Culex tarsalis
History, Biology, Ecology, Public Health and Control

Excerpt from: National West Nile Virus conference call July 10, 2002
Presented by Dr. Bill Reisen

1. **History**
    a. **WEE - Early 1930s:** Not much focus until Meyer et al. 1931 isolated WEE from the brain of a sick horse during a large epizootic in the Central Valley -- 6000 cases with 50% mortality rate. Transmission accomplished using Aedes mosquitoes. First human involvement found when WEE isolated from the brain of child by Howitt in 1938. Epidemiological studies indicated WEE was a rural illness among the young.
    b. **SLE - 1933:** Epidemic in St Louis with >1,000 human cases. Distribution indicated possible Culex involvement.
    c. **Reeves, Hammon, et al. 1939-42** investigated an outbreak of encephalitis in Yakima Valley and soon found that both WEE and SLE were involved, Cx. tarsalis was frequently infected, and a large variety of vertebrates had Nt antibody including 15% of the wild birds. In lab birds produced an elevated viremia but survived infection. Cx. tarsalis was infected and able to transmit virus per os.
    d. **Hammon and Reeves 1943-65:** rapidly confirmed findings in Yakima.

2. **Biology:** reviewed by Reisen and Reeves in Reeves (1990) Epidemiology and Control of Mosquito-Borne Arboviruses in California, 1943-1987.
    a. **Taxonomy:** subgenus Culex of the genus Culex and is distributed through NA from Canada into Mexico and from the West to the East coast. Most abundant in western agroecosystems and wetlands.
    b. **Seasonality:** varies with latitude; unimodal late summer in Canada to unimodal winter abundance in Mexico/southern Texas.
    c. **Diapause:** Similar to *Cx. pipiens,* over winters as inseminated, nulliparous, unfed females in a photoperiod induced and temperature maintained winter diapause. Enters diapause in when light decreases to less than 12:12 light:dark and terminates after winter solstice. The time of emergence and host-seeking related to cumulative heat and occurs in December in SE California, January in San Joaquin Valley, February in Sacramento Valley and April/May in Colorado. Interestingly, females remain active during winter, feeding on sugar, but do not develop their ovaries beyond the resting stage. .
    d. **Host selection:** Early in spring feeds predominantly on passeriform birds. As abundance increases during summer host range expands to include other birds, mammals including rabbits and domestic animals, and humans. Therefore, can function as both enzootic and bridge vector.
    e. **Larval habitats:** Gravid females search for newly created sources with high primary productivity related to nutrient release associated with vegetative decay. After new sources stabilize, oviposition declines unless source is enriched or shoreline is altered. Types of habitat vary immensely from peridomestic sources to pasture and other flood irrigated crops to wetlands.
    f. **Autogeny:** If reared at warm temperature under uncrowded conditions with ample food, some females can develop the first batch of eggs without a blood meal within 4 days of emergence. Genetically controlled and dominant autosomal trait.
    g. **Mating:** Pairing can be seen at male swarms at dusk. Usually few males mate during each evening, but practically all females are inseminated within 1-2 d after emergence.
3. **Ecology**
    a. **Dispersal:** Mark-release-recapture studies have shown population disperses at the rate of about 1 km/day after release. Marked females have dispersed downwind

