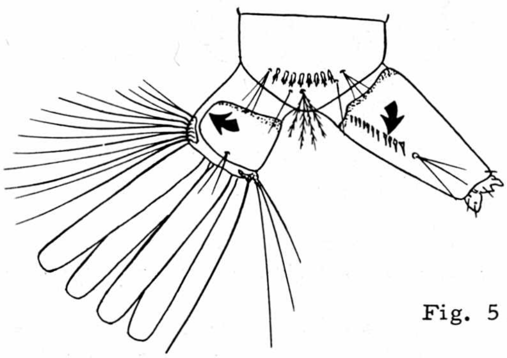


Fig. 5 A

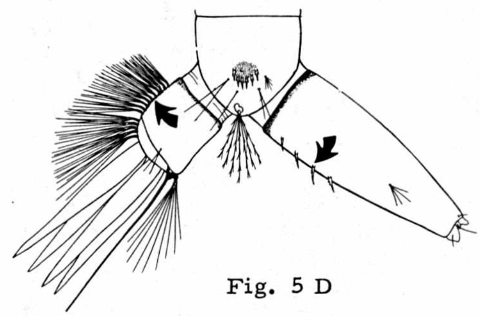


Fig. 5 D

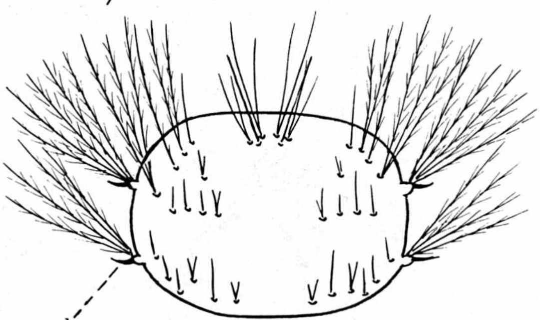


Fig. 5 B

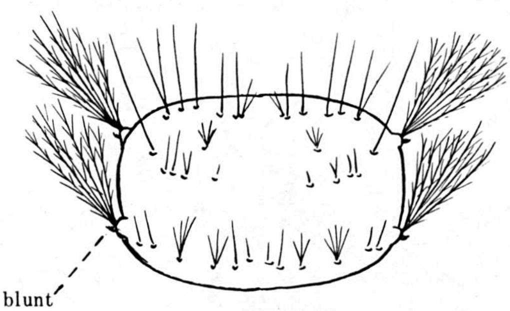


Fig. 5 E

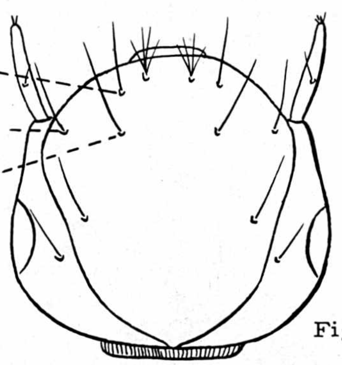


Fig. 5 C

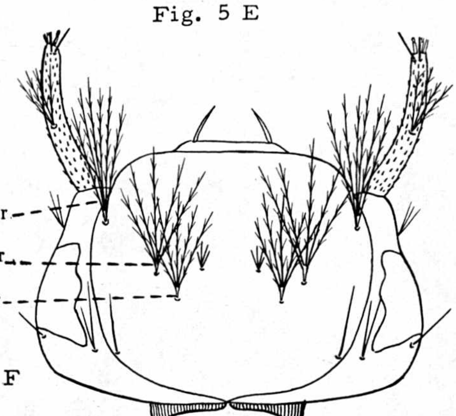


Fig. 5 F

6. Anal segment not completely ringed by sclerotized plate (Fig. 6 A)....................7

Anal segment completely ringed by sclerotized plate (Fig. 6 B)...................... 10

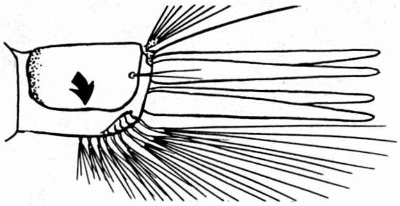


Fig. 6 A

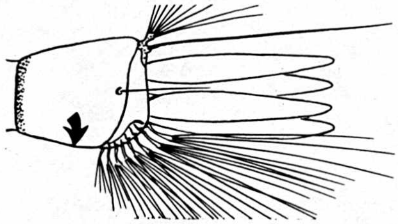


Fig. 6 B

7. Pecten with all teeth evenly spaced (Fig. 7 A).. 8

Pecten with one or more distal teeth more widely spaced (Fig. 7 B)...................9

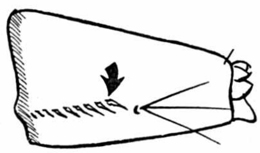


Fig. 7 A

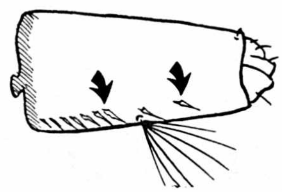


Fig. 7 B

8. Anal segment without a light-colored depression anterior to the lateral hair (Fig. 8 A); larva dark................................TREE HOLE MOSQUITO *Aedes triseriatus*

Anal segment with a light-colored depression anterior to the lateral hair (Fig. 8 B); larva light. Texas, Oklahoma, and Kansas........................ *Aedes zoosophus*

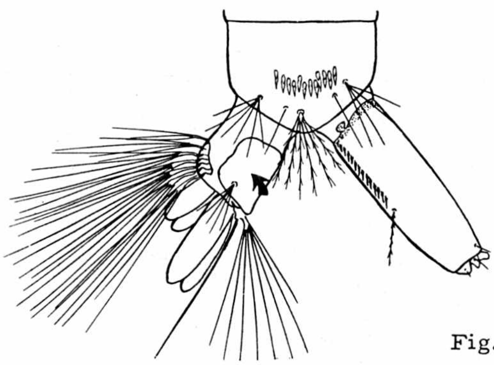


Fig. 8 A

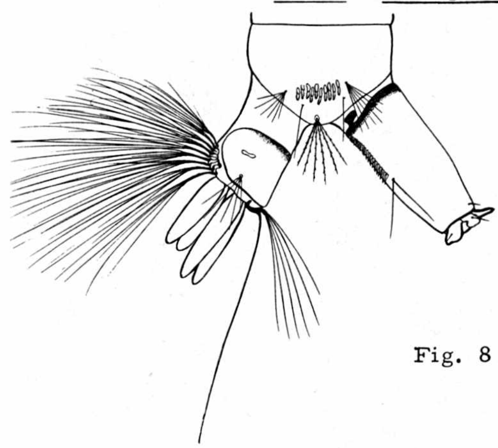


Fig. 8 B

9. Tuft of hairs inserted on air tube within the pecten (Fig. 9 A)......... *Aedes atropalpus*

Tuft of hairs inserted on air tube beyond the pecten (Fig. 9 B).............*Aedes vexans**

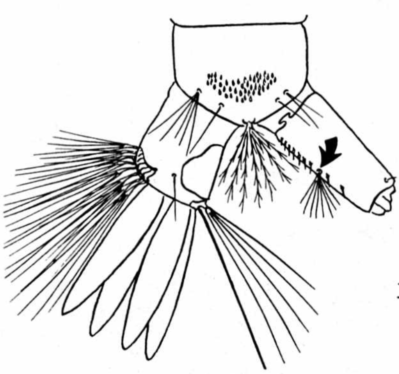


Fig. 9 A

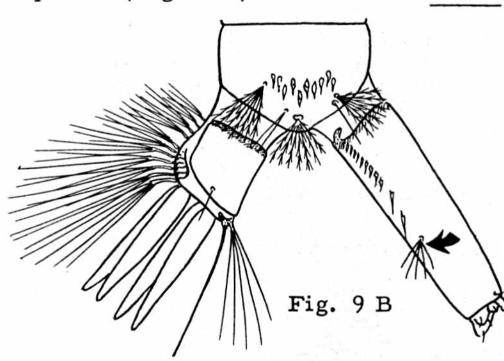


Fig. 9 B

* Usually not found in receptacles

10. Air tube average length, 3 to 3 1/2 times as long as basal width; pecten not quite reaching middle of the air tube (Fig. 10 A); upper head hair and lower head hair well barbed...... ....Aedes mitchellae*

Air tube short, 2 to 2 1/2 times as long as basal width; pecten reaching middle of air tube or slightly beyond (Fig. 10 B); upper head hair and lower head hair smooth or finely barbed.. 11

