Aedes vexans nocturnus (Theobald) in Hawaii

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INTRODUCTION

A new immigrant mosquito, *Aedes vexans nocturnus* (Theobald), has become established on Oahu and Kauai, the first record of a mosquito accidently becoming established in the Hawaiian Islands in more than 60 years. Our other blood-sucking species, *A. aegypti* (Linnaeus), *A. albopictus* (Skuse), and *Culex quinquefasciatus* Say arrived prior to 1900 (Hardy, 1960). This new immigrant differs in that it is a floodwater mosquito which does not normally breed in artificial containers close to human habitation.

The first recovery of *A. vexans nocturnus* (Theobald) was one female taken in a light trap on January 2, 1962, at the Public Health Quarantine station on Fort Armstrong in Honolulu, in connection with routine surveillance about ports of entry by the Foreign Quarantine Division of the Public Health Service. Immediately the State Department of Health and military agencies were notified of the possible establishment of this species on Oahu. Surveys made in the Honolulu Harbor and International Airport areas to discover the breeding source were negative. Quarantine records were checked for ship arrivals from areas where this mosquito is known to occur. A careful search was made at the piers where these ships docked and cargo manifests were checked for materials which might harbor eggs, larvae, or adults, both with negative results.

Another female was taken in the Fort Armstrong trap the week of January 15. Since *vexans* mosquitoes are known to have a long flight range, the Health Department then set up additional traps in a widening circle around the point of initial recovery. On January 23, 1962, 420 adult *vexans nocturnus* were identified in a weekly catch from a trap at the Ewa Hospital. Later larval collections pinpointed the major focus in the Honouliuli area on the Ewa side of Pearl Harbor.

An intensive three-month, February through April, surveillance and control program was instituted, designed to determine the distribution of the species and to prevent the rapid spread throughout Oahu and to the neighbor islands. Control effort were concentrated in areas where the mosquito was found. A three-fold program included surveillance and

measurement, area control, and quarantine measures. At the close of the three-month period, a less intensive surveillance and abatement program was maintained for the remainder of the year.

SURVEILLANCE AND MEASUREMENT

As *Aedes vexans* mosquitoes are known to be readily attracted to light traps, a network of 87 standard New Jersey mosquito light traps was set up on Oahu and the major outer islands as follows: Oahu, 61; Kauai, 12; Hawaii, 11; Maui, 2; and Molokai, 1. The 61 Oahu traps were adequate to provide island-wide coverage. Adult recoveries were followed up with larval surveys of the area adjacent to each light trap station to determine existence of actual breeding. Larval samples collected prior to spraying were brought in routinely from the field by spray crews for identification.

