

CULICOIDES BREEDING IN HUMAN SEWAGE SITES OF DWELLINGS IN TEXAS¹

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In 1955 a program was initiated to develop techniques for colonizing *Culicoides varipennis sonorensis* Wirth and Jones, a suspected vector of blue tongue of sheep. To facilitate collection of these insects, it became necessary to locate natural areas of heavy, concentrated breeding. Surveys were made of numerous types of environments in the vicinity of Kerrville, Texas. With one exception, the only breeding places that contained large numbers of *sonorensis*, sufficiently concentrated for rapid collection, were on ranches at the outlets of disposal systems for human sewage. Observations on the characteristics of these sites and the species breeding in them are presented in this paper.

GENERAL FEATURES OF BREEDING SITES. In this paper a human sewage site refers to the wet area at the outfall of a drain pipe from which water-borne human sewage or sewage effluent flows out onto the ground. In this type of site, the water disappears into the ground within a short distance of the outlet, owing to the relatively small amounts of water discharged, as these sites are associated with single dwellings for a few people.

Apparently many of these sites on Texas ranches are septic tank overflow areas or, possibly, disposal areas for fluid waste from sources other than the toilet, since raw, whole excreta were rarely noted at the drain openings.

Psychodids were always present in these sites. However, in areas of dense *sonorensis* breeding they were found in small numbers. In several sites that had very large psychodid populations, no specimens of *Culicoides* were found. Several sites of

dense psychodid breeding had a much heavier cover of algae than was found on good *sonorensis* sites.

The extent of the sites studied varied considerably, depending on such factors as the terrain, the rate of water flow, the porosity of the soil, and the amount of weed cover present. The area encompassed by each of the three sites of heavy breeding was 30 to 40 feet in length, with the first 10 to 20 feet consisting of a narrow ditch.

INDIVIDUAL SITES. (1) Edwards County, Substation No. 14, Texas Agricultural Experiment Station, human habitation, numerous observations from August 1955 to December 1957. This site apparently resulted from a septic tank overflow, as raw sewage was not evident at the drain opening.

Since there was no cover of weeds, the mud surfaces were exposed to direct sunlight. In 1955 this site consisted of a narrow, shallow ditch that led to areas of exposed mud 20 to 40 feet down a slight slope. These mud areas were surrounded by a very boggy carpet of Bermuda grass that was about 6 feet in width. Two large central areas, each 1 to 2 square yards in size, were completely free of grass and contained loose, brown, fine silt several inches in depth. Densest breeding occurred in these areas and consisted almost entirely of *sonorensis*, although a few specimens of *crepuscularis* were always present. In these two exposed pools the mud was never covered with water deeper than $\frac{1}{2}$ inch. Some mud protruded shallowly above the water in addition to the shallow mud banks. Much of this exposed mud had a moderate covering of algae.

The occurrence of culicoid breeding in this site was briefly described by Wirth and Bottimer (1956).

In a similar area close by, but completely

¹ The following personnel of the Kerrville, Tex., laboratory assisted in the work reported in this paper: H. M. Brundrett, R. R. Kott, M. O. Pickens, and D. E. Hopkins.

and heavily grassed, slight breeding of *sonorensis* occurred in the mud of the boggy turf in 1957. Moderate breeding had occurred prior to 1956 in a few small areas of exposed mud that at that time were not overgrown with grass.

(2) Gillespie County, ranch house, numerous observations from July through December 1957. Fresh human excrement was present at the drain opening at all times. This site ranged from about 30 to 40 feet in length and was free of weeds. The first 10 feet from the outlet consisted of a shallow ditch about 1 foot wide. There was considerable water present, with a pool about 6 inches deep at the drain's exit.

Some larvae were found in the fresh sewage at the drain opening, and they became numerous at the beginning of the black silt banks about 6 feet distant. Densest breeding occurred in these mud banks and in small areas of exposed silty mud in the moderately heavy carpet of Bermuda grass that began at the point where the main channel was diverted into several shallow flows. Later in the year, with an increase in the rate of water flow, heavy breeding became established farther down the gentle drainage slope in a shallow layer of silt that was heavily covered with algae.