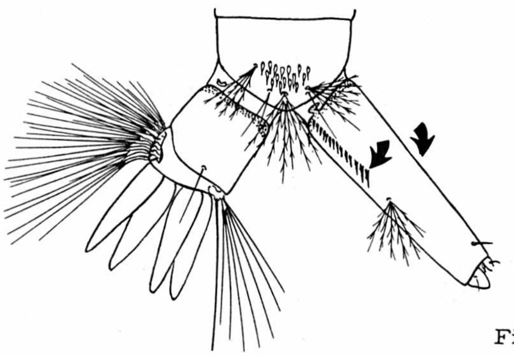


Fig. 10 A

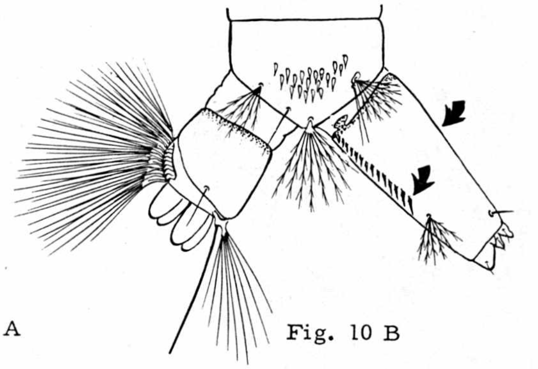


Fig. 10 B

11. Individual comb scale long and pointed apically (Fig. 11 A); lateral abdominal hairs double on segments 3 to 5..Aedes sollicitans *

Individual comb scale short and rounded apically (Fig. 11 B); lateral abdominal hairs triple on segments 3 to 5... Aedes taeniorhynchus *

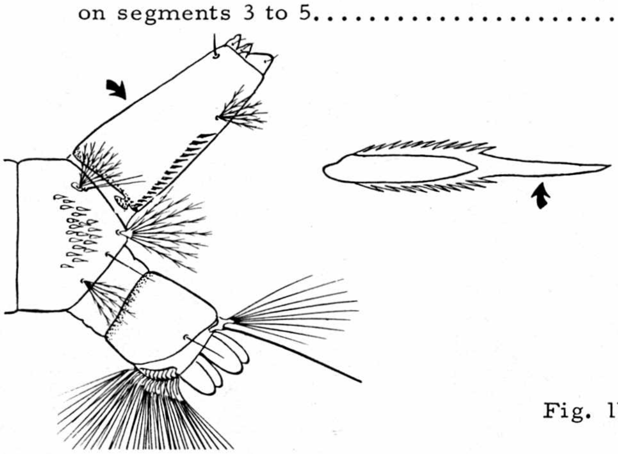


Fig. 11 A

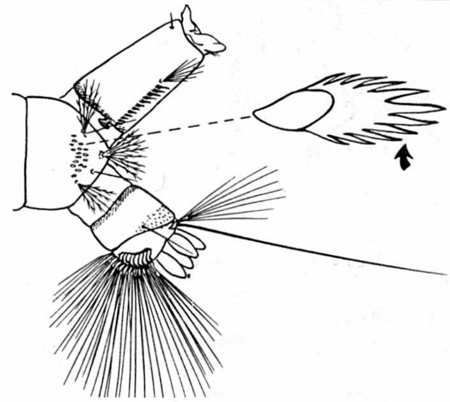


Fig. 11 B

12. Air tube without basal pair of tufts; 4 to 5 hairs or tufts of hairs beyond pecten (Fig. 12 A) ....(Genus Culex)............ 13

Air tube with a basal pair of hair tufts; many hairs or tufts of hairs beyond pecten (Fig. 12 B & C)...(Genus Culiseta)..........19

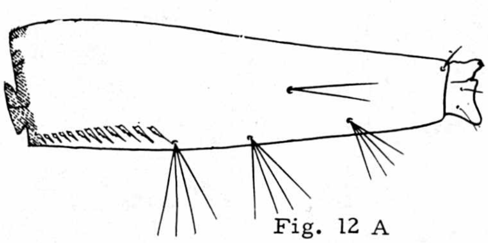


Fig. 12 A

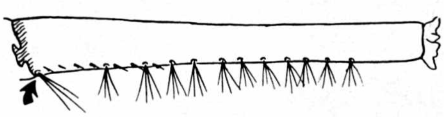


Fig. 12 B

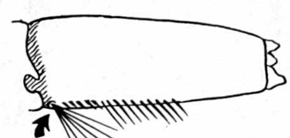


Fig. 12 C

* Usually not found in receptacles

13. Antenna with antennal tuft inserted at about middle of the shaft; air tube with a number of scattered single or double hairs (Fig. 13 A & B)........................*Culex restuans*

Antenna with antennal tuft inserted beyond the middle of the shaft; air tube with most of the tufts with two or more branches (Fig. 13 C & D).......................................14

Fig. 13 A

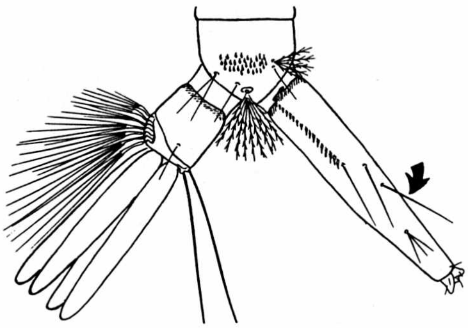


Fig. 13 B

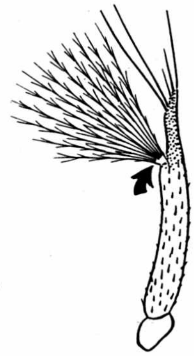


Fig. 13 C

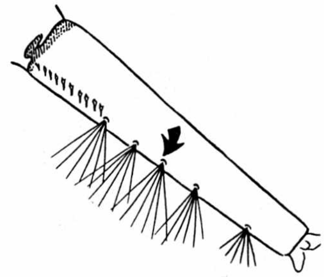


Fig. 13 D

14. Air tube moderately long, usually 4 to 6 times as long as basal width (Fig. 14 A).........15

Air tube very long, 6 to 10 times as long as basal width (Fig. 14 B).................... 16

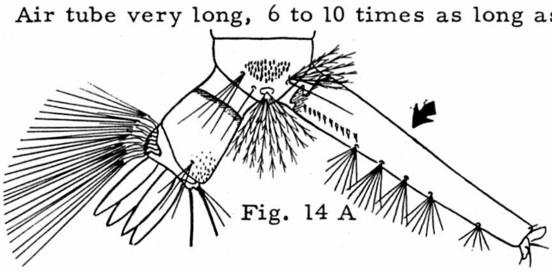


Fig. 14 A

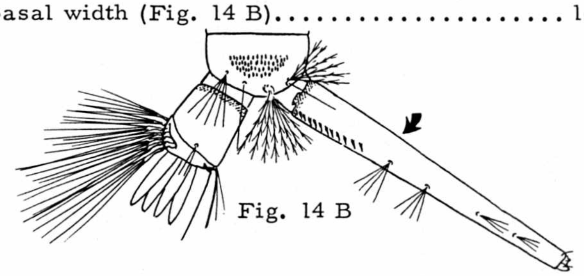


Fig. 14 B

15. Basal tubercle of hair tufts on air tube in straight line (Fig. 15 A)...........*Culex tarsalis*

Basal tubercle of hair tufts on air tube not in straight line (Fig. 15 B)....................
............................SOUTHERN HOUSE MOSQUITO *Culex quinquefasciatus*

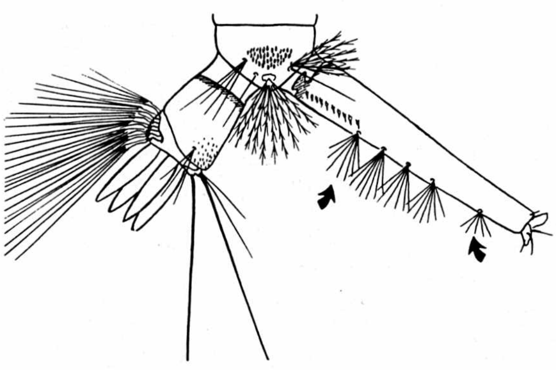


Fig. 15 A

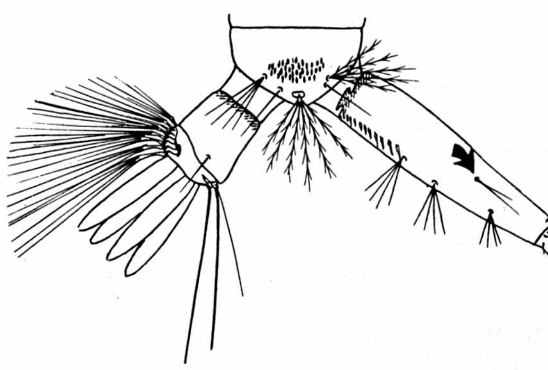


Fig. 15 B

16. Upper and lower head hairs single or double (Fig. 16 A)................. Culex territans

Upper and lower head hairs with three to four branches (Fig. 16 B).....................17

