

SABOTEUR MOSQUITOES

With 12 Illustrations

By HENRY STAGE

LIFE STORY OF THE MOSQUITO

With 6 Illustrations and 10 Paintings

By GRAHAM FAIRCHILD

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Life Story of the Mosquito

BY GRAHAM FAIRCHILD *

ONE of my earliest experiences with mosquitoes occurred when as a youngster I was returning from Barro Colorado Island in the Canal Zone. On leaving, I noticed a small boil on my leg, which grew progressively more painful. I finally went to the ship's doctor to have it treated. After applying a compress, he extracted from the wound a disgusting white grub nearly half an inch long.

On arriving in Washington, I told my entomologist friends of my experience. They were much annoyed with me for not allowing the grub to finish its career in my leg! It was the larva of the human botfly (*Dermatobia hominis*), an insect then rare in collections.

The adult female, which looks much like an overgrown bluebottle fly, hovers about animals and people in the woods. It does not bite, but comes only to seek mosquitoes and other small flies. These the botfly catches carefully in flight, without injuring them, and glues its slender eggs to the sides and bottoms of their abdomens (Color Plate VIII).

It even seems able to gauge the "pay load" each can carry. On small mosquitoes it will deposit only a few eggs, but to large flies it will attach fifty or more.

When a mosquito bearing these eggs lights on a man or an animal, the body warmth causes the young larvae to crawl out and drop to the skin. They soon burrow in and in a few months grow to maturity, crawl out, drop on the ground, and pupate.

Years later when I went to Brazil to study mosquitoes, I became only too well acquainted with this nuisance. It is a serious pest to Brazilian cattle, rendering some hides worthless and seriously detracting from the value of others. Each grub leaves a hole in the skin. We often saw cattle with backs and shoulders one mass of lumps from the grubs.

Wild animals are also attacked. We obtained a number of grubs from the tail of an ocelot.

Of course, the biggest nuisance was to ourselves. I remember extracting eight young grubs from my ankle on one occasion, and later found others in my scalp and back (page 190).

Of all the winged pests, mosquitoes are the most widely distributed. There is scarcely a spot on the globe where mosquitoes do not take their toll of blood and sleepless hours.

People who come from places notorious for mosquitoes are sometimes proud of the size and viciousness of their native product. Many

times I have listened to spirited debates on the relative nuisance value of Alaska and New Jersey mosquitoes.

To prove the superiority of the Louisiana breed, a New Orleans friend told of being awakened one hot night by the voices of two large mosquitoes, discussing whether they should eat him immediately or carry him away. The first proposal won, for, as its proponent said, "If we try to carry him off, one of the big fellows will take him away from us."

People have immortalized these nuisances by naming places after them. There is a Mosquito Mountain in Maine and several states have Mosquito Creeks.

One mosquito looks pretty much like another to most people. Indeed, even those who have made a life study of them are not always able to agree on just what a particular specimen may be.

Mosquito Portraits Done from Life

The accompanying color series of mosquitoes, painted exclusively for the NATIONAL GEOGRAPHIC MAGAZINE, graphically depicts some of the more interesting and important members of the vast mosquito family. Extreme accuracy of detail characterizes each painting. Even the hairs on legs and antennae of each mosquito are accurately drawn. To paint such exact reproductions required months of first-hand observations. Small breeding pools were set up in the studio, so that the entire life cycle of mosquitoes could be carefully observed.

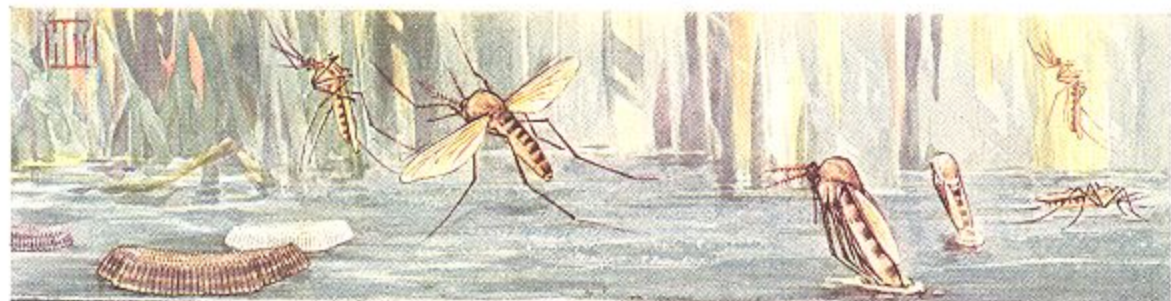
As the painting progressed, Dr. Alan Stone, entomologist of the Bureau of Entomology and Plant Quarantine, Department of Agriculture, carefully checked each detail to assure precision.

Mosquitoes belong to the most primitive division of flies, a division which includes the crane flies; the sand flies; the black flies, or buffalo gnats of the north woods; the punkies, or "no-see-ums"; and several other groups.

Mosquitoes may be distinguished from their relatives by their slender bodies, long legs, and long, biting beaks. These are flexible tubes containing slender lancetlike organs attached at the base to a powerful suction pump. Their bodies and wings are clothed with scales (Plate IV and page 191).

* Formerly a medical entomologist with the Gorgas Memorial Laboratory in Panama, Dr. Graham Fairchild is now a First Lieutenant in the Sanitary Corps, Army of the United States, working on new insect repellents and insecticides.

