

MOSQUITOES IN HAWAII.

(U. S. Bulletin.)

BY D. L. VAN DINE.

Previous to the year 1826 mosquitoes were unknown in Hawaii. During that year they were brought to the port of Lahaina, on the Island of Maui, in the ship "Wellington" from San Blas, Mexico. The story, as told by the late Rev. Wm. Richards, (the writer is indebted to Prof. W. D. Alexander of Honolulu for this account) at that time in charge of the Mission Station at Lahaina, is as follows: Mr. Richards was returning to Lahaina one evening and met a native who informed him that there was a new "fly" in the place. The native described the insect as being a very peculiar "fly" that made its presence known by "a singing in the ear." Shortly after this, Mr. Richards being on the outlook for the new fly, heard the "singing" in his ear and recognized the sound as that of the mosquito, which up to that time had never been seen or heard of in the Islands. Furthermore, up to the year 1826 there was no word in the Hawaiian language for mosquito. The native term is "makika," a corruption of the word mosquito. Lahaina was at that time the port for incoming and outgoing ships. It is easy to understand that the ships coming here were few and far between and how general opinion could center on the ship "Wellington" as the carrier of the pest.

Since the mosquito introduced in 1826 on the ship "Wellington" was a so-called "night" mosquito, the writer infers that the species determined as *Culex pipiens* Linn., so abundant and wide-spread here, was the one introduced at that time. The two species of *Stegomyia* or "day" mosquitoes were introduced during the present generation.

DISTRIBUTION AND ABUNDANCE OF MOSQUITOES IN HAWAII.

The mosquitoes were a long time spreading over the Islands. Two generations ago there were many districts entirely free from this pest. Today such places are exceptional. In the eighties there were no mosquitoes at Makawao on the same Island as Lahaina. Makawao is some fifty miles from Lahaina "as the crow flies," with a mountain range nearly six thousand feet in elevation intervening. The building of roads, making settlement and communication possible, and the intimate inter-island communication of late years, has so favored the distribution of this pest that only a few places at the higher elevations can offer to visitors the inducement that the district is free from mosquitoes.

The abundance of mosquitoes in Hawaii may be accounted for by the facts that up to this time there has been no effort to do away with their breeding places, that the number of natural breeding places is unusually large, and that the pest is not checked at any season of the year by climatic conditions, it being possible for them to breed uninterruptedly during the entire year.

A GENERAL ACCOUNT OF MOSQUITOES.

To make this paper of practical value to the people of Hawaii in fighting this general pest, the accepted facts regarding mosquitoes are briefly given. Dr. L. O. Howard, Entomologist of the United States Department of Agriculture, first advanced the idea of the "wholesale" destruction of this insect. His book, "Mosquitoes," (Mosquitoes: How they live; How they carry disease; How they are classified; How they may be destroyed. Howard, 1900.) is the authoritative work on the subject. In 1892 Dr. Howard conducted during the summer experiments in the Catskill Mountains, New York, the success of which became widely known throughout the United States. Since that time it has been repeatedly demonstrated in different mosquito-ridden sections of the country that it is unnecessary for any community to submit to the mosquito nuisance. Particularly convincing are the experiments being carried on in the State of New Jersey in which Dr. J. B. Smith of the New Jersey Experiment Station is taking an active interest. The work of destruction is directed against the breeding places.

The Breeding Place of Mosquitoes.—The post-embryonic development of the mosquito, that is, the interval between the egg state and the adult winged form, occurs entirely beneath the surface of water. The young during this portion of their life-cycle are true aquatic insects with one exception, they do not breathe the air dissolved in the water as do fish, but by a special structure, a respiratory siphon breathe the free air above the surface of the water; deprived of this they perish. By nature of their structure the young of mosquitoes can develop only in water and then only under certain conditions. As a rule mosquitoes breed in small collections of standing fresh water. Specimens are sometimes found in streams and some species are known to breed in salt or brackish water. For all economic purposes the statement is correct that mosquitoes breed only in water, usually stagnant fresh water in artificial places. Do away with these places and it becomes impossible for mosquitoes to breed.

Life History of Mosquitoes.—The determination of methods for destroying an injurious insect implies a careful study of its life-history in order to find the vulnerable point in the life-cycle of the pest. All insects undergo during their developmental period remarkable

changes in form, structure and habits. One can certainly detect no resemblance between the wriggling larva of the mosquito in the water and the adult winged insect in the air. In the higher animals there are no distinct periods or stages of development. The young on hatching from the egg or at birth resemble the parent with the exception that they are smaller in size and undeveloped, but as growth continues they gradually acquire the size and characteristics of the adult. The life history of insects, on the other hand, is, generally speaking, divided into three distinct stages after hatching from the egg: the young or larva, the growing stage in the life of the insect; the pupa, a period of development during which a wonderful change or transformation in the form, structure and habits occurs; and the adult or winged insect, the form we usually recognize.