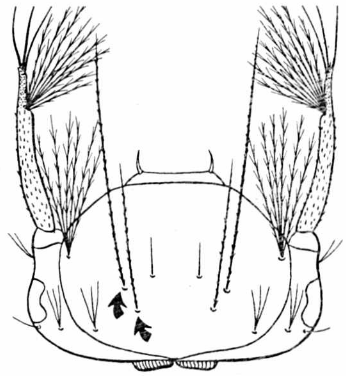


Fig. 16 A

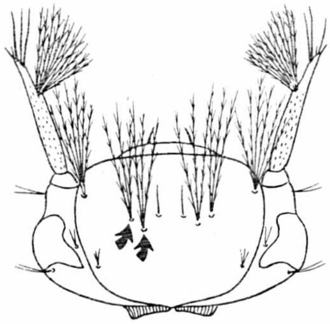


Fig. 16 B

17. Air tube with strong subapical spines (Fig. 17 A). Texas................Culex coronator*

Air tube without strong subapical spines (Fig. 17 B)....................................18

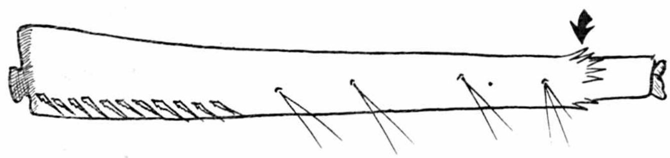


Fig. 17 A

Fig. 17 B

18. Thorax densely spiculate (spicules dark); lateral hair of anal segment usually single (Fig. 18 A & B).. Culex nigripalpus*

Thorax with few or no spicules; lateral hair of anal segment usually double (Fig. 18 C).... .... Culex salinarius

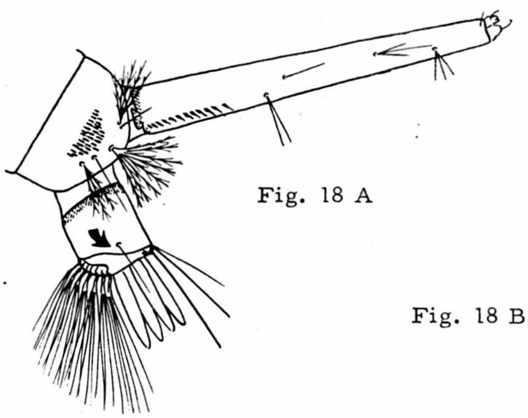


Fig. 18 A

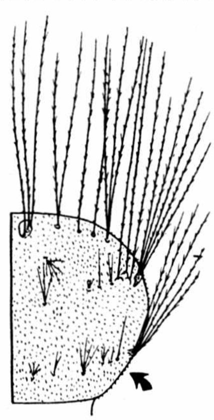


Fig. 18 B

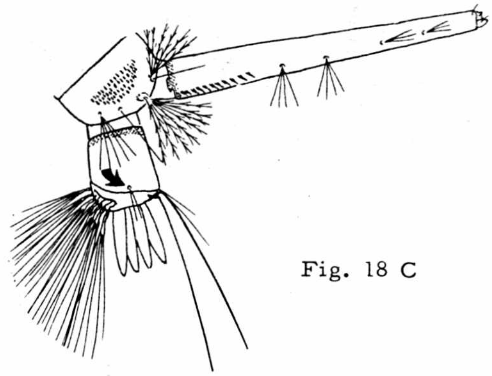


Fig. 18 C

19. Air tube long, 6 or more times as long as basal width, pecten followed by row of tufts; tuft of antenna inserted near end of shaft (Fig. 19 A & B)................ Culiseta melanura

Air tube average length, 2 to 4 times as long as basal width, pecten followed by row of hairs; tuft of antenna inserted at about middle of shaft (Fig. 19 C & D)...Culiseta inornata

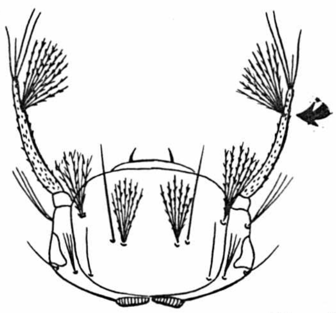


Fig. 19 A

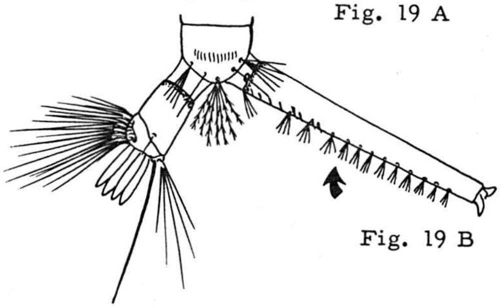


Fig. 19 B

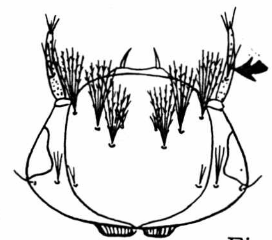


Fig. 19 C

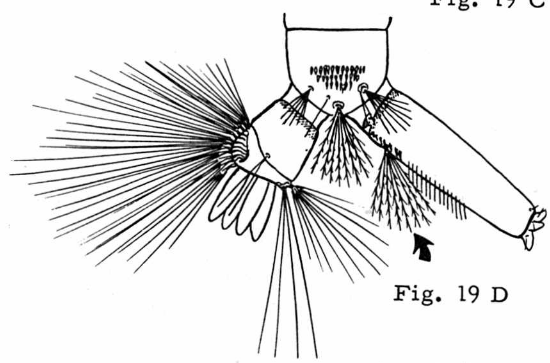


Fig. 19 D

20. Large larvae without comb scales on eighth abdominal segment, simply a plate bearing four hairs (Fig. 20 A).................................... Toxorhynchites rutilus

Small to medium larvae with a double row of comb scales on eighth abdominal segment (Fig. 20 B)...................................(Genus Orthopodomyia).......... 21

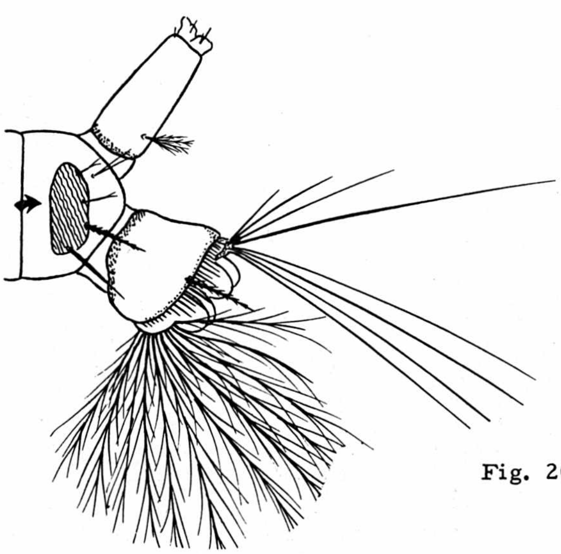


Fig. 20 A

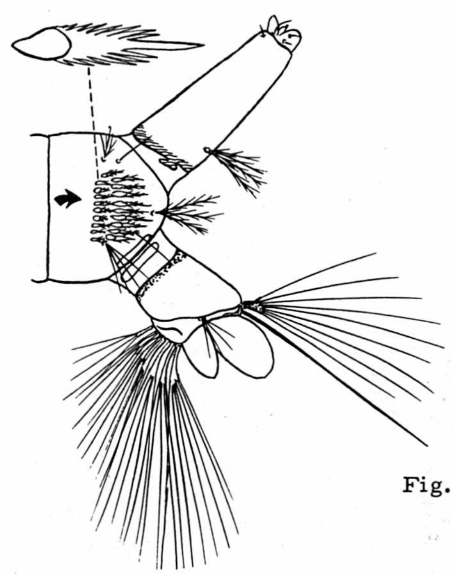


Fig. 20 B

21. Anterior row of comb scales about twice as wide as posterior row (17-23 scales to 6-10); in the 4th instar the eighth abdominal segment with large dorsal plate; lateral hair on anal segment single (Fig. 21 A). Larva usually pink, ... Orthopodomyia signifera

Anterior row of comb scales only slightly wider than posterior row (12-17 scales to 8-12); dorsal plate absent on eighth abdominal segment in all stages; lateral hair on anal segment multiple (Fig. 21 B). Larva usually straw colored. . . . . Orthopodomyia alba*

