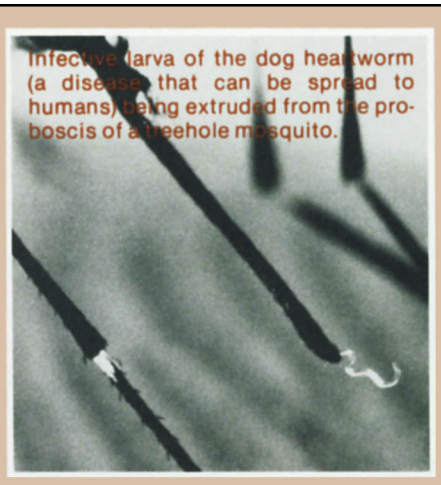
Treehole mosquito may spread canine heartworm

Richard Garcia

Clarence J. Weinmann



Infective larva of the dog heartworm (a disease that can be spread to humans) being extruded from the proboscis of a treehole mosquito.

Canine heartworm disease is becoming a major concern to dog owners in many areas of California. Although heartworm was originally believed to be a minor problem, recent information received from veterinarians and other sources indicates that concentrations of infection exist in several counties, mostly those in the hill and mountainous regions of northern California. They include El Dorado, Humboldt, Marin, Placer, San Mateo, Santa Cruz, Santa Clara, Shasta, Tehama, and Riverside counties. One veterinarian has reported an infection rate of more than 10 percent among local dogs, on routine examination.

Some 60 mosquito species have been implicated elsewhere around the world in the transmission of this exclusively mosquito-borne disease. California has at least a dozen of these species, two of which were recently discovered. One of the species studied, the western treehole mosquito (*Aedes sierrensis*), seems to be a particularly suitable host for development of this worm. This mosquito is common in most of the areas where heartworm has become a problem, survives as an adult for long periods, and readily feeds on canines.

Canines other than dogs may serve as reservoir hosts of the disease. An examination of coyote hearts from El Dorado County revealed a relatively high infection rate among the animals in that area. The adult treehole mosquito is abundant there and is a potential link in the chain of transmission between coyotes and dogs. Much further work is necessary before we can conclude with any certainty the precise vector or vectors involved in this disease, although the western treehole mosquito must be considered a prime suspect in the transmission cycle.

Richard Garcia is Associate Entomologist, Division of Biological Control, and Clarence J. Weinmann is Professor of Parasitology, and Helminthologist, Division of Entomology and Parasitology, University of California, Berkeley, CA 94720.

Encephalitis viruses persist in southern California

Telford H. Work

Although epidemic threats of *Culex tarsalis* mosquito-transmitted viral encephalitis have diminished during the last two decades in the Central Valley of California, some human cases have occurred in southern California. This may be the result of the changing way of life of a fast-growing human population and the extension of irrigation agriculture in the former Colorado Desert.

The elusive explanation of how virus transmission is maintained between encephalitis epidemics and during the winter led to research by the University of California, Los Angeles, Department of Public Health. Studies began in 1967 in the Imperial Valley to define the existence and year-round behavior of *Culex tarsalis* mosquitoes, carriers of the disease, and to determine the dynamics of any arboviruses being transmitted.

By 1973, it had been established that St. Louis encephalitis (SLE) virus appeared every year, and western equine encephalitis (WEE) virus occurred in most years in a water habitat bordering the Salton Sea. This same area supports winter transmission of California encephalitis viruses by *Culiseta inornata* mosquitoes. Turlock virus in *Cx. tarsalis* appeared intermittently, unrelated to season.

Intermittent appearance of viruses suggested that they were disseminated from a more central point. Intensive quantitative studies initiated in 1970 at Finney Ramer Refuge in the middle of the Imperial Valley revealed a location, which by 1976 was shown to produce SLE virus transmission by *Cx. tarsalis* every year by early June. Simultaneous studies of native cottontails and young steers at an adjacent feedlot eliminated these animals as a source of virus to mosquitoes. Appearance of WEE virus intermittently with substantial periods of absence indicated a different source and mechanism of dissemination, which is as yet undetermined. This difference was strengthened by serological epidemiology of a high-risk population of agricultural workers, through the Campesino Clinic in Brawley. Up to 12 percent of certain age and occupational groups had evidence of prior infection with SLE virus, while there was negligible evidence of WEE virus infection in any group tested. Actual occurrence of SLE cases since 1974 in persons exposed in the Imperial Valley supports the possibility of periodic transmission of the virus to man. (More detailed analysis is made in a doctoral dissertation by Martine Jozan, UCLA, 1977, demonstrating that life-long residents of the Imperial Valley have been infected with SLE.)