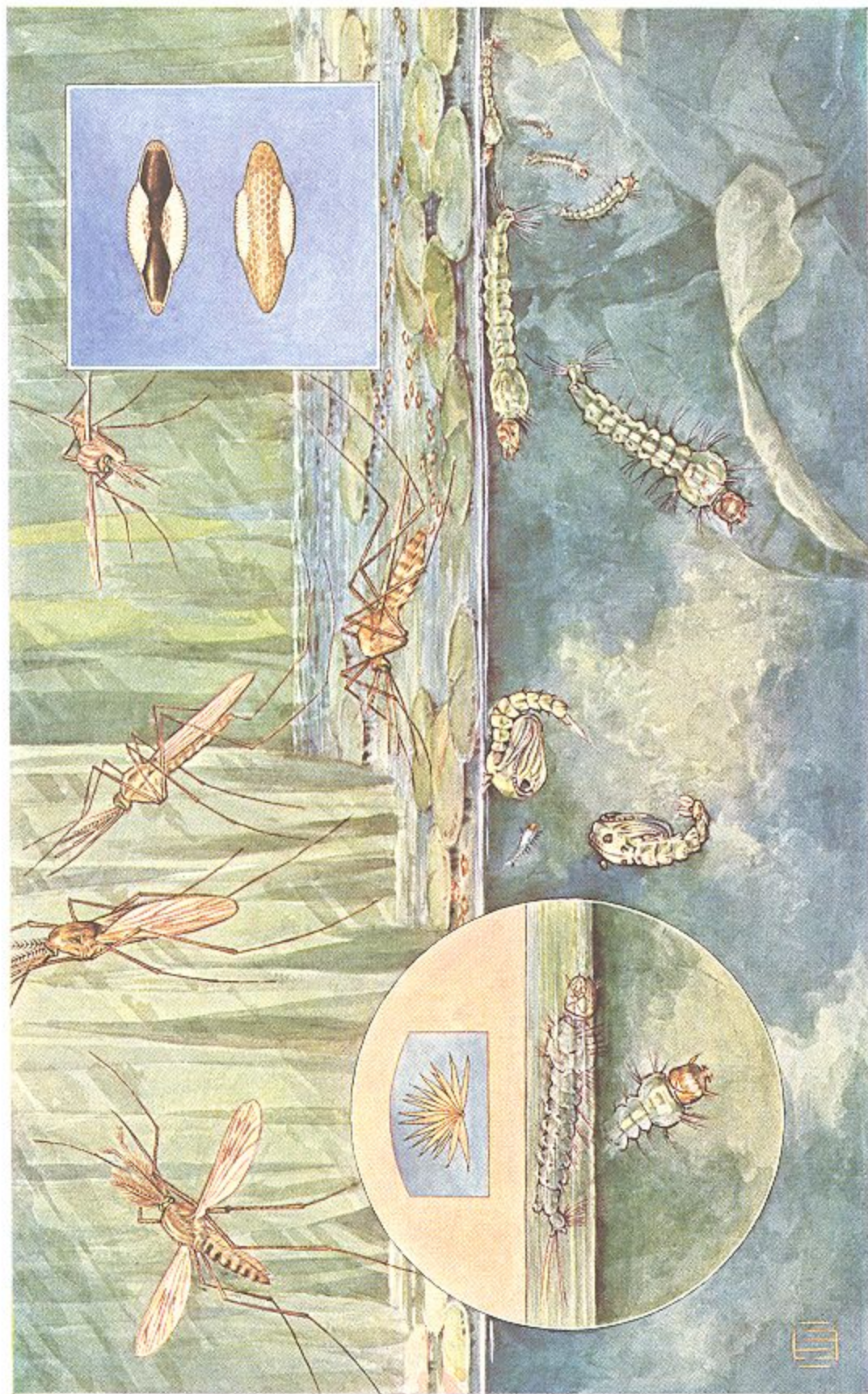
Life Story of the Mosquito



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Clean Up That Rubbish Pile! Mosquitoes Breed in Old Tin Cans

Bassinets for southern house mosquito's babies may be a barrel or old bottle. The female lays a raft of 150 eggs (upper left). *Culex quinquefasciatus* is one of the species in the Tropics which spread elephantiasis.



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In a Quiet Pool, Nature Produces a Ferry Command for the Spread of Malaria

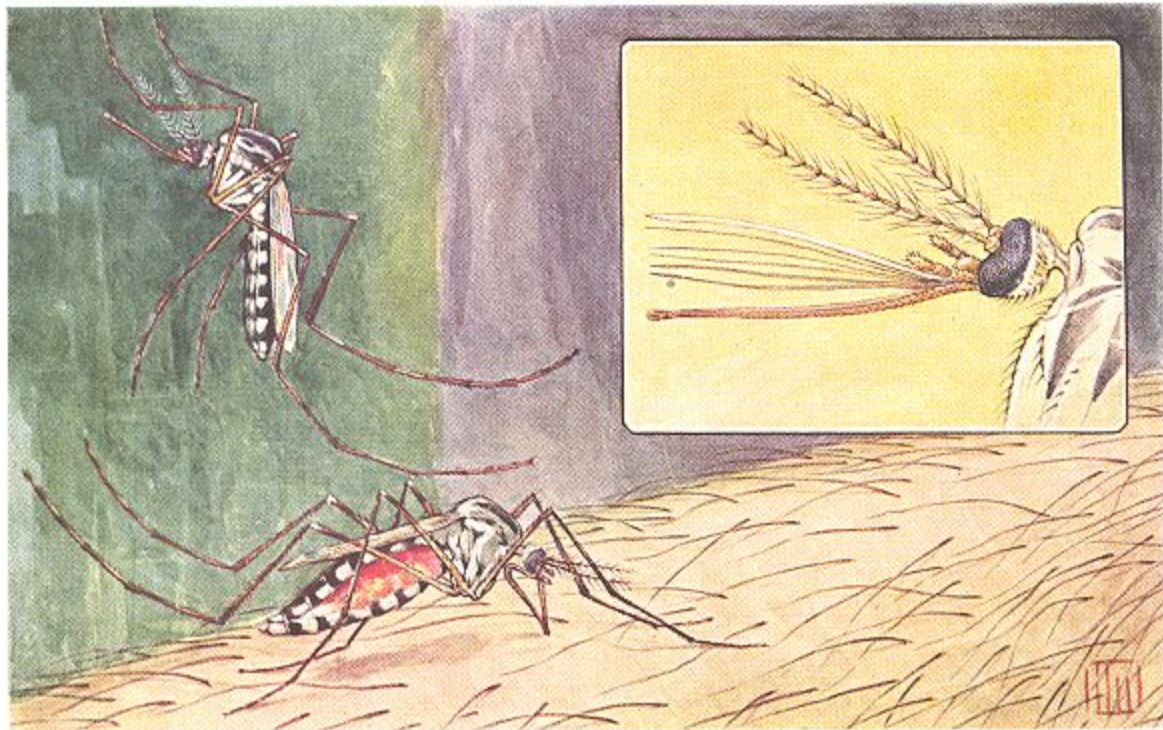
Here the female of the common malaria mosquito, *Anopheles quadrimaculatus*, lays her eggs singly. Insert, upper right, shows them greatly enlarged. Within two days they hatch into tiny wigglers. Eight days later the full-grown larvae (inset), much like a butterfly's chrysalis. In another two days, the back of the pupal shell splits and the young, full-grown mosquito emerges, ready for its nuisance raids (see Plate V). Crude oil spread on such pools smotheres and poisons the pupae and wigglers, which must come to the surface to breathe through their tails. An effective and cheaper larvicide is Paris green.



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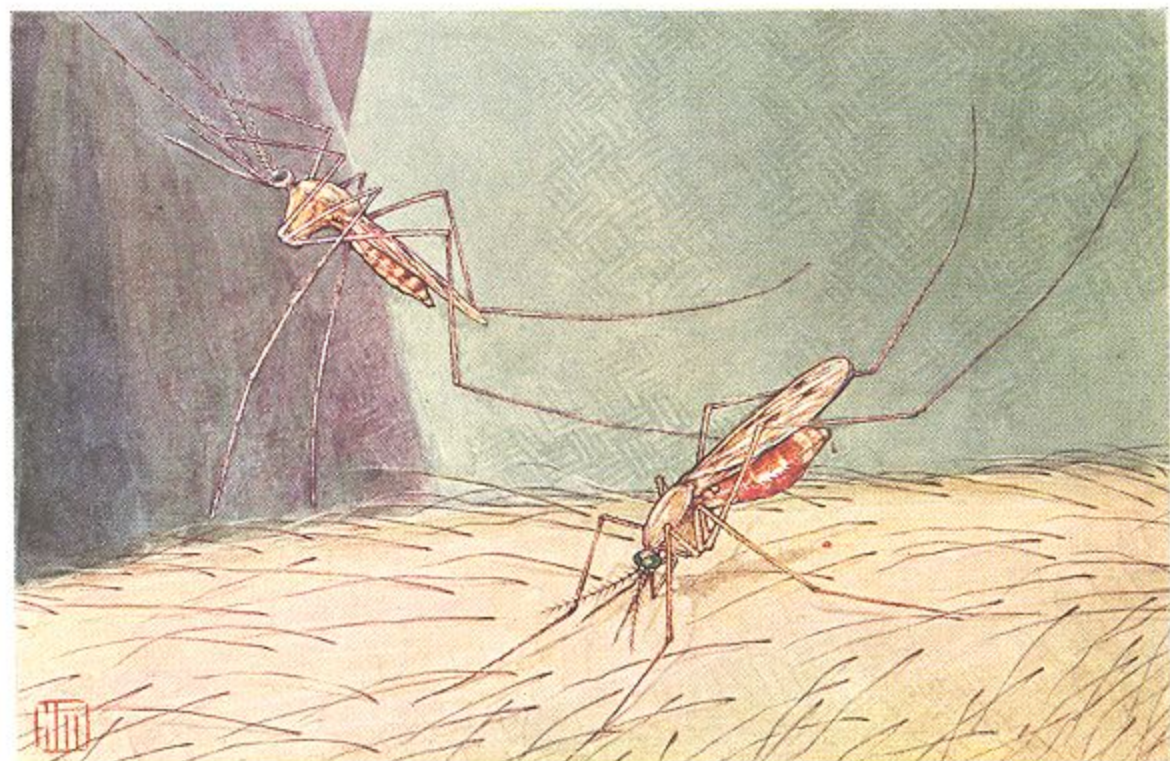
Forest-loving Mosquitoes Lay Their Eggs in Water-filled Leaves of Tropical Plants or Tree Holes

A Trinidad malaria carrier lives only in bromeliads attached to trees. A cannibal type, *Megarrhinus splendens*, breeds in bamboo trunks in Malaya. Since it eats the larvae of other mosquitoes but does not bite man, it has been introduced into the Fiji Islands to help exterminate a harmful species there. Starting lower left, clockwise: *Megarrhinus hypoptes*, *Orthopodomyia fascipes*, *Aedes terreus*, *Sabethoides chloropferus*, *Limatus durhami*, *Aedes mediovittatus*, *Aedes fuscithorax*, *Sabethes cyanus*, *Culex neitempytus*, all female, and *Megarrhinus haemorrhoidalis* (female and plumed male). Extreme right, *Wyeomyia melanoccephala* (female).