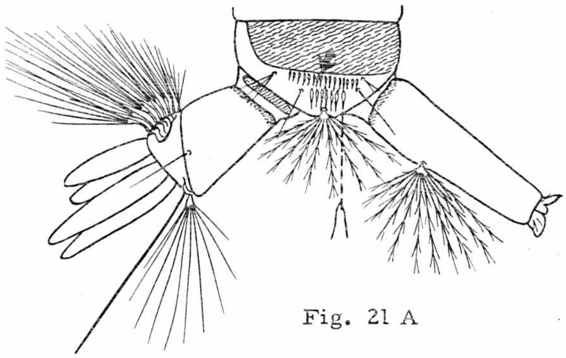


Fig. 21 A

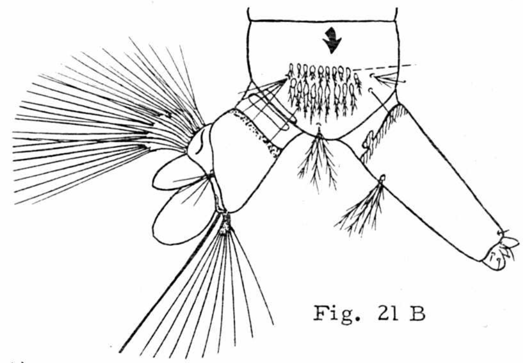


Fig. 21 B

22. Outer clypeal hairs densely branched (Fig. 22 A). 23

Outer clypeal hairs simple (Fig. 22 B). 25

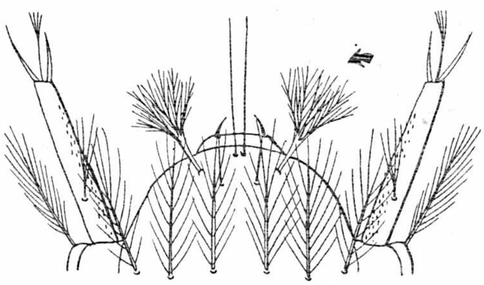


Fig. 22 A

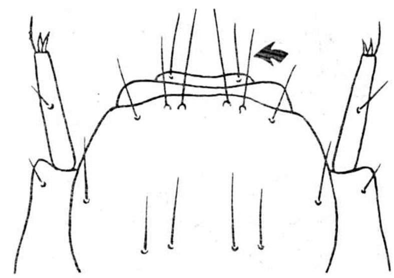


Fig. 22 B

23. Basal tubercles of inner clypeal hairs usually separated by at least the diameter on one tubercle; antepalmate hair usually single on segments IV and V (Fig. 23 A & B). . . . . Anopheles quadrimaculatus*

Basal tubercles of inner clypeal hairs usually separated by less than the diameter of one tubercle; antepalmate hair usually double or triple on segments IV and V (Fig. 23 C & D). 24

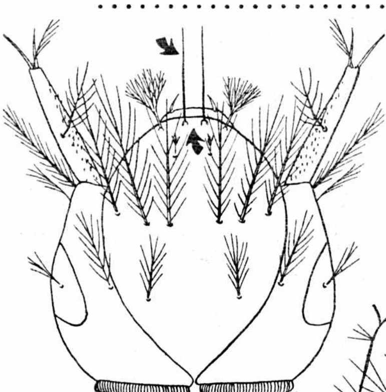


Fig. 23 A

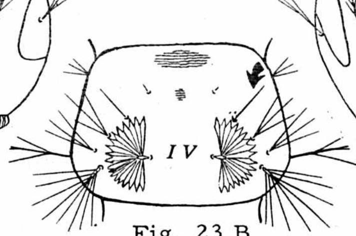


Fig. 23 B

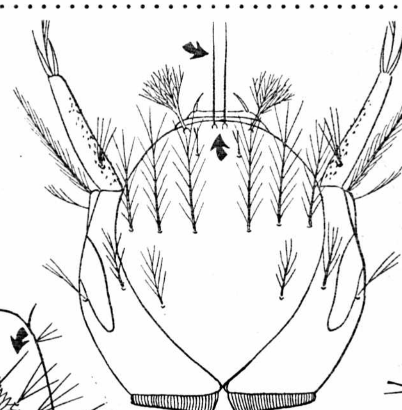


Fig. 23 C

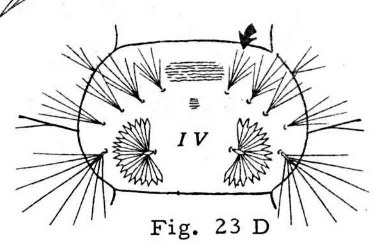


Fig. 23 D

24. Abdominal segments 4 and 5 with several hairs with 3-5 branches or more in front of palmate hairs (Fig. 24 A)..Anopheles crucians

Abdominal segments 4 and 5 with a large single or double hair in front of palmate hairs (Fig. 24 B).. Anopheles punctipennis

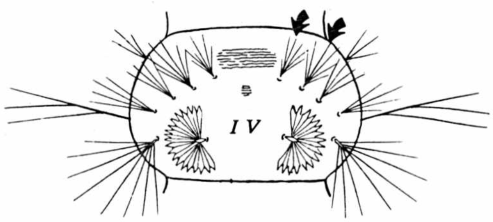


Fig. 24 A

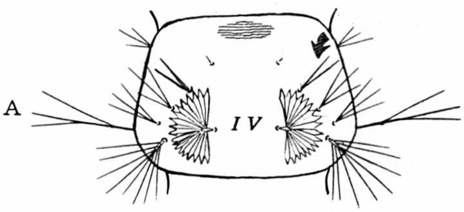


Fig. 24 B

25. Lateral abdominal hairs long and plumose on segments I to VI; all head hairs single (Fig. 25 A & B). Larvae small.......................................Anopheles barberi*

Lateral abdominal hairs long and plumose only on segments I to III; many of the head hairs branched (Fig. 25 C & D). Texas........................ Anopheles pseudopunctipennis

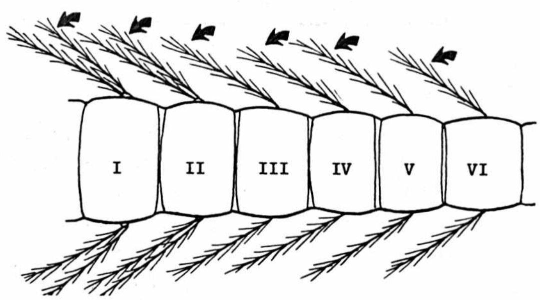


Fig. 25 A

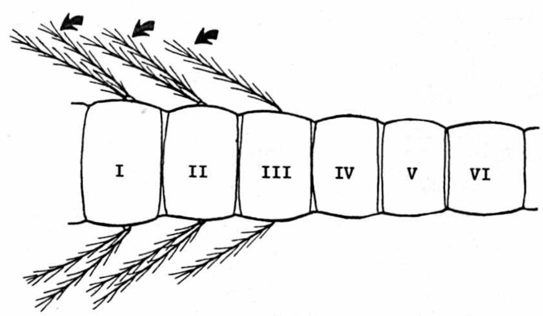


Fig. 25 C

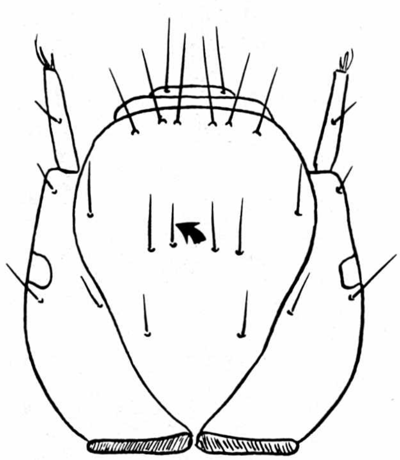


Fig. 25 B

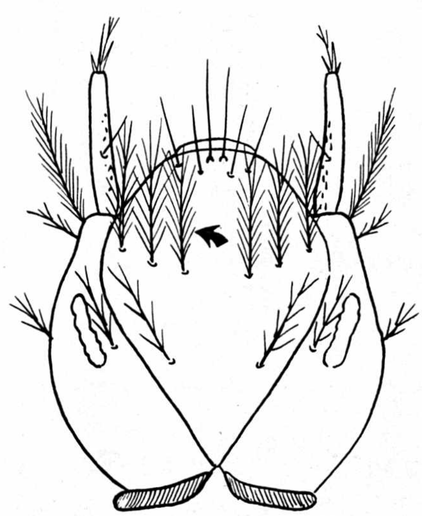
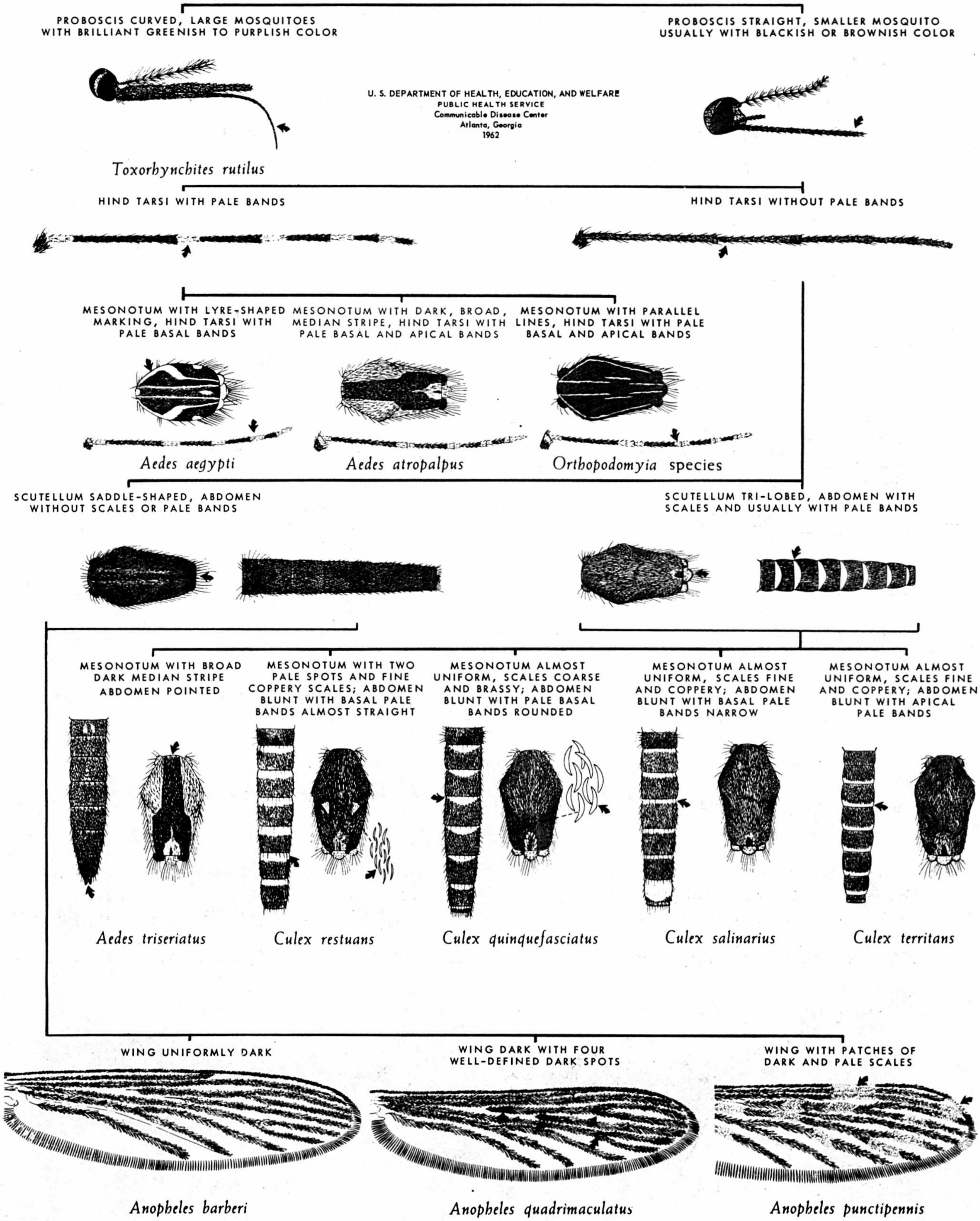