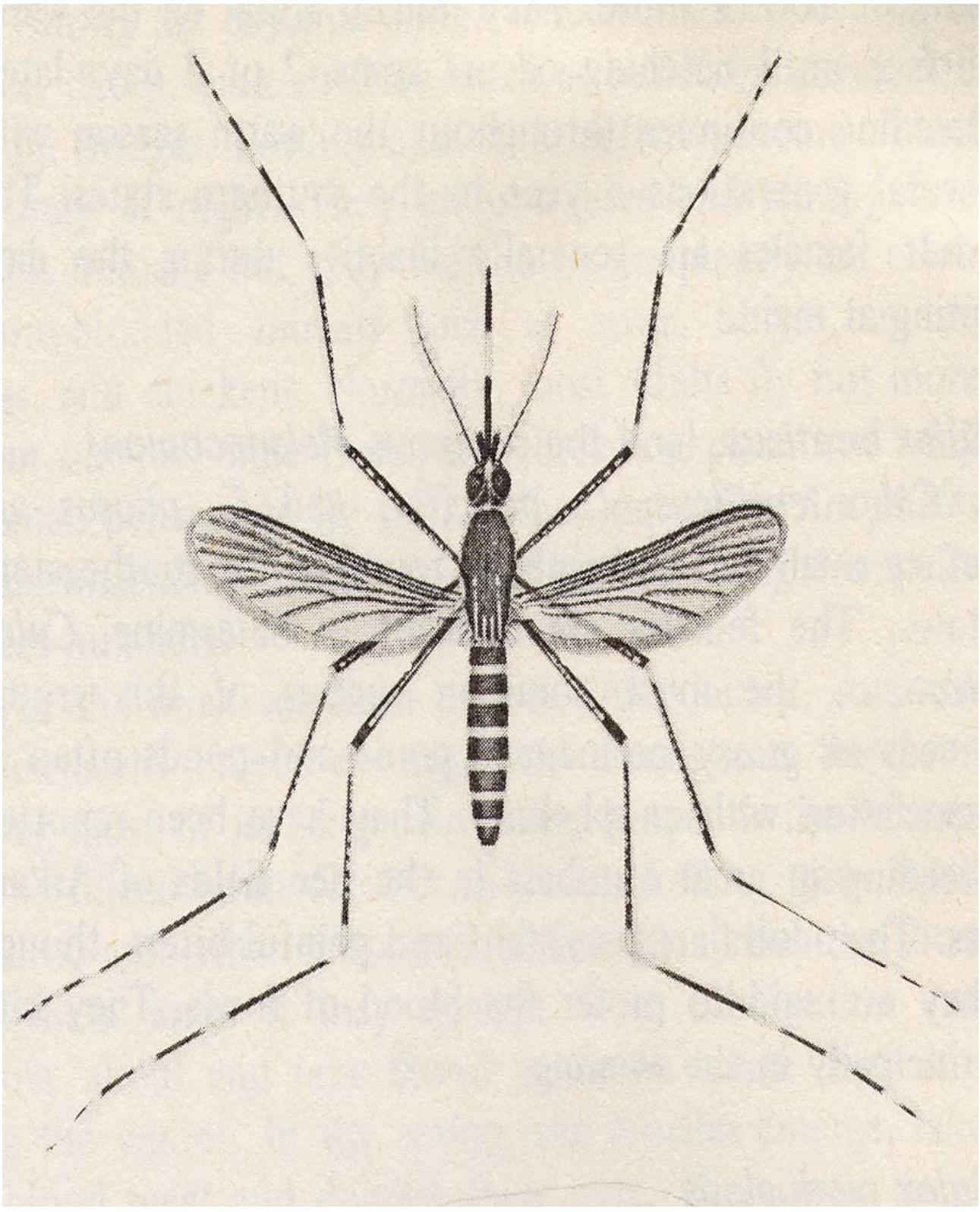
along riparian corridors up to 22 mi. We have recaptured marked females 6 mi on night of release.

b. **Dispersion:** Clumped at upland vegetative ecotones. Host-seeking females congregate along the edge of orchards, riparian corridors and woodlands, but are rarely collected over low vegetation, sand spits or open water.
c. **Survival:** Mark-release-recapture estimates approach 80% per day, but decrease about 1% for each 1C rise in temperature. Losses here include emigration.
d. **Gonotrophic cycle:** Duration >4 days, with little refeeding on the night of oviposition.

4. **Public Health Significance.**
   a. **Field infection:** Frequently infected with arboviruses with an avian reservoir including WEE, SLE, Turlock and Hart Park.
   b. **Vector competence:** Efficient laboratory vector of WEE and SLE. Well studied by Hardy, Reeves and colleagues and found to vary markedly over time and space. Competence limited by gut infection and escape, dissemination and salivary gland infection and escape barriers. Gut infection barrier most frequently studied using the media virus doses necessary for 50% infection [ID50 value]. WEE ID50 varies up to 3 logs over time, being highest or most resistant to infection during midsummer when virus is most actively transmitted.
   c. **Host selection:** Feeds most frequently upon upland birds that roost and nest at elevated vegetative ecotones. Our studies indicate that house finches, house sparrows, doves and quail are most frequently infected. Females frequently feed on chickens exposed in wire mesh cages and sentinel chickens provide the most sensitive and cost effective method of monitoring enzootic transmission activity.
   d. **Surveillance:** Readily sampled by dry ice-baited CDC style traps with catch greatest at vegetative transitions. They are phototactic, but sensitivity limited by background illumination.
   e. **Epidemiology.** Elevated abundance, good dispersal and survivorship, avian dominated host-selection pattern and enhanced susceptibility to infection makes Cx. tarsalis the primary enzootic vector of both WEE and SLE throughout the west in both rural and urban habitats. In LA there has never been an increase in SLE activity without Cx. tarsalis involvement. Cx. tarsalis also may function as the bridge vector to horses and humans as well as to seed virus into secondary cycles involving Ochlerotatus and rabbits or other Culex such as quinquefasciatus and stigmatosoma and birds.

5. **Control.**
   a. **Larvae:** Control programs in California focus on the surveillance and control of immature stages. Operators search potential larval habitats on a 10-14 d cycle and treat with BTI. Other compounds include BS, Altocid and in some instances Golden Bear oil.
   b. **Adults:** Done only in a health emergency, when there is large scale larval control failure, or when the size of the larval habitat is excessive [eg., rice growing area in the Sacramento Valley]. Most frequently adult control is by ULV using ground equipment applying either Pyrethrum or Pyrethroids. Resmethrin and Sumithion also have been used.

6. **West Nile**
   a. **Vector competence:** Studies by Goddard et al. have shown that Cx. tarsalis is the most susceptible California mosquito to infection, followed by Cx. pipiens and Cx. erythrothorax, then Ochlerotatus, Aedes and Culiseta.
   b. **Rural ecology:** Cx. tarsalis may be the most important species
   c. **Urban ecology:** Cx. pipiens/quinqe. Could be most important because of enhanced numbers and catholic feeding habits.



Culex tarsalis