Ouch! A Mosquito Darts Her Stinger into a Man's Arm

Inset shows the mosquito's dagger and blood-sucking tube, with protecting hairs above. (*Aedes atropalpus*.)

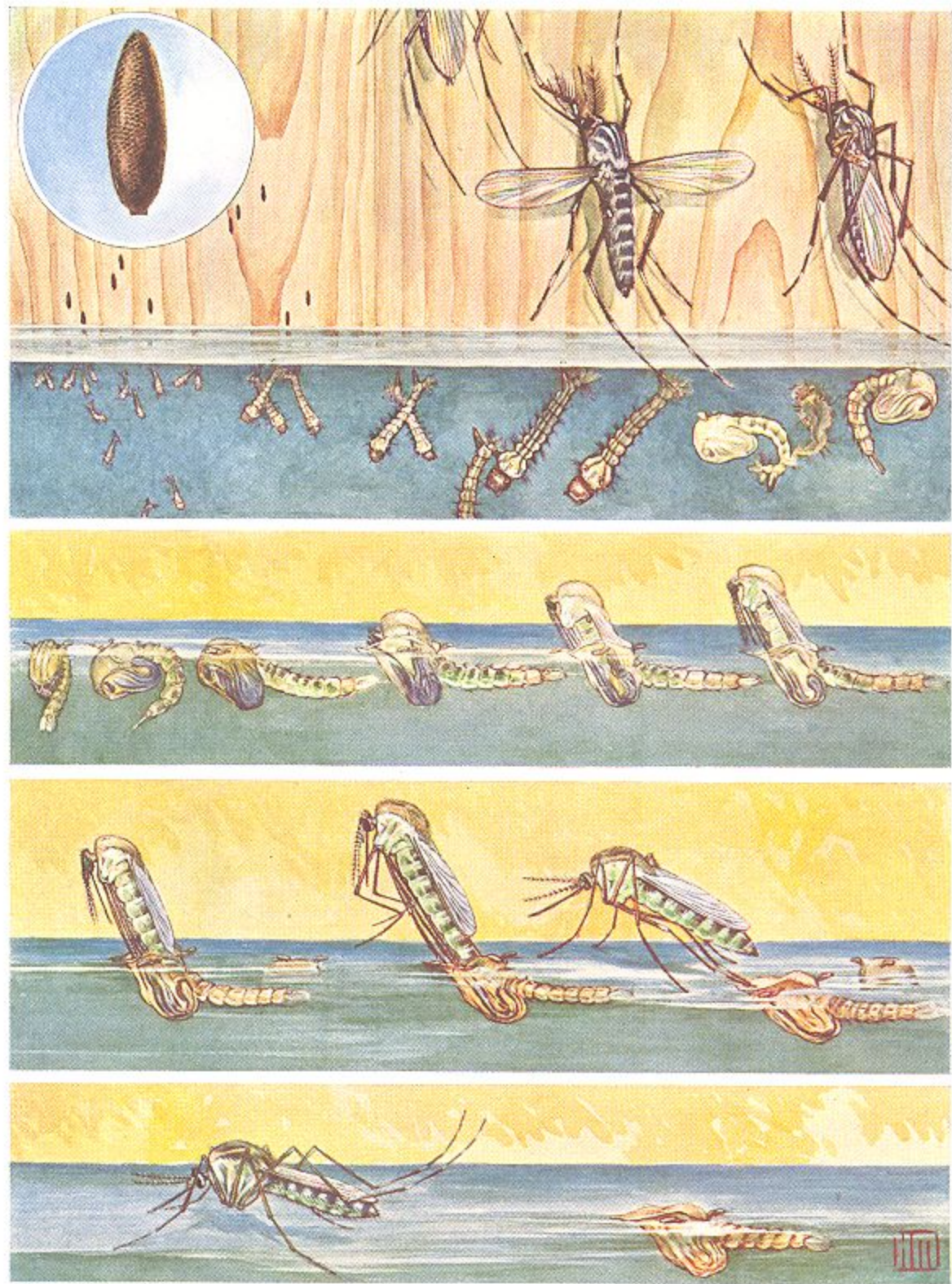


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If That Skeeter Stands on Her Head, Beware! It's Mrs. Anopheles

In exchange for a sip of human blood, *Anopheles quadrimaculatus* may leave a malaria parasite acquired while stinging a malaria patient. Her bite is harmless unless she has tasted infected blood. Females only have a mouth fitted for biting.

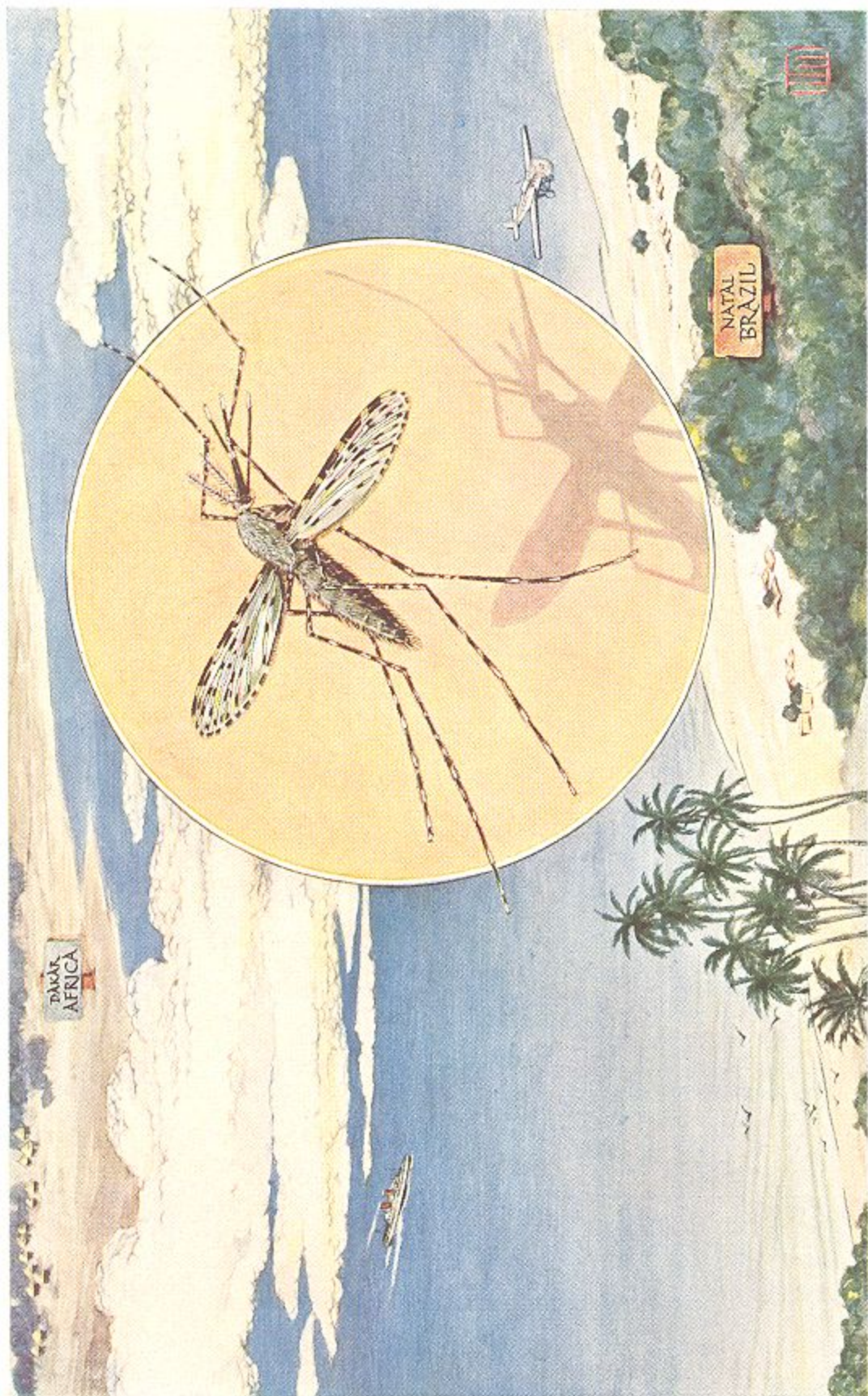
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Birth of the Dainty but Vicious *Aedes aegypti*, Carrier of Yellow Fever