Fig. 25 D

PICTORIAL KEY TO SOME COMMON ADULT MOSQUITOES ASSOCIATED WITH *AEDES AEGYPTI*

Harry D. Pratt and Chester J. Stojanovich



KEY TO ADULTS OF RECEPTACLE-BREEDING MOSQUITOES

Milton E. Tinker and Chester J. Stojanovich

1. Legs with white bands (Fig. 1 A)..2

Legs unbanded, entirely dark or terminal segments white (Fig. 1 B).................... 13

Fig. 1 A

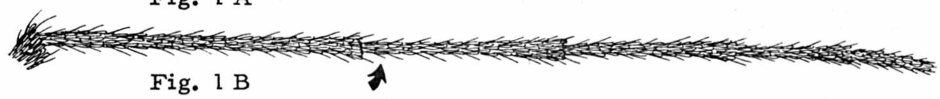


Fig. 1 B

2. Proboscis unbanded (Fig. 2 A).. 3

Proboscis with white band (Fig. 2 B)... 8

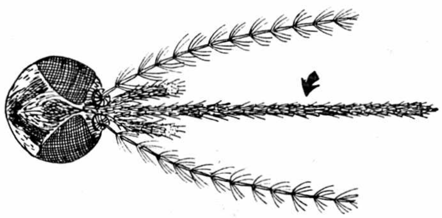


Fig. 2 A

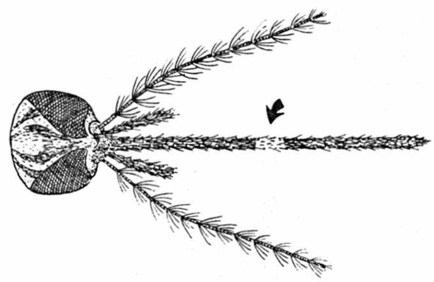


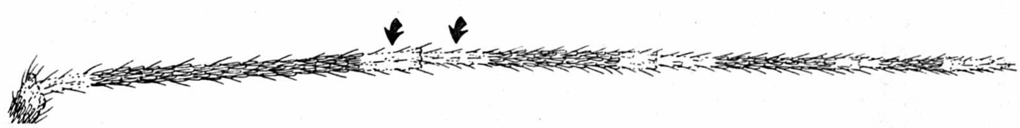
Fig. 2 B

3. Tarsal segments with white bands at basal ends (Fig. 3 A)............................ 4

Tarsal segments with white bands on both ends (Fig. 3 B)..............................6

Fig. 3 A

Fig. 3 B



4. Thorax with lyre-shaped marking formed by silvery-white scales on a blackish background; silvery-white scales on clypeus and palpi (Fig. 4 A)....................................... ....YELLOW FEVER MOSQUITO Aedes aegypti

Thorax without lyre-shaped marking; clypeus and palpi dark (Fig. 4 B).................5

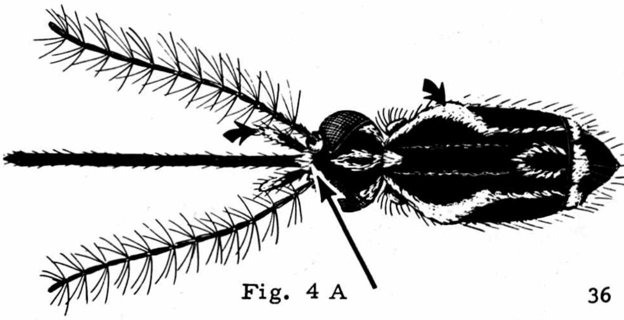


Fig. 4 A

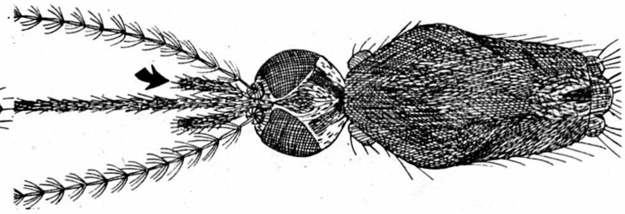


Fig. 4 B

5. Hind femur entirely pale on all aspects of anterior or basal half (Fig. 5 A); abdomen with pale bands not notched on midline (Fig. 5 B). Texas.................. Aedes zoosophus

Hind femur with anterior or basal half of ventral surface dark or with scattered pale scales (Fig. 5 C); abdomen with pale bands on segments 3-6 notched at middle (Fig. 5 D)........ .... Aedes vexans*

Fig. 5 A

Fig. 5 C

Fig. 5 B

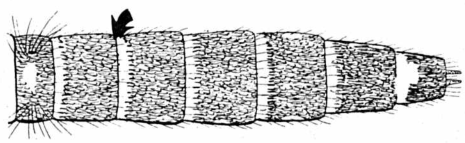
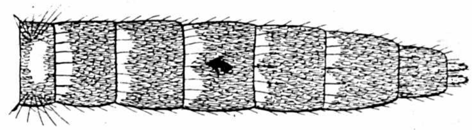
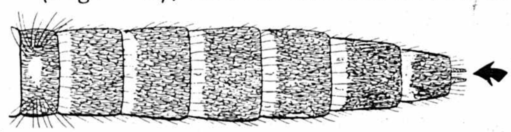


Fig. 5 D



6. Abdomen pointed, segment 7 of abdomen narrowed, segment 8 much narrowed and retractile (Fig. 6 A); mesonotum with a broad patch of pale scales on each side (Fig. 6 B)........... ....Aedes atropalpus

Abdomen blunt, segment 7 of abdomen not narrowed, segment 8 short but not retractile (Fig. 6 C); mesonotum uniform or with fine lines of pale scales (Fig. 6 D)..............7



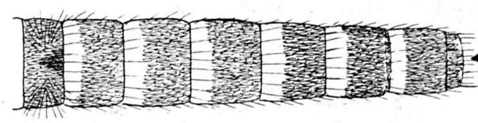


Fig. 6 A

Fig. 6 C

Fig. 6 B

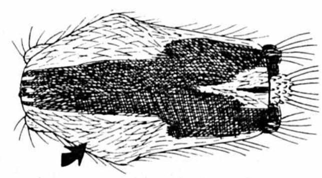
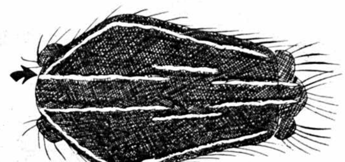


Fig. 6 D



7. Four fine longitudinal white lines on thorax (Fig. 7 A); scattered white scales on femur and tibia (Fig. 7 B); mixed dark and white scales on wings (Fig. 7 C).................... .... Orthopodomyia signifera or Orthopodomyia alba

No fine lines on thorax (Fig. 7 D); no scattered white scales on femur and tibia (Fig. 7 E); dark scales on wings (Fig. 7 F). Texas............................. Culex coronator