The eggs of the common mosquito, *Culex*, are deposited on the surface of standing water. Under the right conditions of temperature they hatch in about twenty-four hours. The larvae develop to their full size in the course of eight to fourteen days during which time they moult or cast off their outer covering several times to provide for increase in size. The development of the larvae depends on the temperature of the water and the food supply. Their food consists of the plant and animal matter, often microscopic in size, common to standing water.

The pupa of the mosquito is also aquatic, normally resting inactive at the surface. This is the period during which the mosquito transforms from an aquatic insect to one of the air. The young or growing stage has passed. The pupa takes no food and moves only when disturbed as a matter of protection. The pupal stage is much shorter than the larval. In two or three days the pupa transforms to the adult mosquito and becomes the notorious household pest, the entire life-cycle being a matter of eleven to eighteen days.

The only remedy for adult mosquitoes is protection by screening, or the

tions of Mr. H. W. Henshaw, the well-known naturalist of Hilo, Hawaii. The writer has not observed evidences of migration among the species of mosquitoes occurring in these Islands. Invariably the source of mosquitoes infesting any district has been found to be nearby natural and artificial collections of water, usually artificial collections in the immediate vicinity. Mr. Henshaw in speaking of invasions of mosquitoes says in a letter to the writer:

"So far as my own observations extend such accidental invasions of mosquitoes are rare in these Islands, the insects here as a rule being extremely local. Nevertheless that such accidental dispersal of the pests in the Islands does actually occur is proved by an instance in point which came under my personal observation in June, 1899, at Pahala, Kau (Island of Hawaii). Mr. C. M. Walton, the then manager of the plantation, informed me that prior to the visitation of the pests about to be described, mosquitoes were practically unknown about the village; if found at all it was in such small numbers as to cause no annoyance, and mosquitoes were unknown.

"In the spring of 1899 there was an unusual quantity of waste water from the mill and this ran down to the flats about a mile below and there formed a series of small ponds aggregating a considerable expanse of shallow water. Not long after the formation of the ponds swarms of mosquitoes made their appearance about the mill and in all the dwellings, evidently brought there by the strong trade winds which blew directly from the ponds. At the time of my visit the mosquitoes (*Culex pipiens*) put in an appearance about dusk and soon rendered life a burden and sleep impossible except under nets which every householder had been compelled to provide for every bed.

"A few days later I visited the Kapapala Ranch, distant from Pahala about four miles in an air line and about five miles from the ponds in question and there found a similar state of affairs. Mr. Julian Monserratt, manager of the ranch, told me that the invasion occurred at the same time as at Pahala prior to which no mosquitoes had been seen at or near the ranch headquarters where, indeed, there was no possible breeding place for them.

"Unquestionably the clouds of mosquitoes originated in the same ponds below Pahala and were carried by the trade winds not only to Kapapala but for miles over the surrounding country.

fact it has been proved in the case of yellow-fever and malaria that without certain species of mosquitoes as hosts, the life-cycle of the organisms responsible for the disease is interrupted. This has changed the mosquito problem from one of discomfort alone to one of health also. The most complete work in preventive medicine is the result of experiments along these lines. That yellow-fever and malaria are conveyed from diseased persons to healthy people by the bites of certain species of mosquitoes is an acknowledged fact in recent medical literature.

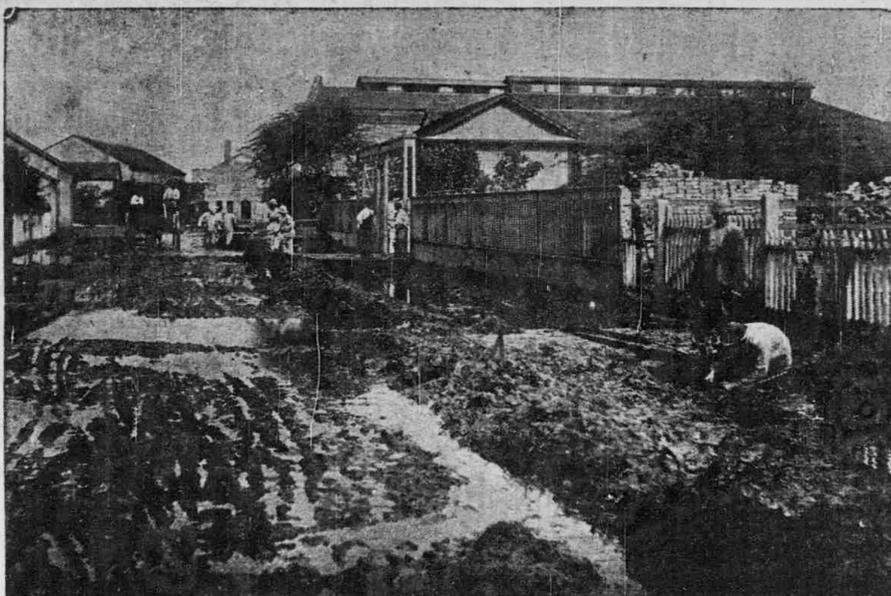
Aside from yellow-fever and malaria, mosquitoes are credited with the dissemination of elephantiasis, filariasis, and possibly the dengue fever and leprosy. The relation of certain insects to diseases, both plant and animal, is a study which in the future will do much to prevent their present serious work.