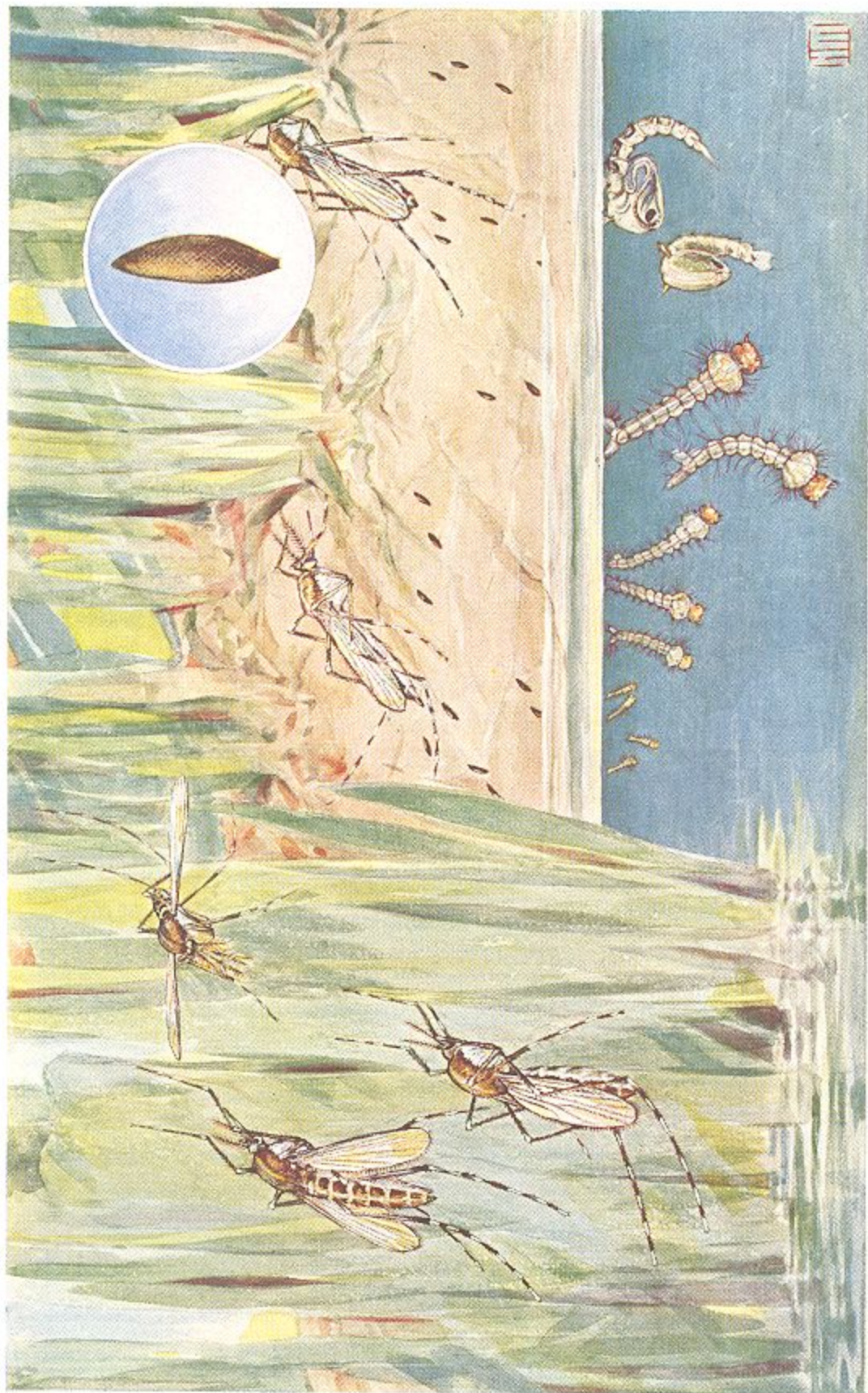
Upper panel shows female (right) laying eggs close to the water in a rain barrel (enlarged egg in inset). Immediately below, larvae, "hanging by their tails," breathe air at the surface; pupae to the right. The three lower panels portray the emergence of the mosquito from pupa to winged saboteur.



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From Dakar, Africa, This Malaria Carrier Hitchhiked 1,865 Miles across the Ocean to Brazil, by Airplane or Ship

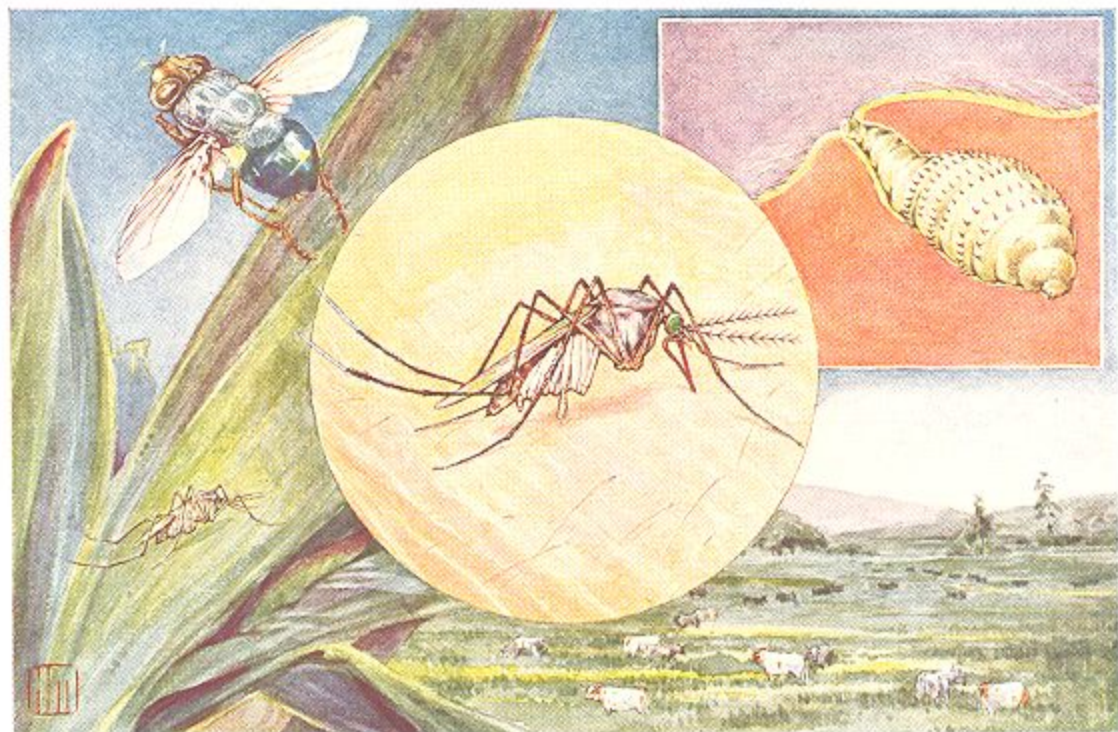
Discovered in Natal in 1930, the rapidly multiplying *Anopheles gambiae*, whose home is in Africa, caused 14,000 deaths from malaria in northeast Brazil during 1938-39. Then the Brazilian Government and the Rockefeller Foundation put an army of 2,000 doctors, technicians, and other workers in the field. In a dramatic 19-month fight, the intruder from overseas was exterminated in the Western Hemisphere. Ever since, planes from Africa have been treated with a lethal spray before landing in South America, to kill any mosquito stowaways.