As material used for transmission studies was obtained from this site, and therefore a large quantity of flies had to be carefully determined, an opportunity was presented to determine the sex ratio of *sonorensis* and the kind and number of other species present. Of the total of 10,421 specimens determined from randomly selected groups of flies that emerged over a 2-week period, 10,354, or 99.4 percent, were *v. sonorensis*, 61 percent of which were females. In addition, 65 specimens of *crepuscularis* and 2 of *haematopodus* were present.

(3) Kerr County, ranch hunting cabin, numerous observations from July 1956 through June 1957. Fresh feces were not evident at this site. It was ascertained that the fluid waste passed through a septic tank.

This site was about 30 feet long. The first 15 feet consisted of a moderately deep

ditch with a narrow muddy area at the bottom. The second 15 feet, where the ditch broadened out, was a flat, oval area well covered with Bermuda grass but interspersed with small muddy spots caused by the trampling of livestock. Cow manure was usually present in small amounts. This site was dry during the drought of 1955. In 1956 and the spring of 1957 the water flow was sufficiently strong for livestock to drink. A weed growth was not present in 1956. However, a heavy cover of weeds developed by June of 1957 and, because of the subsequent shading and reduction in water flow, heavy breeding no longer occurred.

This site was unusual in that it was not characterized by areas of loose, silty mud free of grass. Breeding was heavy in the intermittently muddy sod of the lower flat area and in the muck of the narrow upper ditch. Moderate to heavy breeding was found in 1956, and collections were made in May, July, and September. In 1957 moderate breeding was discovered on February 6, and heavy breeding was first noted on March 19. On this date thousands of larvae could be collected by merely scooping them from the clear water in the lower flat area where it was as deep as 1 inch. At this time larvae were also commonly noted in the shallow, clear, running water, maintaining a static position by swimming against the currents, above the mixture of leaves and mud contained in the narrow upper ditch.

This unusual activity of the larvae in the clear water was apparently the reaction of a high population to an inadequate food supply. This conclusion is strengthened by the fact that the size of collected full-grown larvae diminished during this 2- to 3-week period. Those collected in March were retained by a 50-mesh screen, but in April larvae ready to pupate passed through the 50-mesh screen but were retained by a 60-mesh screen. This lessening in size of collected full-grown larvae was believed to be a response to overcrowding, with the resultant scarcity of nutrients, as there was probably not sufficient time for a seasonal effect to take place.

On the morning of April 24, 1957, a 4+ inch rain fell very rapidly. As this site is close to the bottom of a shallow draw, it was covered by the swiftly flowing water to a depth of several feet and most of the larvae were swept away. However, about 2 weeks later a few full-grown larvae were found, indicating that some had survived the torrent, probably in the mud held in place by the sod.

Two collections of pupae were made to determine the number of each species present. In addition, a mud sample for laboratory emergence (March 4, b) was taken. Results are given below.

Date 1957	Total	<i>variipennis</i>		<i>crepuscularis</i>		<i>haematopodus</i>
		Total	♀ ♀	♂ ♂	♀ ♀	♂ ♂
February 6	100	96	—	—	4	—
March 4						
Sample a	91	91	53	38	—	—
Sample b	96	94	50	44	—	1

The occurrence of *sonorensis* breeding at this site was mentioned by Wirth and Jones (1957).

(4) Gillespie County, ranch house, July 1957. Fresh excreta were evident at the mouth of the drain. Moderately heavy breeding of *sonorensis* was found at the mud margins close to the drain opening. A cover of Bermuda grass was not present. Breeding was not found farther down the slope where there was a heavy growth of weeds. There was little silt at this site, and one moderately large collection of silt reduced breeding to almost nothing.

ABUNDANCE OF BREEDING SITES AND SEASONAL OCCURRENCE. Heavy-breeding areas of *sonorensis*, either small sites of dense breeding or large sites of moderately concentrated breeding, were not common in the Kerrville area during the last few seasons. A survey of ranches in midsummer of 1957 covered 69 sites that appeared to be suitable for breeding of this species. Of these, 26 were human-sewage effluent sites. One heavy and one moderately heavy breeding site were discovered, both human-sewage sites. Other sites had slight or no breeding of *sonorensis* at the time of sampling.