THE COMMON HAWAIIAN MOSQUITOES.

(The specimens from which the determinations were made were forwarded to Dr. O. L. Howard, Entomologist of the United States Department of Agriculture, and were examined and reported upon by Mr. D. W. Coquillett of the Division of Entomology.)

The abundant mosquito in Hawaii, known locally as the "night" mosquito, is a species of the well known genus *Culex*, *Culex pipiens* Linn. All members of this genus taken generally from the Islands of Hawaii, Maui, Oahu and Kauai belong to this one species. The vicious "day" mosquito proved to be dangerous Cuban yellow-fever mosquito, *Stegomyia fasciata* Fabr. (This species is recorded from these Islands by Grimshaw under the name *Culex taeniatus* Wied. Fauna Hawaiiensis. Diptera. Vol. III, Part 1, p. 6.) Another species of this genus, *Stegomyia Scutellaris* Walker, occurs here but is not so abundant in the towns and cities as the former species and, being found to a great extent breeding in small natural collections of water in the forest, such as the leaves of plants and the hollow decayed stumps of trees and branches, it is referred to as the forest mosquito to distinguish it locally from the yellow-fever species.

The Abundant Mosquito, *Culex pipiens*.—The members of the genus *Culex* are distributed generally over the world and seem to be limited by neither altitude nor climate. The species so abundant here, *Culex pipiens*, is the



THE MOSQUITO CRUSADE—Prison labor being used to drain stagnant surface water off Kakaako streets.

burning of insect powder. These remedies bring only temporary relief and do not remove the source of the nuisance. The importance, then, of not allowing mosquitoes to develop beyond the pupal or final aquatic stage is evident. No practical method of destroying adult mosquitoes is known.

The length of the life of adult mosquitoes varies. It is difficult to get insects to repeat correctly in confinement what their life-history and habits would be under natural conditions; therefore the length of the life of the adult cannot be determined by experiment. As a rule the males of insects do not live any great length of time after maturity, and the females die soon after depositing their eggs. In a tropical country, like Hawaii, where no difficulty is encountered by the gravid female in securing favorable breeding places throughout the year, the length of the adult life is probably at the most only a matter of several weeks. In cold countries the male mosquitoes are known to die in the early winter and the females hibernate during the cold season, a period of several months, until suitable conditions for egg-laying prevail.

Migrations of Mosquitoes.—The adult mosquito is a very feeble flyer and is usually found in the vicinity of its breeding place. Instances are on record where mosquitoes have been carried in large numbers for long distances by the wind but invasions from one locality to another are exceptional. It is well known that on windy days mosquitoes are less in evidence and the general belief is that they "have been blown out to sea." It is evident from the structure of their organs of flight that mosquitoes cannot long endure in a high wind. In an infested locality, mosquitoes are always in evidence immediately after a wind subsides, especially in places where the vegetation is abundant, in the foliage of which they seek shelter from the wind. Smith says that the habits of mosquitoes in regard to their flying any distance varies with the different species. He discusses a salt-water species, *Culex sollicitans*, which is apparently a true migratory form. It can be stated without qualifications that the source of mosquitoes is generally the immediate vicinity of the infested places.

The above statement is subject to exceptions as proved by the observa-

in the direct track of the breezes. At Pahala, at least, the colonization has proved to be permanent as here, as elsewhere on cane plantations where water flumes are in use, leaky flumes form small pools at many points along their track which make ideal breeding places for mosquitoes.

"At the time I speak of, comparatively little information had reached the general public in relation to the methods of abating the mosquito nuisance, though Mr. Walton had tried experiments with kerosene on some of the pools, if I remember correctly, with poor success and they had been abandoned. With our present knowledge of the use of the heavy crude petroleum it cannot be doubted that prompt and regular treatment of the ponds in question with proper oil, together with frequent inspection and treatment about the village itself, would have abated the nuisance within a reasonable time. In eternal vigilance and in prompt remedial measures alone lies safety from mosquitoes in the tropics."

Mr. Henshaw has since informed the writer that the ponds mentioned are quite exposed and unsheltered by vegetation, and agrees with the writer that had the ponds been surrounded by trees or had vegetation intervened to which the insects could have clung for shelter, the distribution would not, probably, have been so widespread.

The Food of Adult Mosquitoes.—Their food consists of the blood of animals and the juices of plants and fruits. Mosquitoes are normally plant-feeding insects and only the female is a blood-feeding insect when that is obtainable. The male satisfies his appetite on the juices of fruits or other liquids since the proboscis is not constructed, as is that of the female, for piercing anything with any degree of resistance, as the skin of animals or the epidermis of plants. Howard says, speaking of female mosquitoes: "It is safe to say that only an infinitesimal proportion of them ever taste the blood of a warm-blooded animal."

Mosquitoes and Disease.—The greatest impetus to the warfare against mosquitoes was given by the recent positive demonstrations that certain species are the carriers of disease, that is, the agents (germs) responsible for the disease are parasitic to certain mosquitoes during an intermediate stage in their developmental cycle. In

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