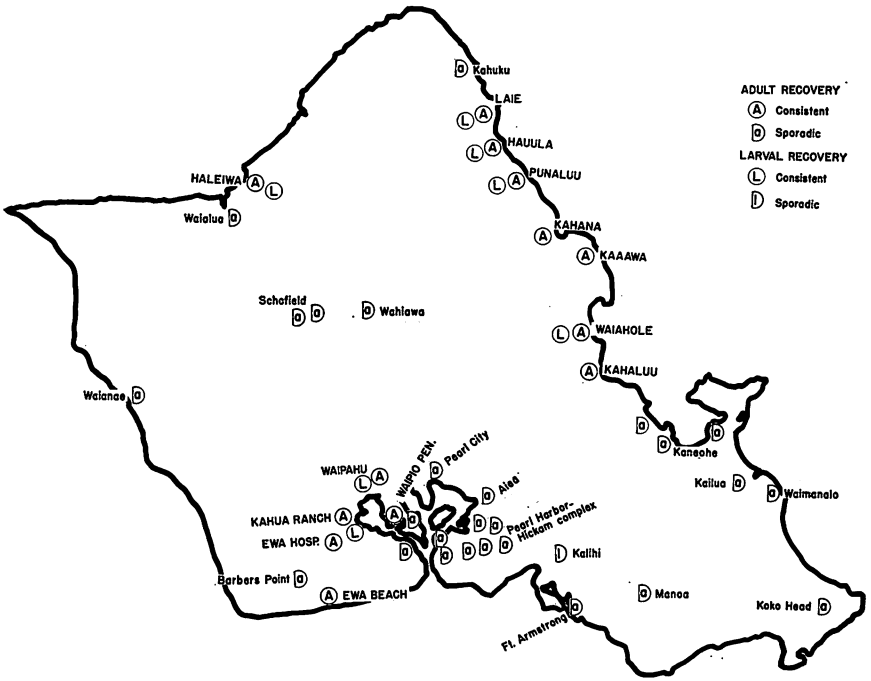

FIGURE 1.—Recovery pattern of adults and larvae of *Aedes vexans nocturnus* (Theobald) on Oahu, Hawaiian Islands.

Early in February the mosquito first appeared sporadically in light trap catches on the windward side of Oahu. The first larval breeding was detected February 9 on the windward side in Kahana Valley, with a subsequent spread along the coast. Adult and larval surveys to date reveal sporadic records throughout Oahu from Waimanalo and Lunalilo

Home Road to Kahuku, Waialua, and Waianae (fig. 1). The sporadic adult recoveries consist almost entirely of female specimens. Most of the records are confined to lowland coastal areas. Intensive larval surveys concluded on April 30 have confirmed the actual breeding areas to be confined to the Ewa-Honouliuli area of Pearl Harbor and, on the windward side, from Waiahole to Laie. In December 1962 another breeding focus was discovered near Haleiwa on the north side of the island.

Records indicate continuing activity of the mosquito throughout 1962 on Oahu. The extent of buildup of *nocturnus* populations in two leading foci, Ewa Hospital near Honouliuli, and Punaluu, is shown in fig. 2. The similar pattern for these widely separated areas was influenced respectively by two separate sources of water—rainfall and sugar cane

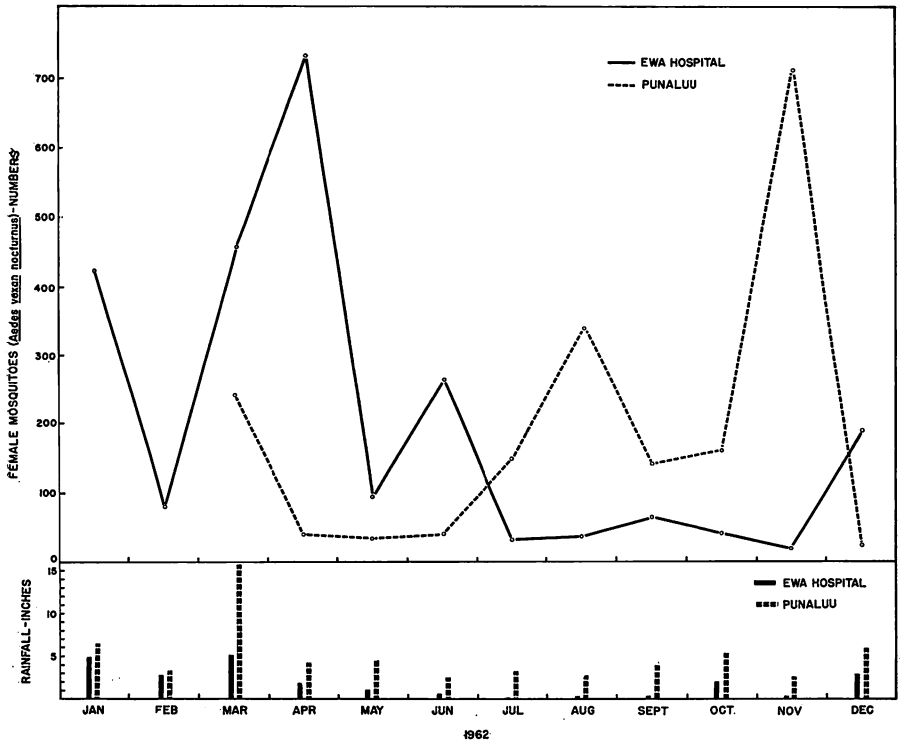

FIGURE 2.—Monthly light-trap catch in two major *Aedes vexans nocturnus* (Theobald) breeding foci for 1962. The January total represents only a one-week catch.