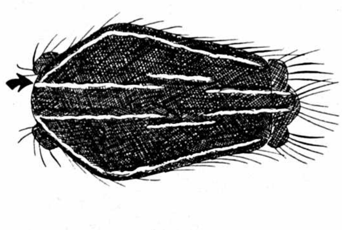


Fig. 7 A

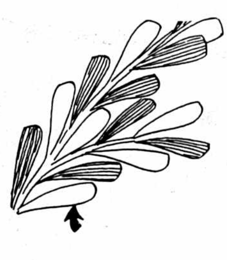


Fig. 7 C

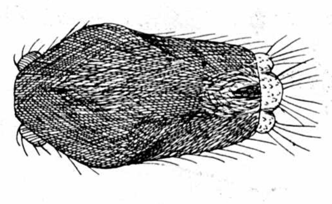


Fig. 7 D

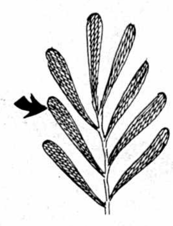


Fig. 7 F

Fig. 7 B

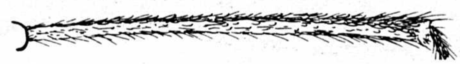


Fig. 7 E

* Usually not found in receptacles

8. Abdomen blunt at tip (Fig. 8 A)..9

Abdomen pointed at tip (Fig. 8 B)...10

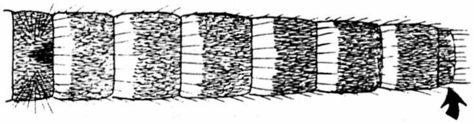


Fig. 8 A

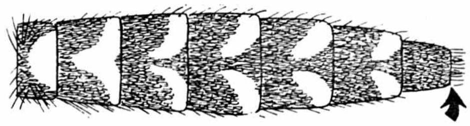


Fig. 8 B

9. White stripe on side of femur, no pale band near apex of tibia, no pale ring at middle of first segment of hind tarsus (Fig. 9 A & B)..................................Culex tarsalis

No stripe on side of femur, pale band present near apex of tibia, pale ring present at middle of first segment of hind tarsus (Fig. 9 C & D).....................Mansonia perturbans*

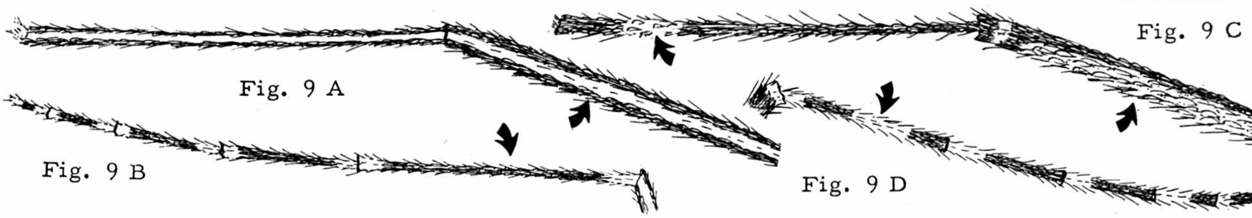


Fig. 9 A

Fig. 9 B

Fig. 9 C

Fig. 9 D

10. Pale ring at middle of first segment of hind tarsus (Fig. 10 A); mixed dark and white scales on wings (Fig. 10 B).. 11

No pale ring at middle of first segment of hind tarsus (Fig. 10 C); only dark scales on wings (Fig. 10 D).. 12

Fig. 10 A

Fig. 10 C

Fig. 10 B

Fig. 10 D

11. Pale band near apex of femur, white spots on side of tibia (Fig. 11 A); upper surface of abdomen with cross bands only (Fig. 11 B)..........................Psorophora confinnis*

No pale band on femur or tibia, no spots on side of tibia (Fig. 11 C); upper surface of abdomen with long longitudinal stripe as well as cross bands (Fig. 11 D).....Aedes sollicitans*

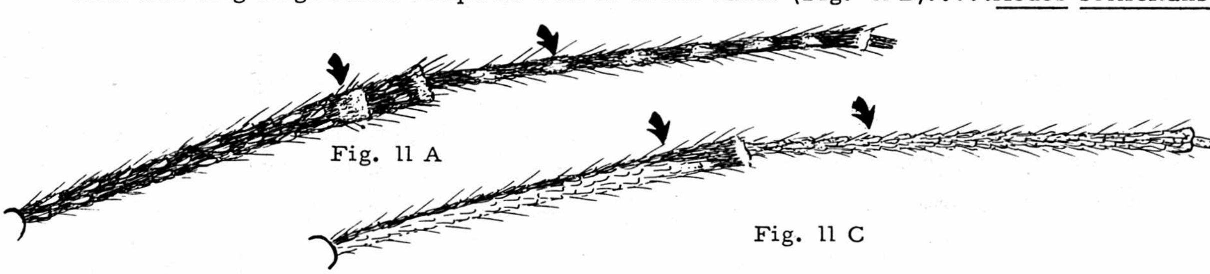


Fig. 11 A

Fig. 11 C

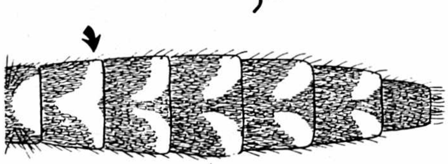


Fig. 11 B

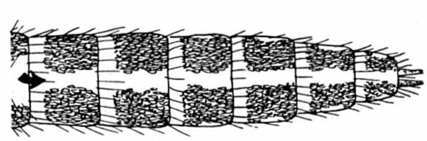


Fig. 11 D

* Usually not found in receptacles

12. Scattered white scales on legs (Fig. 12 A); upper surface of abdomen with median longitudinal pale stripe as well as cross-bands (Fig. 12 B)....................... Aedes mitchellae*

No scattered white scales on legs (Fig. 12 C); upper surface of abdomen with only pale basal cross-bands (Fig. 12 D).. Aedes taeniorhynchus*

Fig. 12 A

Fig. 12 C

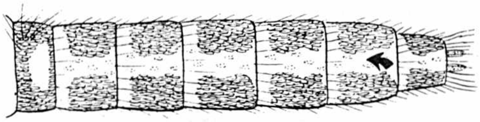


Fig. 12 B

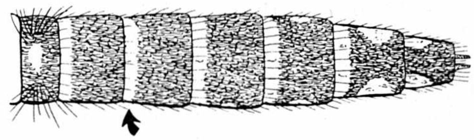


Fig. 12 D

13. Palpi much shorter than proboscis (Fig. 13 A).. 14

Palpi at least 1/2 as long as proboscis (Fig. 13 B).. 21

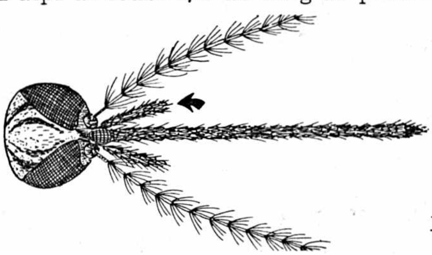


Fig. 13 A

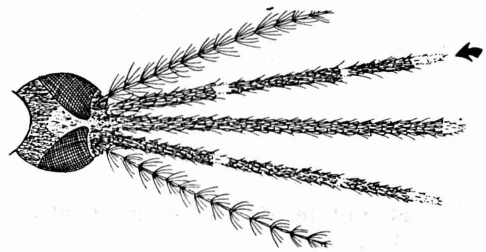


Fig. 13 B

14. Abdomen pointed, segment 7 of abdomen narrowed, segment 8 much narrowed and retractile (Fig. 14 A); mesonotum with a broad patch of pale scales on each side (Fig. 14 B).. Aedes triseriatus

Abdomen blunt, segment 7 of abdomen not narrowed, segment 8 short but not retractile (Fig. 14 C); Mesonotum without a patch of pale scales on each side (Fig. 14 D)............... 15

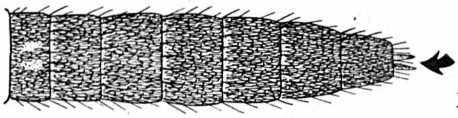


Fig. 14 A

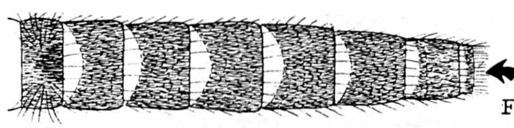


Fig. 14 C

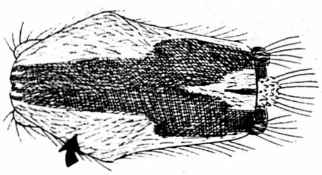


Fig. 14 B

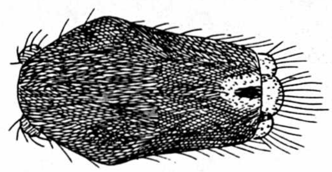


Fig. 14 D

15. Base of subcosta without a tuft of hairs on underside of wing (Fig. 15 A); spiracular bristles absent; proboscis short and straight.......................... Genus Culex........... 16