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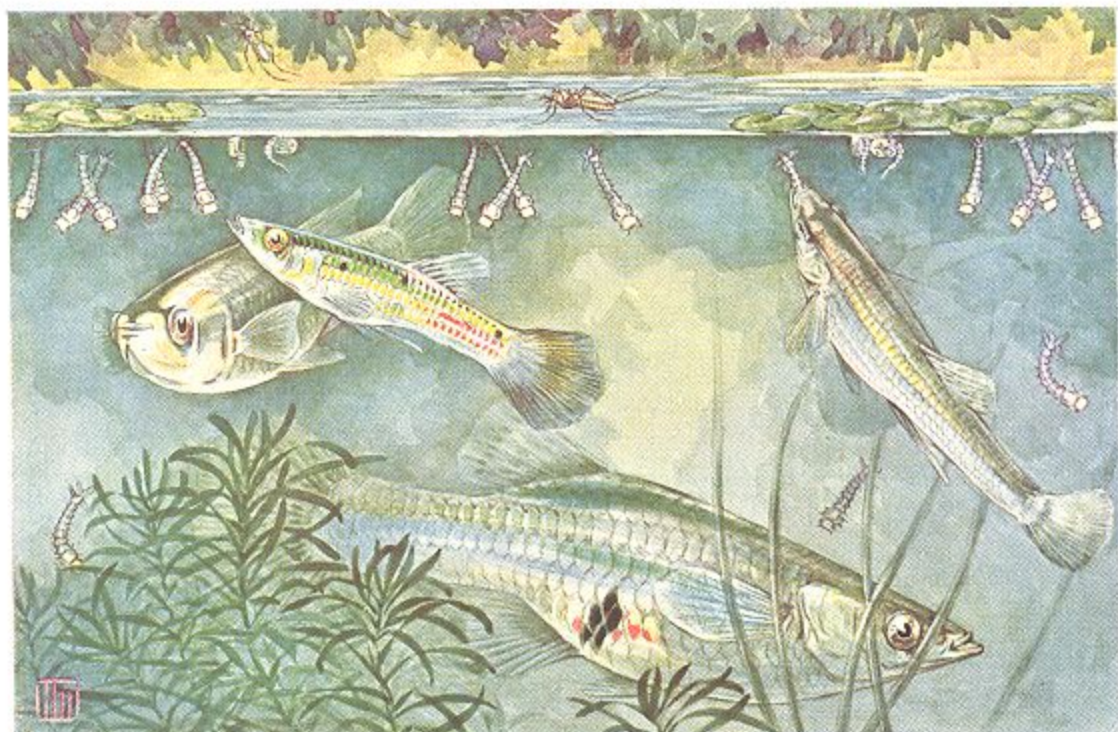
Ever Slap a Skeeter at the Seashore? Here Is Where the Villains Come From

These salt-marsh mosquitoes (*Aedes sollicitans*) lay their eggs on damp ground, to hatch when high tides cover them. The newly hatched wigglers grow in the water, for all mosquito larvae are aquatic. They are called wigglers because of the way they swim. Larvae have changed to pupae in lower right. When the adult mosquitoes emerge, they will head for the nearest summer resort. Every seaside vacationer knows what they do when they get there.



Insect Triple Play: Botfly, to Mosquito, to Man's Arm!

The botfly (*Dermatobia hominis*, upper left) captures a mosquito (*Psorophora ferox*) and lays eggs under its belly. When the mosquito is "on target" (center insert), body warmth causes eggs to hatch. Larvae burrow beneath skin (upper right) and grow, causing painful sores.



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To Control Mosquitoes, Keep Guppies (left) and Top Minnows (right) in Your Pond
Minnows (*Gambusia affinis*), from southeastern United States, now eat wrigglers in many tropic areas.

Sand flies, black flies, and punkies also bite, but the first can be recognized by their smaller size and hairy wings, the second by their stout bodies, short legs and proboscis, and absence of scales, and the last by their tiny size, seldom as much as an eighth of an inch long. The crane flies, although resembling enormous mosquitoes, do not bite.

Mosquitoes are divided into two main groups: those which do not bite, of interest only to a specialist; and those which do bite, of interest to nearly everyone in some degree.

Mosquito Tastes First, Then Draws Blood

Only the female mosquito bites, but it is scarcely worth while to try to segregate the sexes before swatting them! First the female selects a likely spot, perhaps over some small vein, then presses the tubular portion of her proboscis closely against the skin and drives in the cutting lancelets (Plate IV).

If the spot seems not to yield results, she may pull her knives out and try again. When she has "struck oil," she injects saliva into the wound. Some students believe that this saliva is an irritant causing swelling and an increased flow of blood to the area around the bite; others that it prevents clotting of blood and makes it possible for the insect to suck it up more easily.

People who live in badly infested places may become relatively immune to the bites of their native pests. This immunity, however, seems not to hold for imported varieties.

After a year of bites by Goiaz mosquitoes, to which I had become almost insensible, I exposed myself to the lancelets of some other kinds in Paraná. The results were both surprising and painful, for my legs became so swollen I could scarcely walk.

Apparently people differ greatly in their reactions to the bites, and the same person may be more sensitive at some times than at others. A story told about an expedition on the Amazon illustrates this point.

As long as the Indian paddlers ate their own food, they were not troubled by the hordes of mosquitoes and black flies, but when their supplies gave out and they were fed the white man's rations, they immediately began to suffer as much as he.

The song of the mosquito, surpassed only by the buzz of the dentist's drill in unpleasant suggestion, is not yet entirely understood. The vibration of the wings, reaching perhaps 500 strokes to the second, probably has much to do with it, but that is apparently not the whole story. The wings may be removed without entirely stopping the hum.

Response to sounds seems well developed in

mosquitoes, especially in the males, though the sound range is not great. Swarms of male mosquitoes were seen to drop to the ground when certain tones were played near them. A machine which makes a loud buzz of a given pitch attracts them to an electrified screen, where they are killed. The sense of hearing is thought to be located in the base of the antennae, the feathery shaft catching the sound waves as a radio antenna catches the radio waves.

Like many other insects, mosquitoes pass through four distinct stages during their lives: egg, larva or wiggler, pupa, and adult. The eggs are laid singly or in groups, and in innumerable places.

The southern house mosquito (*Culex quinquefasciatus*) lays its eggs in clusters of 150 at a time (Plate I). The eggs, glued together, float on their ends in a raft. They are laid on the water in rain barrels, discarded tin cans, cisterns, gutters—wherever a little water collects.

In warm weather the eggs hatch in one to three days, and the young wigglers swim about in the water. As the larvae must have air, they are provided at the rear of their bodies with long tubes with which they pierce the surface film (page 192). Hanging thus, they seem suspended by their tails! Oil floating on the water effectively clogs the breathing tubes and suffocates the larvae.

Wigglers feed on small organisms and dissolved foods in the water and grow rapidly, reaching their full growth, under favorable conditions, in seven to ten days.