irrigation water. In the light trap record for the Ewa Hospital, the April peak is attributed to the high rainfall during March, and the lesser peak in the dry month of June to the breeding of *nocturnus* in the runoff water from irrigated cane fields seeping into the low-lying pasture lands of Kahua Ranch. In Punaluu the trap was established on February 27,

1962. The initial peak of March was due to breeding which took place in the rain-flooded lowlands, whereas the two subsequent peaks in August and November were predominantly due to the breeding in irrigation water standing in young cane furrows.

On April 5, 1962, one female was taken in a light trap at Kapaa, Kauai, a distance of 8 miles from the nearest port. No further specimens were taken in any of the 12 Kauai traps until early in September when 39 females and 1 male were taken in the Coco Palms area at Wailua and one female at the Lihue airport. It now appears established on Kauai with larval breeding confined principally to the Coco Palms area. A few females have been taken regularly in the Coco Palms trap from September 5 to the present time. One female was taken at Nawiliwili on November 7.

CONTROL

Priorities for control were based on reports obtained from the light trap network and larval surveys. Control involved both larviciding and adulticiding, utilizing various ground-operated power equipment: hydraulic sprayers, mist dust blower, and thermal fog generators. Airplane spraying was used in one area of about 120 acres. In addition to the Department of Health, the Army, Navy, and Air Force carried out similar operations in their respective areas of responsibility on Oahu. Standard recommended formulas for mosquito control were used, with ronnel (Korlan), DDT, and Malathion as insecticides of choice. The Navy performed some source control by ditching and draining some of the salt bed area near Ewa.

Control operations no doubt had some effect on the pattern of *nocturnus* buildup and spread. The immediate and acute-angled peaks for both areas (fig. 2) reflect in general the result of the program. Prompt treatment in other areas likewise brought about a rapid decline in the *nocturnus* population. Post-larvicidal inspections revealed that an effective larval kill was obtained.

QUARANTINE

Because of the possibility that the new mosquito arrived by aircraft, the need for continuing adequate disinsection of aircraft in foreign and domestic traffic was emphasized. Spot checks of commercial aircraft were continued and the respective services were reminded to continue the enforcement of current military regulations governing disinsection of military aircraft and vector control about port areas. To prevent or delay spread of the immigrant mosquito to neighboring islands, surveillance about port areas was intensified. The Navy required the spraying of all their aircraft departing from Barbers Point and Kaneohe for neighbor island airfields and the Army also initiated the disinsection of Army aircraft leaving Wheeler Field. As surveillance records for the Honolulu International Airport area were consistently negative, it was not believed advisable to institute disinsection of inter-island commercial trafffic. As

yet no *nocturnus* mosquitoes have been reported aboard any inter-island aircraft or ship but of course complete inspectional coverage has not been possible.

GEOGRAPHICAL DISTRIBUTION

Aedes vexans nocturnus is a common pest mosquito in many areas of the western and southern Pacific. It has been reported from the Marianas Islands, Philippines, Fiji, Samoa, Marshalls, Carolines, Palau, Ellice Islands, Gilbert Islands, Tonga, New Guinea, New Hebrides, Loyalty Islands, New Caledonia, Ile des Pins, Indonesia, Tokelau Islands, Cook Islands, Rotuma Island and Wallis Island (Stone, Knight, and Starcke, 1959; Bohart, 1957; Iyengar, 1960; Belkin, 1962). The establishment in Hawaii extends the north eastern limit of its range.

MEDICAL IMPORTANCE

Little is known about the disease-carrying potential of this species. It has been suspected as a vector of Japanese "B" encephalitis on Guam as its annual December population peak coincided with the epidemic of 1947 (Bohart, 1957). It has transmitted the virus experimentally in the laboratory (Horsfall, 1955). The female bites man readily although it seems to be less persistent than the closely related *A. vexans vexans* of the mainland United States. The mainland *vexans* has been found naturally infected with western equine encephalitis and has experimentally transmitted eastern equine and St. Louis encephalitis virus (King et al, 1960). The above authors also state that *vexans* can transmit fowlpox experimentally and is a fairly efficient host of *Dirofilaria immitis* (Leidy), the heartworm of dogs. For the above reasons the subspecies *nocturnus* has vector possibilities.