Base of subcosta with tuft of hairs on underside of wing (Fig. 15 B); spiracular bristles present (Fig. 15 C); proboscis long and recurved................. Genus Culiseta........ 20

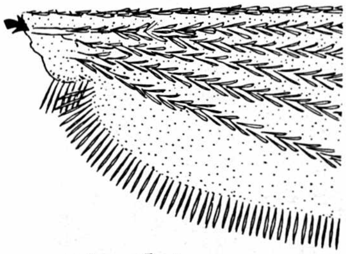


Fig. 15 A

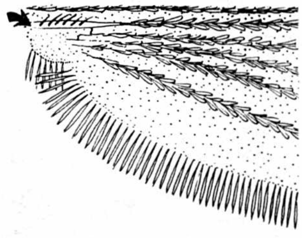


Fig. 15 B

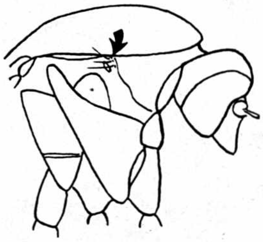


Fig. 15 C

* Usually not found in receptacles

16. Abdomen with white scales at apex of segments (Fig. 16 A).............. Culex territans

Abdomen with white scales at bases of segments (Fig. 16 B)......................... 17

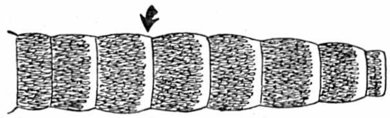


Fig. 16 A

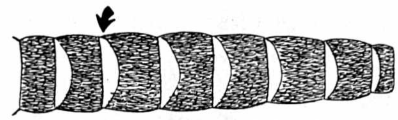


Fig. 16 B

17. Abdominal segments with distinct basal bands or lateral spots of white scales (Fig. 17 A).. 18

Abdominal segments with narrow dingy-white basal bands (Fig. 17 B)................. 19

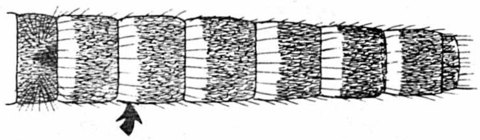


Fig. 17 A

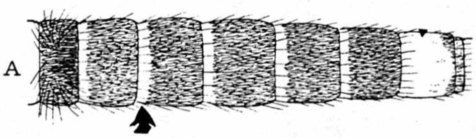


Fig. 17 B

18. Abdomen with rounded pale bands (Fig. 18 A); mesonotum without pale spots, covered with relatively coarse brownish, grayish or silvery scales (Fig. 18 B)..................... .... SOUTHERN HOUSE MOSQUITO Culex quinquefasciatus

Abdomen with pale bands almost straight (Fig. 18 C); mesonotum with two or more pale spots (sometimes only one or two scales) against a background of fine coppery scales (Fig. 18 D).. Culex restuans

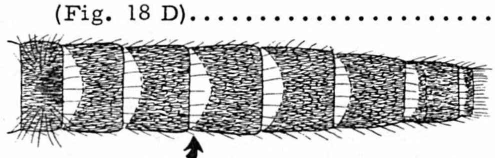


Fig. 18 A

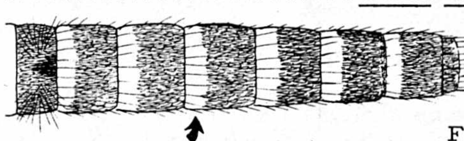


Fig. 18 C

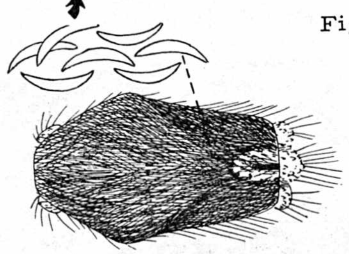


Fig. 18 B

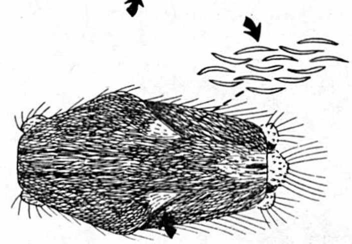


Fig. 18 D

19. Pleuron with several groups of broad scales, each group usually comprised of more than 6 scales (Fig. 19 A); seventh and eighth abdominal segments almost entirely covered with dingy yellow scales (Fig. 19 B).................................... Culex salinarius

Pleuron with few or no scales (when present, rarely more than 5 or 6 in a single group (Fig. 19 C); seventh and eighth abdominal segments banded (Fig. 19 D)..Culex nigripalpus

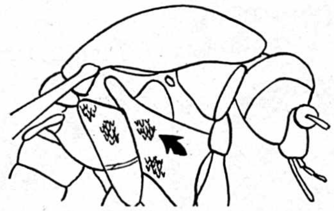


Fig. 19 A

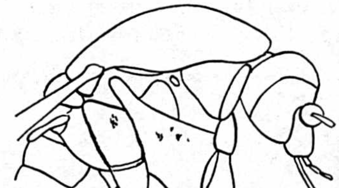


Fig. 19 C

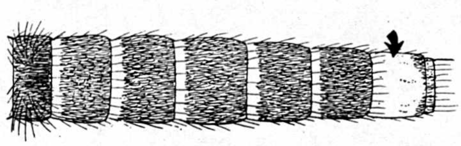


Fig. 19 B

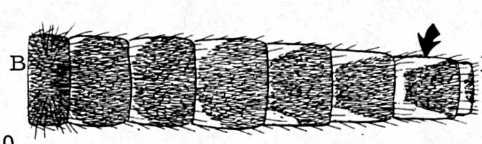


Fig. 19 D

20. With broad lightly scaled wings (Fig. 20 A); legs and wings sprinkled with white scales; a large species...Culiseta inornata

Wings and legs entirely dark scaled (Fig. 20 B); a small dark species.. Culiseta melanura

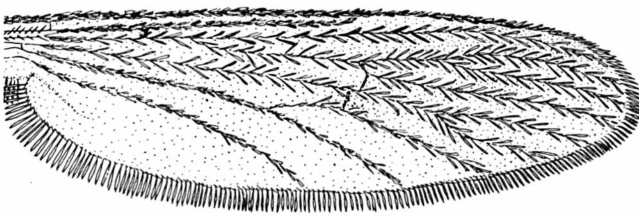


Fig. 20 A

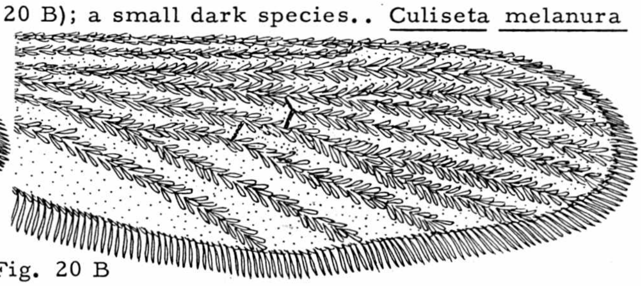


Fig. 20 B

21. Palpi about 2/3 length of proboscis; proboscis strongly turned downward (Fig. 21 A); large mosquito with brilliant metallic bluish greenish or purplish coloring..Toxorhyncites rutilus

Palpi about as long as proboscis, proboscis not strongly turned downward (Fig. 21 B)... 22

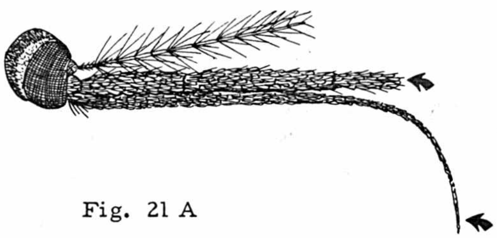


Fig. 21 A

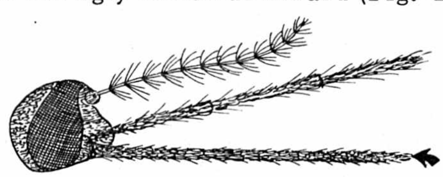


Fig. 21 B

22. Wings with definite areas of white or yellowish scales (Fig. 22 A)...................... 23

Wings without definite areas of white or yellowish scales (Fig. 22 B).................. 25