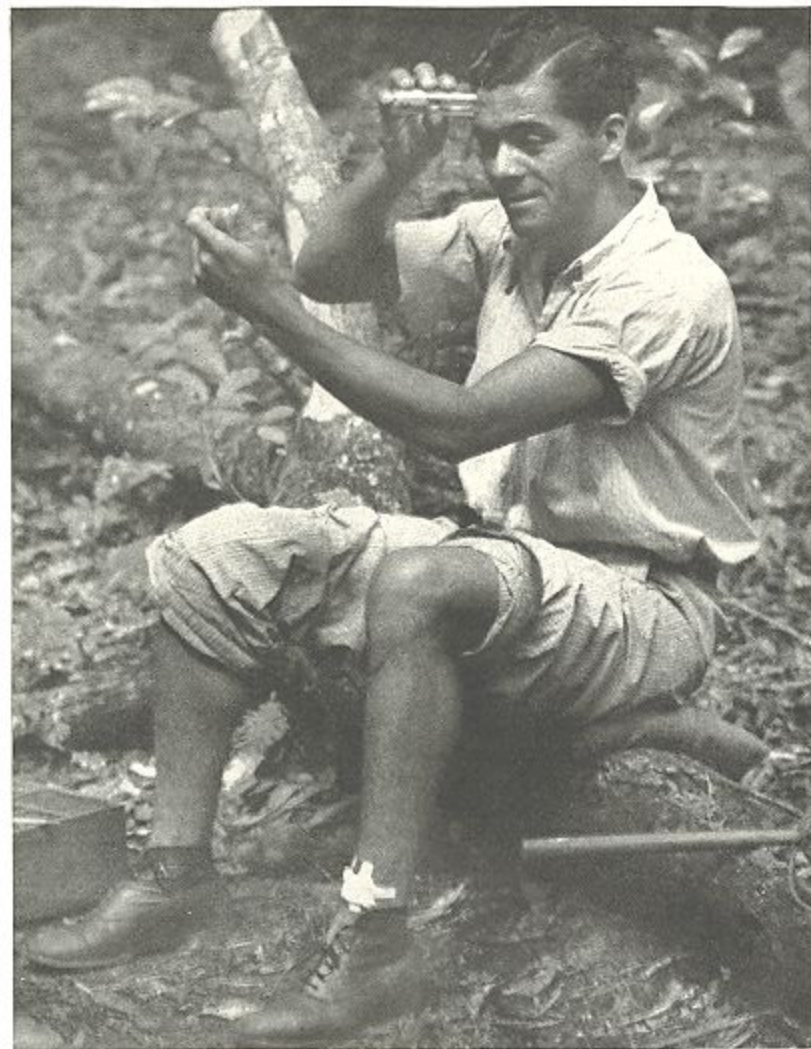
Since all insects have a stiff and unyielding covering, they must shed it from time to time to allow for growth. In mosquitoes this is done during the larval period, when shedding is easier because there are fewer complicated structures such as wings and legs.

Small mosquitoes, therefore, are not the young of bigger ones. When they reach the winged state, they grow no more.

A Skeeter Is Born

Most mosquito wigglers shed their skins four times in the larval stage. The last molt gives rise to the pupa, which is quite different in appearance from the larva. Though able to swim about actively, the pupa takes no food and prefers to float quietly at the surface of the water (Plate II).

During the pupal period, which generally lasts only a few days, the tissues of the larva break down into a sort of soup. The structures of the adult mosquito develop from this unorganized mass. This is one of the most amazing processes in Nature.



Graham F. Patefield

With Tube and Mirror, an Entomologist Traps Mosquitoes in a Brazilian Jungle

When a pest alights on his forehead, its reflection shows him where to clap the tube. This collector is a member of a Rockefeller Foundation expedition seeking sources of a yellow fever outbreak near Rio de Janeiro. The bandage on his leg covers a boil caused by a botfly larva which has burrowed into the flesh (Plate VIII and page 180).

As the mosquito takes form within the pupal skin, the pupa becomes lighter and lighter until it floats with most of its back out of water. Drawing in air through two breathing tubes in the top of the pupa, the unborn mosquito blows itself up until the outer skin splits down the back (Plate V and page 192).

The adult then works its way up and out through the opening. Using the empty pupa skin as a raft, it rests on the surface of the water until its wings become strong enough to support flight.

Generally within a day or so the female mosquito finds a mate, and after its nuptials

goes in search of a meal. The house mosquito seems to prefer human blood, but this is by no means true of all varieties. Most, but not all, females require a blood meal in order to lay fertile eggs.

When blood is not available, most mosquitoes can get along on nectar from flowers or the juices of rotting fruits. After digesting her meal, the female searches out a suitable place and lays her eggs. The next generation repeats the life cycle.

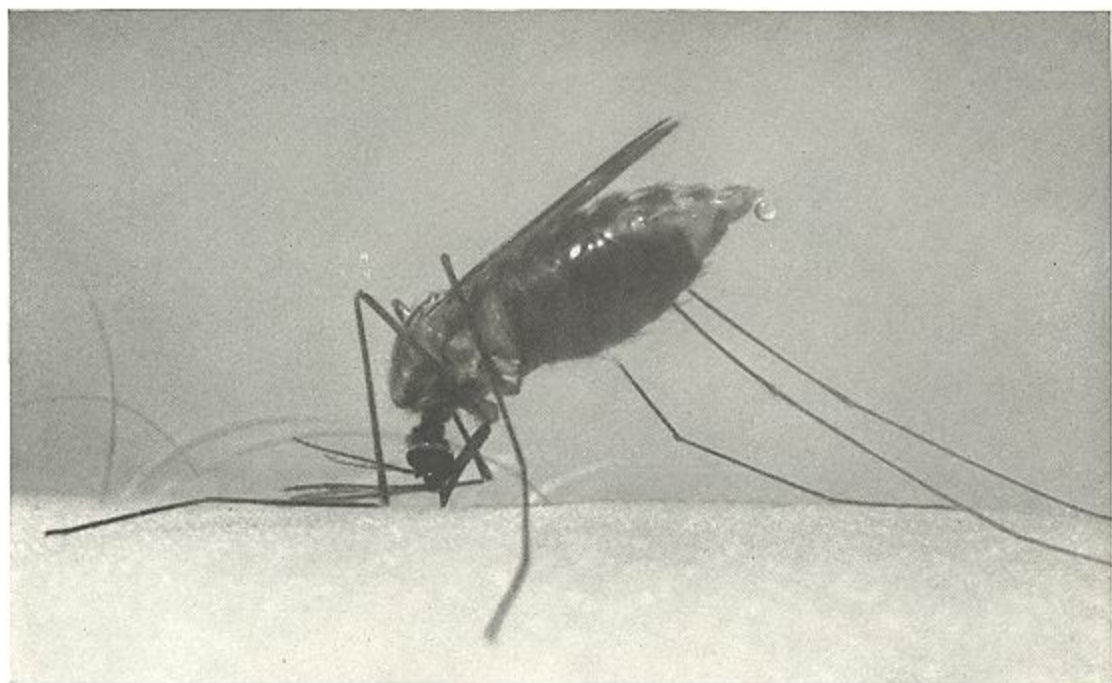
In warm countries breeding is almost or quite continuous throughout the year. But in the north the fertilized females seek cellars, attics, barns, or other hiding places which are cool, moist, and dark, to pass the winter in comparative quiet.

The males are rather short-lived, and in the case of the common house mosquito (*Culex pipiens*), all die when cold weather comes. In the spring the females come out, seek a meal, lay their eggs, and the cycle is begun all over again.

The yellow fever mosquito (*Aedes aegypti*), even more domestic than the house mosquito, is seldom found far from human habitation. Larvae have been found in the bowls and tanks of toilets in unoccupied hotel rooms, in flower vases, in water pitchers, and even in the water wells in jars of library paste.

