

STUDIES OF *CULICOIDES* IN THE PANAMA CANAL ZONE (DIPTERA, HELEIDAE)

STANLEY J. CARPENTER^{1, 2}

The small blood-sucking Diptera of the genus *Culicoides*, family Heleidae, occur in such large numbers in and near tidal marshes on both the Atlantic and Pacific coasts of Panama that they cause a great deal of annoyance to man. Owing to their small size, they find no difficulty in passing through screen meshes and are troublesome within houses. *Culicoides* are so numerous at times on one Army post (Fort Kobbe) in the Canal Zone that they are often extremely annoying inside family quarters and barracks and interfere with outdoor activities.

Since August, 1950, the writer has conducted studies on these insects at Fort Kobbe, located just west of the Pacific entrance to the Panama Canal. Fort Kobbe is bounded on the east and northeast by Farfan swamp, an extensive tidal marsh of several hundred acres, which has been subject to some flooding with salt-water at high tide and with fresh water following heavy rains. Most of the *Culicoides* breeding in this area takes place in this tidal marsh. The principal drainage of the swamp is effected by the Farfan River and its tributaries, which consist of many small drainage ditches.

LARVAL STUDIES

Methods of Study. In searching for the immature stages of *Culicoides*, techniques

¹ Colonel, MSC, Entomologist, United States Army Caribbean, Fort Clayton, Canal Zone.

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employed by Painter (1926), Dove *et al.* (1932), Hill (1947) and others were evaluated. After considerable exploratory work had been done, the following technique was found to be satisfactory for locating heavy breeding of *Culicoides* in Farfan swamp and was adopted. Mud samples from different locations were collected in wide mouth jars, each holding 400 cc. of material. The samples were taken from the top 1½ to 2 inches of the surface mud. Each jar was given a collection number, carried to the laboratory, flooded with tap water and allowed to stand overnight. During the following morning, the water covering the mud was gently agitated and transferred in a pipette to a syracuse watch glass for examination under a stereoscopic microscope. Counts from each sample were based on examinations of 6 watch glasses of water and surface material.

The larvae could often be seen swimming in the water around the edge of the jar. The larger larvae were often visible with the naked eye between the mud and the glass. Each site in the swamp from which a sample was obtained was marked with a wooden stake holding a tin plate through which the collection number was punched. Collection data, compiled for each sample, included location, description of soil, tidal height and density of shade.

Larval Collections. Five hundred fifty-two mud samples were collected from different locations near Fort Kobbe and examined from June through December, 1950. Three hundred forty-two duplicate samples were taken and examined during the testing of larvicides and while making observations on seasonal occurrence of the immature stages of *Culicoides*. In general those collecting stations yielding larvae during the earlier months of the work continued to be positive during successive



FIG. 1. Farfan tidal marsh during the dry season. *Culicoides* breed in these low areas in the swamp during the rainy season, from May to January.

FIG. 2. *Culicoides* breeding is limited mostly to muddy areas along streams and ditches during the dry season.

weeks until after the onset of the dry season. Full grown larvae and pupae were more numerous in the samples taken toward the end of the rainy season, October to January. The soil in the swamp is mostly dark loam and contains large amounts of decomposing organic matter. This dark loam varies in depth from a few inches to one or more feet and is too wet to allow motor driven vehicles to be used in this area for larviciding during the rainy season.

Prior to the establishment of tide gates on Farfan River near its entrance to Panama Bay in August, 1950, low areas of the mangrove swamp were subject to flooding or at least moistening with high tides each day and partial drainage at low tide. After the tide gates were installed, heavy rains continued to flood the low areas at frequent intervals during the remainder of the rainy season forming numerous shallow pools and keeping the water table at or very near the surface of the ground. Heavy breeding of *Culicoides* was limited to this type of condition in the tidal marsh. The remainder of the swamp is a few inches higher and the surface partly dries between floodings. Larvae and pupae were rarely found in these elevated areas.

The most prolific breeding of *Culicoides* was in places fully exposed to the sun throughout the day, although some breeding was found in partly shaded areas. Woke (1942) made similar observations during studies conducted at the nearby Naval Station at West Bank.