BIOLOGY

The mosquito is normally a temporary ground pool breeder. As the eggs may remain viable for a year or more on blades of grass or on the ground, hatching when flooding occurs, it is thus of spasmodic abundance. It prefers flat, semi-marshy, pitted or neglected agricultural land subject to periodic flooding and larvae have also been reported from roadside ditches, ruts, hoof marks, edge of ponds, puddles, artificial containers such as barrels, household containers and tires, and coconut shells (Paine, 1943; Amos, 1947; Bohart, 1957; Yamaguti and LaCasse, 1950). Buxton and Hopkins (1927) recorded it once from Tonga, breeding in a tree hole with *Aedes aegypti*. The artificial container and tree hole breeding is rare, however, and cannot be considered a normal habit. Larval and pupal development is quite rapid, usually involving 5 to 10 days to complete both stages under Hawaiian conditions. Nearly all of the larvae in a given pool seem to develop, pupate, and emerge as adults at about the same time, much ahead of the *Culex* which may follow in the same habitat. In laboratory rearings and probably also in the field the adult males usually emerge first.

The flight range is thought to be considerable, the females migrating in great numbers from the breeding areas, but as far as known no flight range studies have been performed on *nocturnus*. For the closely related *vexans* a maximum range of 25 to 30 miles is reported (Gjullin et al, 1950) with many dispersing 15 to 20 miles from breeding grounds. Horsfall (1954) reports on the migration of the mainland *vexans* from a potential source in Wisconsin to Illinois, a distance of 90 to 460 miles.

DISTINGUISHING CHARACTERISTICS

The mosquito can be readily distinguished from other Hawaiian *Aedes* as the body is predominantly brown, whereas *albopictus* and *aegypti* are black with conspicuous silvery-white markings on the thorax. It may more easily be confused with *Culex quinquefasciatus* but in *nocturnus* the tarsal segments are basally banded, the femora are speckled dorsally with black and white scales, and the tip of the abdomen is pointed. The male is further characterized by the distinctively large claspers at the tip of the abdomen.

The larvae may be distinguished by the distal teeth of the pecten which are more widely spaced and the tuft beyond the middle is inconspicuous with 3 to 5 branches. Comb scales consist of 8 to 11 strong teeth in a partial double row. The pupae can be separated from the other Hawaiian mosquitoes by characters of the terminal abdominal segments and pupal paddle. Figure 3 illustrates some characters for identifying the various stages of *nocturnus* (drawings were made from Hawaiian specimens).

METHOD OF ENTRY AND DISPERSAL

The closest point to Hawaii where the mosquito is known to occur is more than 2,000 miles away, thus it must have reached Hawaii by human agency rather than natural means, probably by aircraft. It has been amply demonstrated that mosquitoes can be transported alive by aircraft for long distances at high altitudes (Sullivan, et al, 1961). Quarantine records verify this fact, as during the last few years *nocturnus* has been the most commonly intercepted *Aedes* found in spot checks of aircraft at Honolulu (Joyce, 1961). From available evidence, Guam, Fiji, or Samoa, in that order, appear the most likely ports of origin of the mosquito.

Though we have no quarantine records of *nocturnus* in surface vessels in Honolulu or elsewhere one cannot, however, rule out the possibility that the mosquito could come by surface vessel. The eggs may have arrived in soil or on vegetation on or in cargo or equipment brought by ship from the western or southern Pacific. The principal Ewa-Honouliuli focus is well within the flight range of mosquitoes from Honolulu and Pearl Harbors, and Hickam, Barbers Point, and Honolulu airports. The mosquito must have been present on Oahu for a year or more before being detected in order for it to build up to the peak abundance of 420 per week light trap catch found in February 1962.