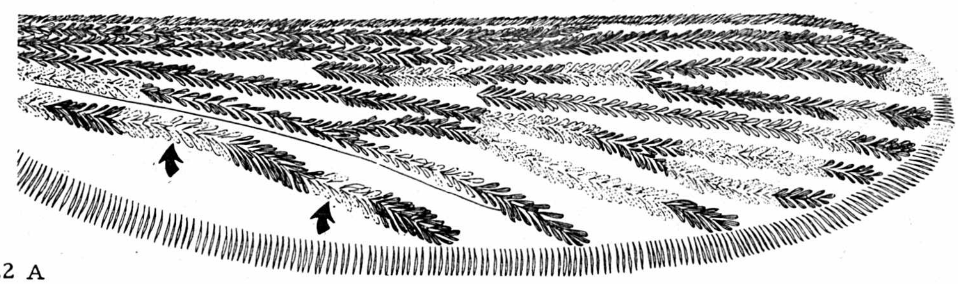


Fig. 22 A

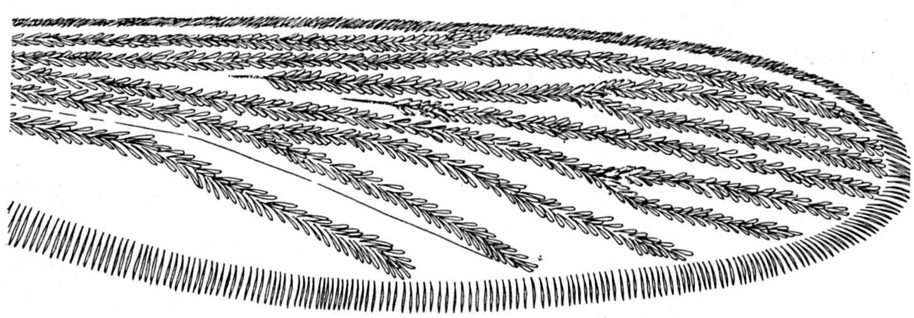


Fig. 22 B

23. Palpi entirely dark (Fig. 23 A); costa with 2 white spots (Fig. 24 B). Anopheles punctipennis

Palpi marked with white (Fig. 23 B); costa with 1 or 2 spots (Fig. 24 A & B)............24

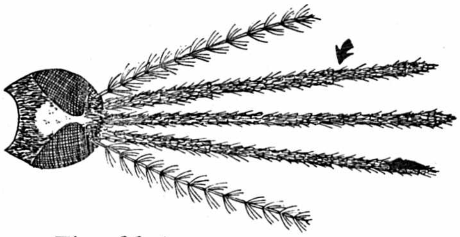


Fig. 23 A

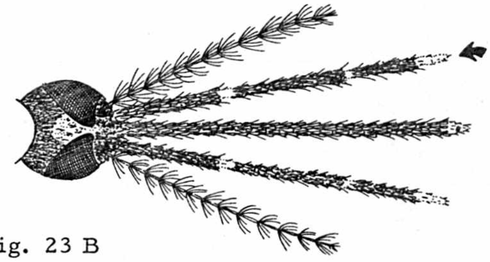


Fig. 23 B

24. Costa with white spot at tip of wing only (Fig. 24 A)................Anopheles crucians*

Costa with 2 white spots (Fig. 24 B).................... Anopheles pseudopunctipennis

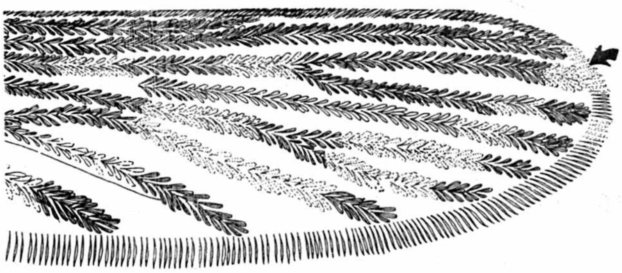


Fig. 24 A

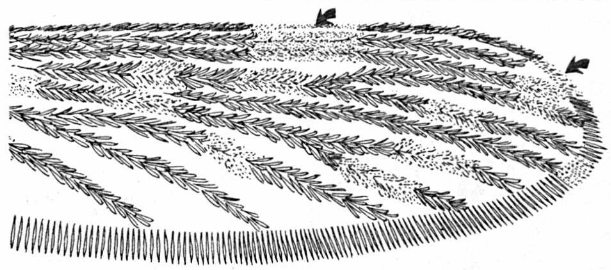


Fig. 24 B

25. Wing spotted (Fig. 25 A); thoracic bristles not very long (Fig. 25 B); mesothorax dull in rubbed specimens; medium sized species..................Anopheles quadrimaculatus*

Wing not spotted (Fig. 25 C); thoracic bristles very long (Fig. 25 D); mesothorax shiny in rubbed specimens; small species................................ Anopheles barberi*

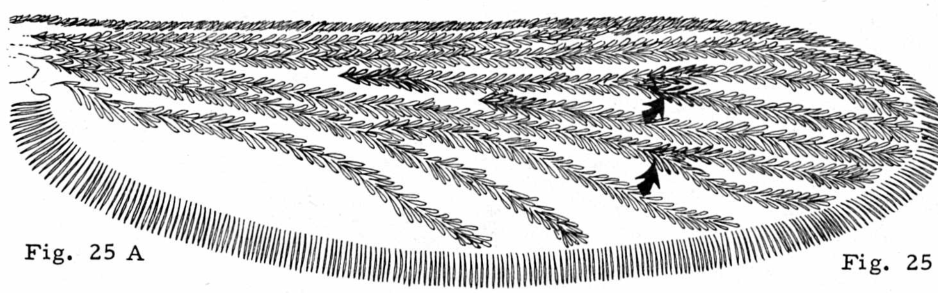


Fig. 25 A

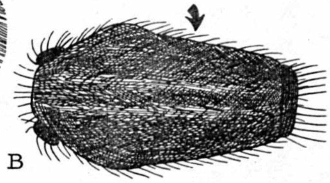


Fig. 25 B

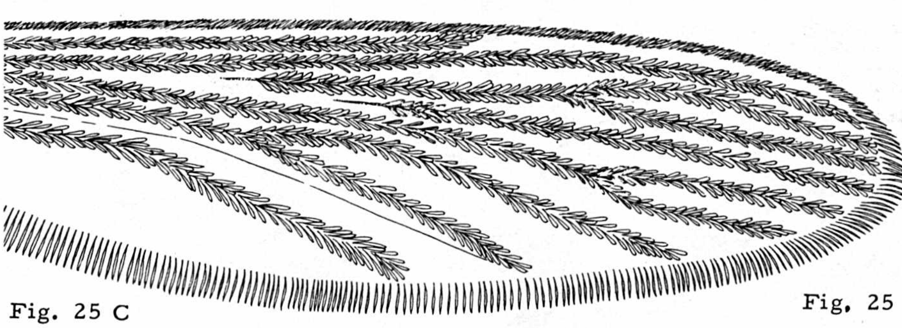


Fig. 25 C

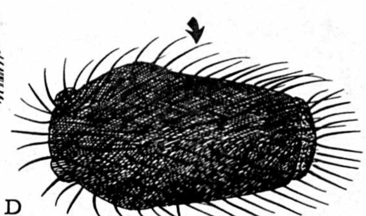


Fig. 25 D

* Usually not found in receptacles

SELECTED REFERENCES

Carpenter, S. J., and W. J. LaCasse. 1955. Mosquitoes of North America (North of Mexico). Berkeley and Los Angeles, Univ. of Cal. Press, pp. vii + 353 + 127 pl.

Flynn, A. D., H. F. Schoof, H. B. Morlan, and J. E. Porter. 1964. Susceptibility of seventeen strains of *Aedes aegypti* (L.) from Puerto Rico and the Virgin Islands to DDT, dieldrin, and malathion. Mosq. News 24 (2):118-123.

Hayes, George R., and Milton E. Tinker. 1958. The 1956-1957 status of *Aedes aegypti* in the United States. Mosq. News 18 (3):253-257.

King, W. V., G. H. Bradley, C. N. Smith, and W. C. McDuffie. 1960. A Handbook of Mosquitoes of the Southeastern United States. Agr. Handbook No. 173, Ag. Res. Serv., U. S. Dept. of Agriculture. Supt. of Documents, U. S. Govt. Printing Office, Washington 25, D.C., 188 pp. (75 cents).

Morlan, Harvey B. 1964. The relationship of laboratory colonies to the *Aedes aegypti* eradication program. Mosq. News 24 (4):388-389.

Pratt, Harry D. 1956. A check list of the mosquitoes (Culicinae) of North America (Diptera: Culicidae). Mosq. News 16 (1):4-10.

Pratt, Harry D., R. C. Barnes, and K. S. Littig. 1963. Mosquitoes of Public Health Importance and Their Control. Pub. Health Soc. Pub. No. 772, Pt. VI, DHEW, Washington, D.C., pp. iv + 64. Supt. of Documents, U. S. Govt. Printing Office, Washington 25, D.C., (40 cents).

Pratt, Harry D. 1964. Virus diseases transmitted by mosquitoes and other arthropods. Mosq. News 24 (2):91-103.

Ross, H.H. 1949. How to Collect and Preserve Insects. Circular 39, Natural History Survey Division, Urbana, Ill., 59 pp.

Schliessmann, D. J. and Nora J. Magennis. 1964. Initial plan for the eradication of *Aedes aegypti* from the United States. Pest Control 7 (32):34-48.

Schliessmann, D.J. 1964. The *Aedes aegypti* eradication program of the U. S. Mosquito News 24 (2):124-132.

Tinker, Milton E. 1964. Larval habitat of *Aedes aegypti* (L.) in the United States. Mosq. News 24 (4):426-432.

Tinker, Milton E., and George R. Hayes, Jr. 1959. The 1958 *Aedes aegypti* distribution in the United States. Mosq. News 19 (2):73-78.