The low areas in the tidal marsh as described above continued to show heavy breeding of *Culicoides* until after the rains stopped, the water table gradually lowered a few inches and the surface soil became dry and hard (Fig. 1). Larvae were found in the dry season only along the muddy sides of ditches and streams (Fig. 2).

During February, 1951, approximately two months after the end of the rainy season, holes were dug at sites where *Culicoides* larvae were numerous during the rainy season, and samples were examined from various depths. All of these

were negative. At that time the holes began filling with water between 8 and 12 inches below the surface. Many other mud samples taken from underneath the dry surface crust were examined for larvae during the dry season, but all these were negative.

On one occasion the writer found a full grown *Culicoides* larva following the flooding of a bamboo section which had been used in the forest as a mosquito breeding trap, carried to the laboratory and kept in a dry condition for one month. Following this observation, it seemed possible that *Culicoides* might pass the dry season as larvae in partly dry soil near the surface or in the mud farther below the surface. A considerable amount of sampling has since been done in the tidal marsh during the dry season and there have been no indications that they do so.

Since *Culicoides* continue to breed along the ditches and streams throughout the dry season, it seems likely that breeding gradually builds up in the main swamp after the rains begin in May until a peak of emergence is reached in the late summer and fall. The fact that full grown larvae and pupae are seldom numerous in the main swamp until late summer would lead one to believe that there is a single brood developed between May and January in these areas. However, on the other hand, emergence may be continuous along the ditches and streams where there may be as many as two broods developed in a year's time.

ADULT SURVEYS

Horse-baited Traps. After several collecting methods had been evaluated for measuring adult densities of *Culicoides* the following was adopted. Sheets of white bond paper (8 by 10½ inches) were treated with castor oil and mounted on plywood boards. The boards were set in an upright position in a horse-baited mosquito trap (Fig. 3) and left overnight. The horse served as an attractant and the *Culicoides* and other small insects coming in contact with the adhesive paper during the night were caught and held. The

boards were removed from the trap the following morning and carried to the laboratory where specimens were examined and counted.

Narrow strips of wood were attached to the plywood board in the form of a double frame (Fig. 4), thus allowing only a minimum amount of the adhesive paper to come in contact with the board. Whenever the paper came in contact with the board, the oil was usually drawn off to the extent that it would not catch and hold *Culicoides*.

Culicoides catches from four horse-baited traps operated at Fort Kobbe totaled some 700,000 specimens. One trap, number 3, was located on the lawn adjacent to family quarters only a few hundred feet from the edge of Farfan swamp. Traps 2, 4 and 5 were located in an area of heavy second growth timber mixed with low undergrowth near a small group of civilian dwellings, about three-fourths mile northeast of the main post and between one-half and three-fourths mile west of Farfan swamp. Traps 2 and 3 began operation August 7, 1950, while traps 4 and 5 did not begin operation until September 11. Six adhesive papers were used in each trap each night of operation, except trap 3 where 12 adhesive papers were used from August 7 to September 7. Occasionally one or two boards were dislodged during the night and destroyed by the horse. Traps 3, 4 and 5 were used occasionally for testing insecticides. Trap 2 served as a control during the entire period of study.

The areas adjacent to and surrounding trap 3 were treated on numerous occasions during the year either with heat-generated DDT aerosol dispersed by a fogging machine or benzene hexachloride suspension dispersed as a wet spray with a mobile mist blower. None of these attempts to control *Culicoides* appeared to affect the nightly catch of biting midges in horse-baited trap 3.

The screen mesh of horse-baited trap 4 at Fort Kobbe was treated with 5 per cent DDT applied with a paint brush September 12, 1950, and there was a sharp reduction in the number of adult *Culicoides*

caught on adhesive papers in this trap during the remainder of the week. The weekly catches from trap 4 remained somewhat lower than those obtained from the nearby traps 2 and 5 for a period of about 2 months. Catches made in horse-baited traps indicate that there is a gradual buildup in population of *Culicoides* during the rainy season until a peak in abundance is reached in November and December. The population of these biting midges decreases rapidly after the onset of the dry season in January due to the limited areas suitable for continuous breeding. Data are not available at this time on population trends during the period from May to August. However, the complaints made by residents of the area would indicate that *Culicoides* are seldom extremely annoying except from September to January.