"Yellow Jack" Lurks in Trash Heaps

In the eighties, the French company attempting to build a Panama canal was frustrated by "yellow jack." Thousands of workmen died. Hospital nurses, unaware of the source of yellow fever, kept potted plants in



Beak Deep in Human Skin, a Malaria Carrier Drinks Her Fill

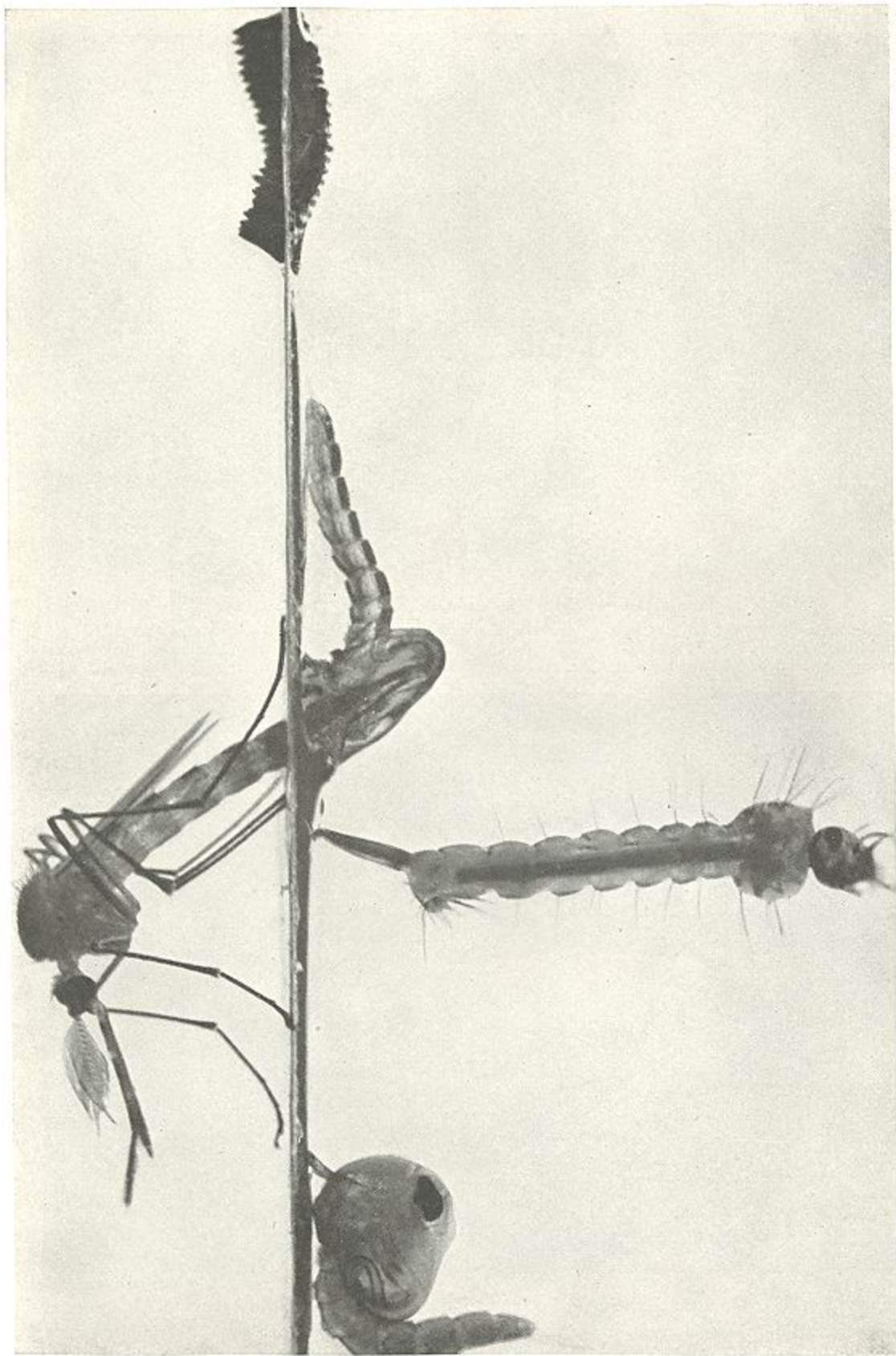
Quadrinaculatus, like all members of the malaria-spreading *Anopheles* family, assumes this tilted pose when biting (Plate IV and page 195). Her abdomen is dark red and full of blood down to the last three segments. Blood is her natural food. A drop of intestinal fluid is leaving the tip of her abdomen.



U. S. Public Health Service

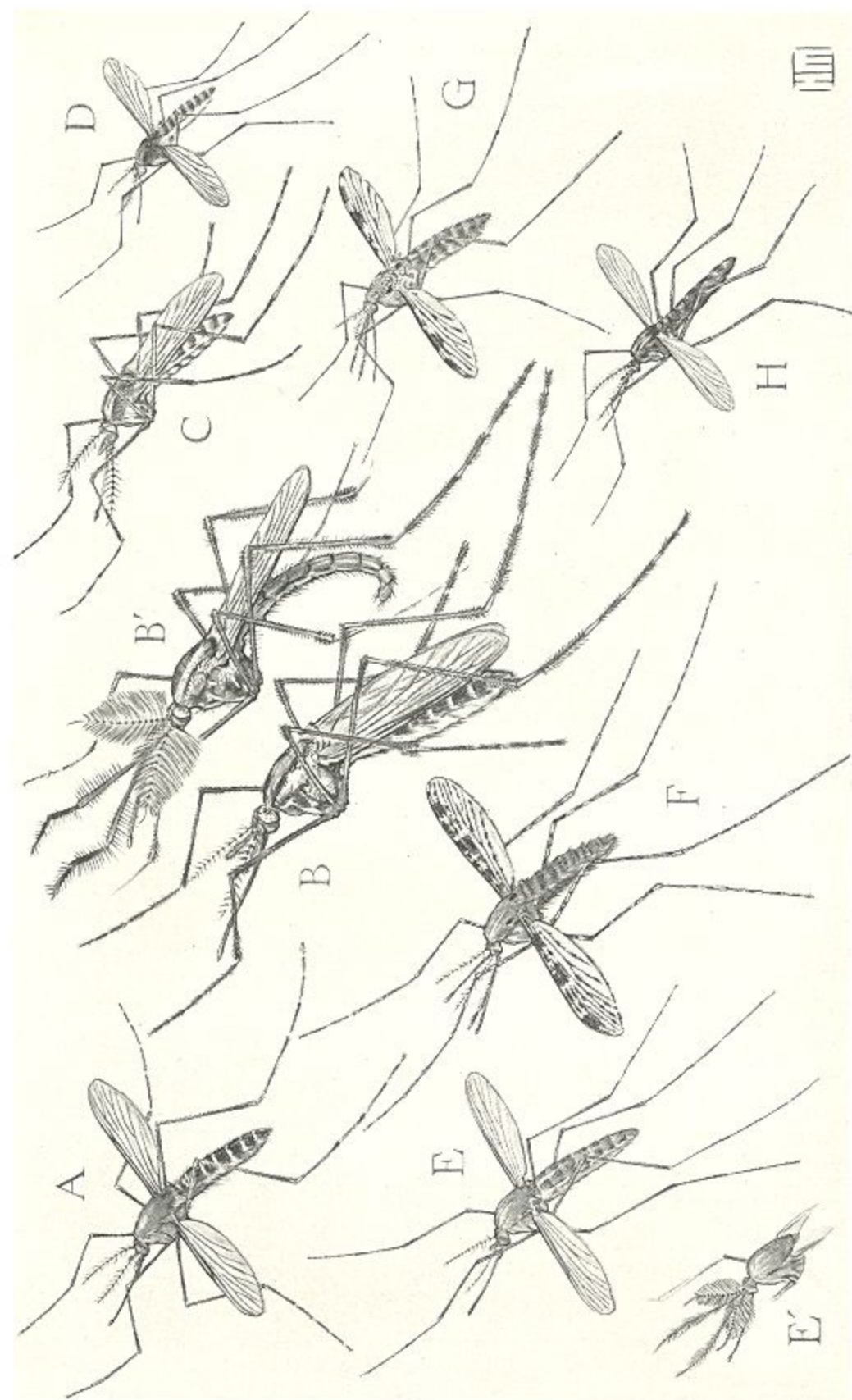
To Cure Paresis, Doctors Expose a Patient to the Bites of Malaria-carrying Mosquitoes

Each jar, with its opening pressed against the sufferer's leg, imprisons a mosquito. Their bites infect their victim with malaria. The resulting high fever counteracts the paresis. Then the patient must be treated for malaria (page 195).