We believe that it spread to Kauai from Oahu, a distance of 70 miles from the nearest points, by natural means because of the following evidence. The mosquito never became abundant at ports of departure of aircraft and ships destined for Kauai. The first recovery on Kauai was

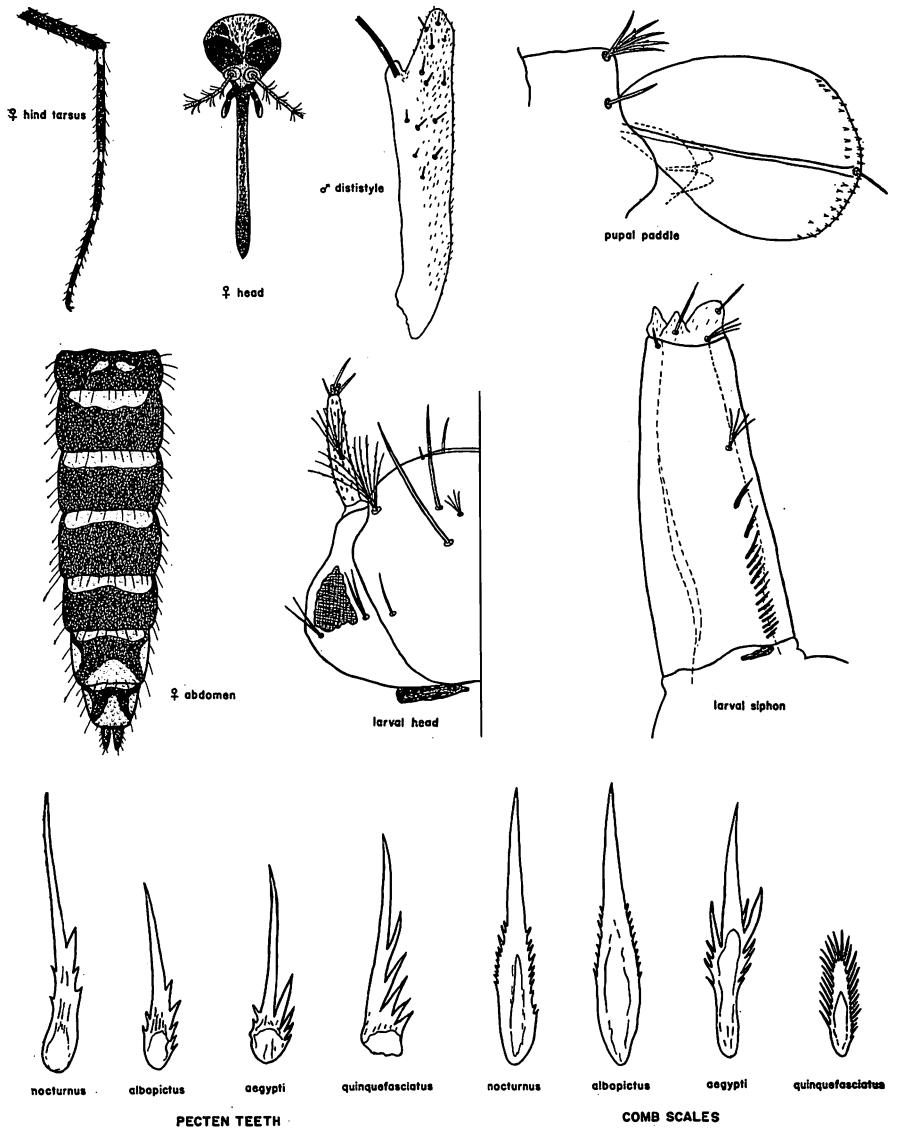

FIGURE 3.—Identifying characters for adult, larval, and pupal stages of *Aedes vexans nocturnus* (Theobald); comparison of a typical comb scale; and pecten teeth of the four common Hawaiian mosquitoes.

made at a time when the population of *nocturnus* on Oahu was at its highest level, and was made at a distance of 8 and 9 miles respectively from the nearest airport and seaport. All other Kauai traps remained negative until five months later.

ACKNOWLEDGEMENTS

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