Light Trap. A New Jersey type light trap was operated at the edge of the jungle on an elevation only a few hundred feet from the Farfan swamp, beginning in December, 1950. Catches of *Culicoides* with the light trap were usually light when compared with those obtained from horse-baited traps. However, the light trap proved useful for catching males and females for identification to species.

Culicoides furens (Poey) comprised about 94 per cent of the total Heleidae taken in the light trap. About 5 per cent of the specimens caught were *Culicoides guttatus* (Coq.) and less than 1.0 per cent were other species of the family Heleidae. Other species identified from Fort Kobbe are *Culicoides* sp. nr. *hoffmani* Fox, *Culicoides dasyporphus* Macfie, *Culicoides roseboomi* Barbosa and *Monohela* sp. Several specimens of *Atrichopogon* sp. were identified from a horse-baited trap catch from Fort Clayton, about five miles north of Fort Kobbe.

Habits of Adults. *Culicoides* are seldom annoying except near their breeding places; however, collections were very heavy in horse-baited traps 2, 4, and 5 at Fort Kobbe between one-half and three-fourths mile from the tidal marsh. A light trap was operated in the vicinity of the above horse-baited traps on February 19 to 21 for an

average of two hours each night and the following *Culicoides* were captured: *C. furens*, 2 males, 72 females; *C. guttatus*, 1 male, 2 females; *Culicoides* spp., 4 females.

Boards with adhesive papers attached were set overnight in one area at Fort Kobbe during heavy flights of *Culicoides* in an attempt to determine the direction of flight but each time catches were greatest on the leeward side of these traps, thus indicating that the adults may avoid flight in direct wind. It was also noted throughout the study that catches were always greater on calm nights than when steady winds blew.

Adhesive paper traps placed in windows at elevations of 7, 23, and 35 feet above the ground on three floors of a building caught *Culicoides* at each level in about equal numbers. These catches indicate that these midges may enter buildings at any average height whenever personnel are inside to attract them.

Culicoides were reported as annoying in family quarters from dusk until dawn, but were rarely encountered biting in the daytime except in dense jungle areas or on cloudy days. Thirty-minute catches were made throughout the night using adhesive papers in horse-baited trap 3 at Fort Kobbe. The activity of these insects varied little through the night.

Boards with adhesive papers attached to both the bottom and the top were placed in a horizontal position on stakes at different heights and set in the jungle (Fig. 5) in an attempt to determine the preferential resting places of *Culicoides* in the jungle. Three of these stakes (Fig. 5) were set and operated during 5 days in January, 1951. Two hundred seventy-eight *Culicoides* were captured on these boards 94% of which were taken on the adhesive papers mounted on the bottom

surface of the boards. The height of the boards ranged from 8 to 68 inches above the ground and there was no significant difference in the numbers of *Culicoides* captured at the different levels. A white cloth treated with castor oil was carefully draped over an area of ground litter to form a small tent. The leaves and dead twigs making up the ground litter were agitated and 8 adults were captured on the oil treated inner surface of the tentlike canopy as they arose from this material. The fact that *Culicoides furens* in this area preferably rest on the under side of jungle foliage and among the ground litter and are not generally disturbed when insecticides are applied as wet sprays, may explain why this method of control is rarely effective against *Culicoides* in this area.