Life Story of the Southern House Mosquito Is Revealed in This Remarkable Enlarged Photograph

Compare the camera's record of the birth of *Culex quinquefasciatus* with Plate I. An adult male with plumed antennae emerges from his pupal cast at the surface of the water. At right, a raft of newly laid eggs. Larva, or wiggler (left center). Fully developed pupa at left.



Faithful in Detail Even to Hairs on Legs and Antennae, This Painting Shows Seven Mosquito Species, 5 Times Life-size

Biggest of all mosquitoes is the hard-biting Gallinipper (*Psorophora ciliata*), whose cannibal larvae feed on smaller species. Like other mosquitoes, the male (B') is distinguished from the female (B) by his plumed antennae. *Aedes vexans* (A) lays her eggs in bottom lands where flood waters, even five years later, will hatch them (page 179). Larvae of *Mansonia fortis* (C) attach their air tubes to underwater cattail roots and take oxygen from them. *Wyeomyia smithii* (D) lays her eggs in common pitcher plants, some of the larvae freezing up in winter and pupating in spring. *Culex quinquefasciatus* (female, E; male, E') is the southern house mosquito (Plate I). *Anopheles punctipennis* (F) is a malaria carrier of the Caribbean. *Anopheles albimanus* (G) was the chief enemy of the builders of the Panama Canal. *Harmagogus argyromeris* (H) breeds in tree holes of Panama.



U. S. Public Health Service

With a Sieve of Mesh-silk Bolting Cloth, He Strains Mosquito Larvae from the Water

These United States Public Health Service entomologists collect larvae and the tiny organisms on which they feed, in a favorite mosquito breeding place. The man at right holds a testing apparatus which tells whether the pond water is acid or alkaline. From their detailed studies, more effective mosquito-control measures may be devised.

the wards. The mosquitoes bred in large numbers in the water in the saucers under the pots. So abundant were the winged carriers that few persons who entered the hospital escaped contracting the disease.

The adult yellow fever mosquito does not survive cold weather, so that, unlike *Culex*, it does not hibernate. The eggs, however, will stand considerable cold, remaining fertile through the winter.

When mosquitoes carry a disease, the germ goes through part of its life cycle in the mosquito. It is really a disease of the mosquito, too, and a man cannot contract the disease unless he be bitten by an infected mosquito (Plate IV).

The *Anopheles*, or malaria mosquitoes, mostly prefer to breed in open water containing water plants and algae, such as shallow, weedy ponds, roadside ditches, swamps, and the margins of slow-running streams. Some

kinds breed in swift streams, in the water in rotted-out holes in trees, and in water-holding plants, pots, cans, barrels, and other artificial containers.

The eggs are laid singly upon the water, and the wigglers, unlike those of most other mosquitoes, rest with their bodies parallel to the surface, where they do most of their feeding (Plate II). The adults, at least in the north, pass the winter in hollow logs, under bark, or in houses, cellars, or barns, as do those of the *Culex* mosquito.

Most of the mosquitoes which annoy us out of doors, such as the salt-marsh mosquitoes of New Jersey and other parts of our coast, those of the northern plains area, and the woodland kinds, belong to the genera *Aedes* and *Psoorophora*. These generally breed in rain-water puddles, pools formed by melting snow in the spring, or in water left by high spring tides in the salt marshes (Plate VII).

Their eggs, like those of the yellow fever mosquito to which they are related, are not laid directly in the water but upon dry ground where pools have been before. Heavy rains filling the depressions cause the eggs to hatch.

Most northern kinds breed in puddles from thawing snow in the spring, and there is only one brood a year. The eggs, laid in summer and late spring, wait over until the next year to hatch. Sometimes, though, when the depressions where they lie are filled by heavy summer rains, the eggs do not hatch, seeming to need a cold treatment first.

Farther south and in desert regions, a brood of mosquitoes follows each heavy rain. Here the wiggler period is very short, sometimes less than two days, since this stage must be completed before the puddle dries up.

Eggs That Live Five Years

Not all the eggs hatch at once. If the first hatch is wiped out by a too-quick drying of the pool, others remain to perpetuate the species. The eggs of these dry-land mosquitoes are extraordinarily resistant to drying, sometimes remaining alive for five years under desert conditions.

In the rainy and heavily forested Tropics, many plants collect rain water and hold it for long periods. Brazil has a number of such plants belonging to the Bromeliaceae, relatives of the pineapple. They grow mostly on trees, like orchids, and collect water between the bases of their leaves (Plate III).

In this water a host of little animals may live—tree frogs, beetles, and flies. Many kinds of mosquitoes breed only in the plants.

Often after climbing 15 or 20 feet to reach these water caches, we found them infested with stinging ants, which drove us down considerably faster than we went up.

We used a rubber syringe with a long tube to suck out the water, then squirted it into bottles. In the laboratory we sorted out the wigglers from the other animal life. Sometimes these plants would hold nearly a gallon of water and several hundred wigglers.

The malaria-carrying mosquitoes belong to the genus *Anopheles*, but only a few of the many kinds are known to be carriers. Of these, some are much more dangerous than others. In the United States there are only eight kinds of *Anopheles*, and only two are of much importance as malaria carriers.

Adult *Anopheles* can generally be easily recognized by their spotted wings and by the fact that when biting they hold the proboscis in a nearly straight line with the body, not bent at an angle as with other mosquitoes (Plate IV). In Brazil they are called *mos-*

quito prego, or "nail mosquito," because they look like tiny nails driven into the skin at an angle.

Of recent years it has been found that the fever which accompanies malaria is beneficial in treating certain types of syphilis affecting the nervous system. For this purpose, certain kinds of *Anopheles* mosquitoes have been "domesticated," and are bred in quantity and allowed to become infected from malaria patients (page 191).

I once visited one of the malaria experiment stations of the Rockefeller Foundation in north Florida. Here several species of *Anopheles* were being bred in specially constructed cages for use in experiments on the relief of syphilis. Each cage was the size of a small chicken house and was made as comfortable as possible for its inmates. They had a tank of water to breed in, damp, shady resting places, and even air conditioning!

The man who cared for them collected the new-laid eggs every morning from the breeding tank and transferred them to special rearing pans. Here the larvae were allowed to grow in a hay infusion, rich in the microorganisms which form their food. They were also fed yeast, which seems to make them grow into bigger, healthier mosquitoes.

The attendant also looked carefully for dead or sick ones, since mosquitoes are subject to fungus diseases which, if allowed to get a start, may wipe out the colony. The pupae were taken from the rearing pans and placed in special hatching cages, from which the fledglings could easily be removed. Adults were either liberated with the colony or taken to the laboratory for use in the antisiphilis work.

An Uncomfortable Job—Feeding Domesticated Mosquitoes!

The catch in the otherwise interesting job of the attendant was that he furnished food for the mosquitoes, and there were many hundreds in each colony. He rolled up his trousers to the knees and his sleeves to the elbows while working in the colony, and let them go to it. He could not even have the satisfaction of swatting his tormentors! After a week or so, he told me, he got quite used to it.

Then these domesticated mosquitoes were taken to the laboratory and fed on a malaria patient. When the malaria organisms in their bodies had fully developed, the carriers were allowed to bite patients with syphilis, thus inoculating them with malaria. This method is considered by some doctors to be better than blood transfusions from one patient directly to another, since it avoids the danger of transmitting any disease but the malaria.