Quantitative studies initiated at Finney Lake in 1973 established that the dynamics of *Cx. tarsalis* vector mosquitoes was consistent and predictable during three subsequent years. *Culex tarsalis* was active every night of the year, with low maintenance populations during the cold months of December, January, February, and March. By April, trap-night yields rapidly increased until late June, when a mean maximum temperature of 110° F and decreased relative humidity below 20 percent resulted in a population crash. By this time, SLE virus infection rates were significant. A substantial mosquito population was maintained in July and August with persistence of SLE infection, followed by a secondary population increase with continued SLE

Biology, and

Research on mosquito biology and ecology yields fundamental knowledge of the behavior, habits, breeding preferences, flight range, survival rates, and other characteristics of pest and disease-vector mosquitoes—information essential for effective planning and execution of control programs. Ecological studies assume greater importance in California than elsewhere because of the state's diverse climate and topography. Forty-nine mosquito species are found here, of which six are confirmed disease vectors.

Carbon-dioxide light trap is used, along with other baited traps, to collect mosquitoes in studies of virus transmission.

virus transmission in the cooler months of September, October, and November.

The other abundant mosquito, *Culex erythrothorax*, fed on man but was virtually devoid of either SLE or WEE viruses, indicating that this species had no role in arbovirus transmission. Capture of *Culex pipiens quinquefasciatus* occurred only occasionally, showing that the habitat was unsuitable for this vector species.

Blood studies of adjacent feedlot cattle, a large native population of cottontail rabbits, and other wild mammalian species established that mammals played virtually no role in providing virus to *Cx. tarsalis*. The question of whether persistence of SLE-virus-infected populations of *Cx. tarsalis* for more than six months resulted from low-level cycling or survival of the early summer adults has not been resolved.

Two questions emerged from this research. First, what mechanisms resulted in periodic predictable reintroduction of SLE virus into the Finney focus? Second, from what vertebrate species did *Cx. tarsalis* obtain the virus?

Failure to catch *Cx. tarsalis* more than 100 meters from the vegetation associated with the Alamo River drainage in sufficient numbers to examine for virus suggested that the courses of the Alamo and New rivers, originating in Mexico and emptying into the Salton Sea, may be a conduit for the vertebrate-vector cycle of introduction from a permanent source further to the south—possibly not far away.

To examine the hypothesis, a sample area was staked out along the New River from the Mexican border 15 miles to the northwest. Light traps were placed at 1-mile intervals. Monthly collections (more frequently in warmer months) in 1976 and 1977 confirmed that virus appeared along this course. Simultaneous collections at Finney established a preliminary impression that SLE virus appeared in the Finney focus later. This was definitely established for WEE viruses in 1978.

Being an effluent outlet from Mexicali, the New River proved to be a favorable habitat for *Cx. p. quinquefasciatus*. The carbon-dioxide-baited mosquito light trap is not very useful for collecting *Cx. p. quinquefasciatus*. However, some pools caught in these and pigeon-baited lard-can traps yielded SLE virus.

With the appearance of sporadic human cases of SLE, most recently recognized in Mexicali, the evidence of human SLE infection in the Imperial Valley, and isolations of SLE from local populations of *Cx. p. quinquefasciatus*, the next problems to be solved became clear. Only when we establish mechanisms for annual reintroduction and movement along the Alamo and New rivers, the avian sources of virus to *Cx. tarsalis* mosquito vectors, and the crossover locale into local *Cx. p. quinquefasciatus* mosquitoes can effective control and preventive measures be defined.

More effective disease surveillance is needed, and some answers to these questions lie south of the border. Continued support of mosquito research in California can also lessen the threat of mosquito-borne virus disease in the state's richest agricultural domain, which is also becoming one of its most important recreational regions.

Telford H. Work is Professor of Infectious and Tropical Diseases, University of California, Los Angeles, CA 90024.