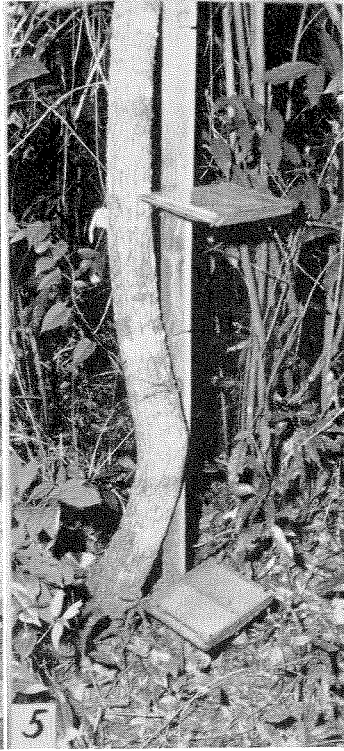
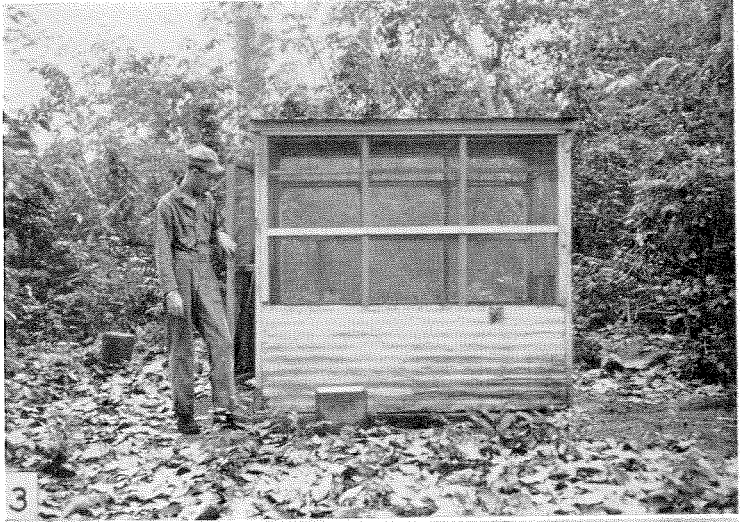
Color Attraction. Hill (1947) noted in England that when collectors wore light-colored apparel very few *Culicoides* would alight on them; on the other hand, when collectors wore dark clothes, great numbers would alight on their clothing within a few minutes. Hill then hung dark pieces of cloth on bushes and the adult flies were collected from them as they alighted. Kettle (1949) used black adhesive traps instead of white, as he says, to take advantage of the attractiveness of black to female *Culicoides*. Dorsey (1947) used lanterns with red, green, blue, yellow and clear globes on Peleliu Island to determine if one color were more attractive to *Culicoides peleliuensis* Tokunaga than another. He found that an intense clear light attracted more of the gnats than all of the other colors.

The writer compared castor oil treated adhesive paper traps of different colors in horse-baited traps with a white standard at Fort Kobbe. In all of these tests, the white papers proved to be superior to black, yellow, red or green papers.

FIG. 3. Horse-baited trap used for sampling *Culicoides* and mosquito populations at Fort Kobbe.

FIG. 4. Box containing boards and adhesive papers used for catching *Culicoides* in horse-baited traps.

FIG. 5. Horizontal boards mounted on stakes for determining resting position of *Culicoides* in the jungle. Each board has an adhesive paper mounted on both the upper and lower surfaces.



SUMMARY

Mud samples were collected and examined from 552 locations in Farfan swamp, near Fort Kobbe, for the purpose of locating the important breeding places of *Culicoides* in the area. Heavy breeding of biting midges was generally confined to low areas which were constantly saturated or covered with shallow water or were subjected to frequent flooding.

Castor oil treated papers set in horse-baited traps proved to be more satisfactory than light traps or hand catches for measuring densities of adult *Culicoides*. This measure is described in some detail and is presented as a new and improved method for sampling *Culicoides* populations in this area.

Data presented in this paper indicate that the *Culicoides* population in this area is extremely low during the dry season due to the limited areas suitable for continuous breeding of these insects. Following the onset of the rainy season in May the population gradually builds up until it reaches its greatest height between the period of late September through the end of December.

Light traps were valuable for capturing male *Culicoides* and for determining what species were in the area, but were not considered equal to horse-baited traps equipped with adhesive papers for population studies.

Observations made in the jungle near Fort Kobbe indicate that *Culicoides* generally rest during the daytime on the underneath surface of foliage and among the ground litter.

White adhesive papers proved better than either black, red, yellow or green for catching *Culicoides* in horse-baited traps.

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Salt Lake City in March!

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