The time of year at which populations of *sonorensis* were heaviest was not ascertained, because large quantities of material were constantly being removed from the breeding sites for laboratory experimentation, but it was evident that population levels were lowest during the winter months.

ECONOMIC CONSIDERATIONS. Heavy, concentrated breeding of *variipennis sonorensis* was not commonly found on ranches, and most of the flies found on a ranch could be controlled easily by the treatment of one small site. Control at the ranch house could be very important, as this area is fre-

quently the pivotal point of ranching operations. On many ranches the animals pass through corrals near the house at least once a year in normal handling, and culicoid breeding in this area could well be a center of animal disease transmission.

An abundance of these flies breeding in human sewage close to habitations might also constitute a human health hazard. Although culicoid flies have thus far not been incriminated in the transmission of human disease in North America, it remains a possibility. Whitehead (1934) has shown that under outbreak conditions *variipennis* prefers livestock to man. According to Wirth and Jones (1957), P. J. Spangler found that in Missouri man is not a preferred host of *variipennis australis*. Wirth and Jones, the subspecies associated with saline environments.

Laboratory tests at Kerrville indicate that *sonorensis* is not host-specific. It readily engorges with blood from cattle, sheep, rabbits, and mice. In one test with a few flies, two females readily fed on the foot of a chicken. In a small series of tests, in which a Jersey bull calf, a ewe lamb, and the author as observer were confined in a cubical cloth cage with released flies, they

showed preference for cattle, sheep, and man in descending sequence. The author received 8 bites in comparison with 42 observed engorgements on the calf. Under certain conditions this species might constitute a health hazard to man, especially in the absence of a preferred host.

SUMMARY. Four good breeding sites of *Culicoides variipennis sonorensis* Wirth and Jones were found near Kerrville, Texas, three with a heavy and one with a moderate population. These sites were human-sewage disposal areas at dwellings, and were the result of allowing water-borne sewage or sewage effluent to flow out onto the ground. Two of these four sites were apparently created by septic tank effluent. The other two resulted from the discharge of raw sewage, as evidenced by the presence of whole excreta by the drain opening.

One factor associated with heavy breeding was the presence of a heavy carpet of Bermuda grass instead of weeds, with consequent exposure of the mud surfaces to direct sunlight. Larvae were not found in areas that were thickly covered with weeds. Breeding was heaviest in nonvegetated areas of exposed, silty mud, such as shallow banks close to the drain opening, and open pools of mud surrounded by the turf that carpeted the drainage slope.

At least small numbers of psychodids

were always present in association with *sonorensis*. A dense population of one apparently precluded a large population of the other.

Heavy-breeding sites of *sonorensis* were scarce in the vicinity of Kerrville. A survey of ranches in midsummer of 1957 covered 69 sites that appeared to be suitable for breeding of this species. Of these, 26 were human-sewage effluent sites. One heavy and one moderately heavy breeding site were discovered, both human-sewage sites. Other sites had slight or no breeding of *sonorensis*. Breeding occurred throughout the year, but population levels were lowest in the winter. Apparently *crepuscularis* and *haematoposus* usually occur along with large populations of *sonorensis* in these sites, but in such small numbers that their presence is frequently concealed by *sonorensis*.

References Cited

WHITEHEAD, F. E. 1932-4. Damage to livestock by blood sucking midges. Oklahoma Agric. Expt. Sta. Rpt., pp. 264-268.

WIRTH, W. W., and BOTTIMER, L. J. 1956. A population study of the *Culicoides* midges of the Edwards Plateau region of Texas. Mosquito News 16:256-266.

WIRTH, W. W., and JONES, R. H. 1957. The North American subspecies of *Culicoides variipennis* (Diptera, Heleidae). U. S. Dept. Agric. Tech. Bull. 1170. 35 pp.

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